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SYLLABUS

MANAGEMENT OF TELECOMMUNICATION SYSTEM

Course Contents

Role of Telecommunications; Effects of technology and scale on cost of service, Organisation, management and financing in Telecommunications; Global and domestic competition in Telecommunication; telephone access and use; characteristics of telephone subscribers, use of business and residential telephones, use of public call office telephones, Telecommunication tariff policy, Mobilising resources for expansion, Impact of Telecommunications on rural development, organizational studies of BEL, C-DOT, and Telecom Commission.

CHAPTER 1 TELECOM MANAGEMENT —OPERATIONS

NOTES

★ STRUCTURE ★

1.0 Learning Objectives
1.1 Introduction
1.2 Management System
1.3 Basic Process Part
1.4 Handling of Virtual Private Resources
1.5 TMN Functional Areas
1.6 Service Management
1.7 TM Operations from a Roce Perspective
1.8 Customer Care and Data Warehousing
1.9 Security Management
1.10 QoS Management
1.11 Terminal Management
1.12 Access Network Management
1.13 Management of Layered and Serial Interworking
• *Summary*
• *Review Questions*

1.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- describe the task of management system.
- discuss about the network elements, managers and agent.
- differentiate between fault management and security management.
- define the customer care and data warehousing.
- know about the terminal management.

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1.1 INTRODUCTION

The aim is to take a final step in acquiring a holistic and consistent view of the subject. Unfortunately, the telecom management area often gets less attention than it deserves. A reason for a holistic approach is that the extensively segmented network demands a subsequent integration to produce income. End users and telecom businesses need single, predictable and reliable network behaviour. An important requirement is to integrate segment behaviour into an end-to-end behaviour. Telecom management fulfils the wanted role as a network integrator, laid down in fundamental technical plans or similar rules. Telecom management allows configuration of the network and control of the network elements, as well as its overall behaviour, supporting the fulfilment of the business plan targets. Among the targets are conditions set and agreed between end users and the operator for service provisioning, activation of the required services and billing. (See Figures 1.1, 1.2 and 1.3).

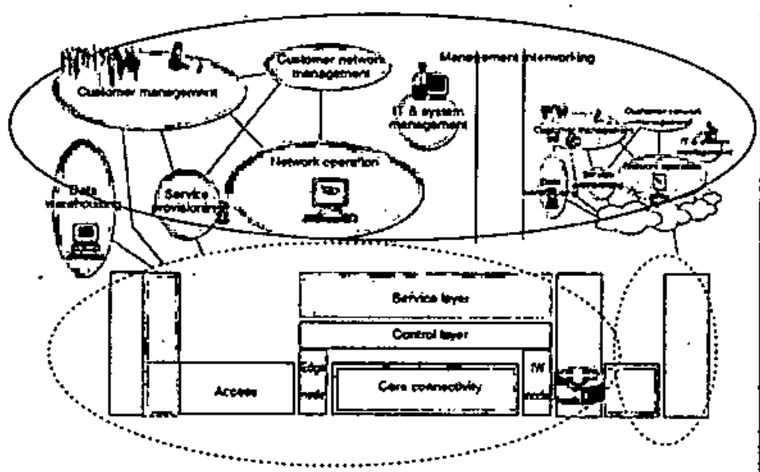

Fig. 1.1: Position of telecom management — Operations

1.2 MANAGEMENT SYSTEM

The modern management structure is shown in Figure 1.4.

The Task of the Management System

There is a close relationship between management and the control performed in the traffic system. Management acts on a general basis (fixing policies or general directives), while control acts case by case and in real time. With increased personalization we will also see more of individual management.

A Brief on History

Two technically different management approaches have developed during the last decade. They address mainly the basic structure and data interchange within the emerging management network.

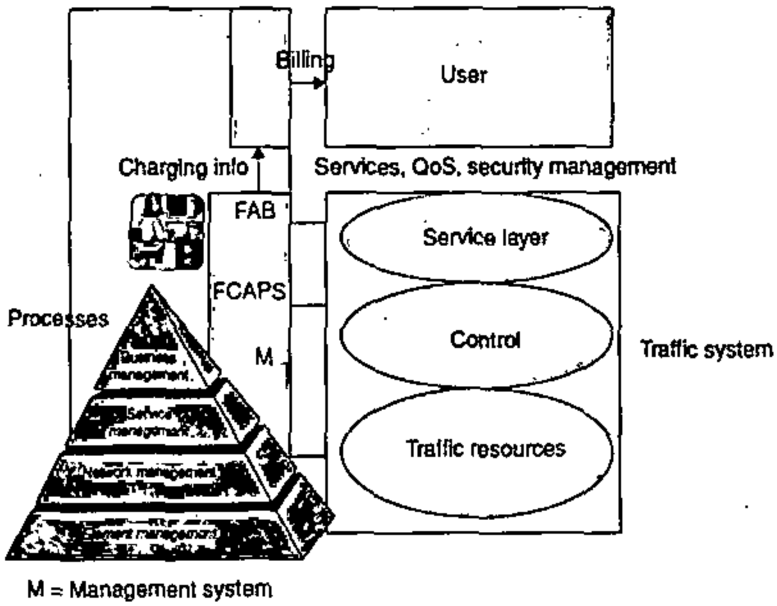

Fig. 1.2: *The focus moves to a management system and management processes*

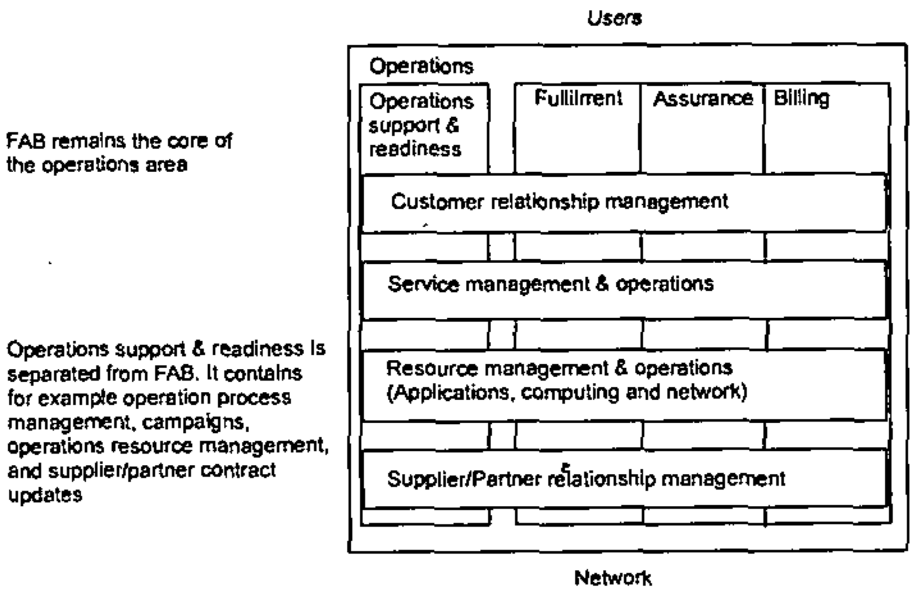

Fig. 1.3 : The TM operations area

From the telecom side the need to concentrate and standardize many different types of management systems into an integral network management became apparent. The business side put forward a requirement to cope with the increasing operational costs derived from network expansion.

On the data side the explosion of Internet networking caused a tremendous expansion on the networks that brought many of them close to collapse. The network administrators needed *solutions to smoothly adapt the* networks to the pace of expansion.

Telecom: ITU-T developed the TMN concept (telecommunication network management). TMN is based on an OSS (operation support system) platform. It has a hierarchical structure based on two nodes levels, the OMC (operation and maintenance centre) and the NMC (network maintenance centre). The OMC takes care of the direct management of the network nodes, called network elements (NEs), while network configuration, performance data, alarm and traffic statistics are managed by the NMC. Several OMCs may exist in large networks to regionally distribute the NE management. There is usually one single NMC. Additional centres have lately been introduced for service management and enterprise management. The ITU-T defined the Q3 interface based on the SMI model (structure of management information) and a group of ISO standards like CMIP (common management information protocol) for manager–agent communication, and FTAM (file transfer access and management).

The NE agents and the central manager communicate by means of a network called DCN (data communication network). For DCN the fairly secure X.25 technology was proposed.

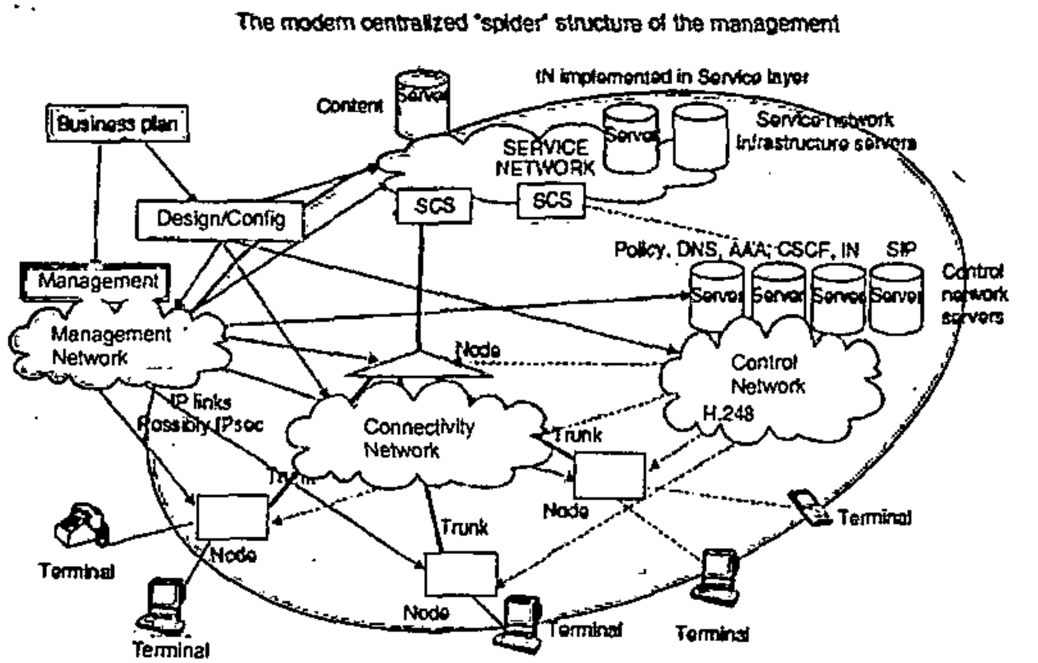

Fig. 1.4: The management network applied to the network element

TMN is a detailed model that has not become fully implemented. This is partly due to the strong advance of IP technology and the progressive obsolescence of X.25 networks, making IP a better solution (but less secure) for the DCN communication. The telecommunication management communication normally utilizes a specific telecommunication management network. This could be illustrated by means of the telecommunication management network model in Figure 1.5.

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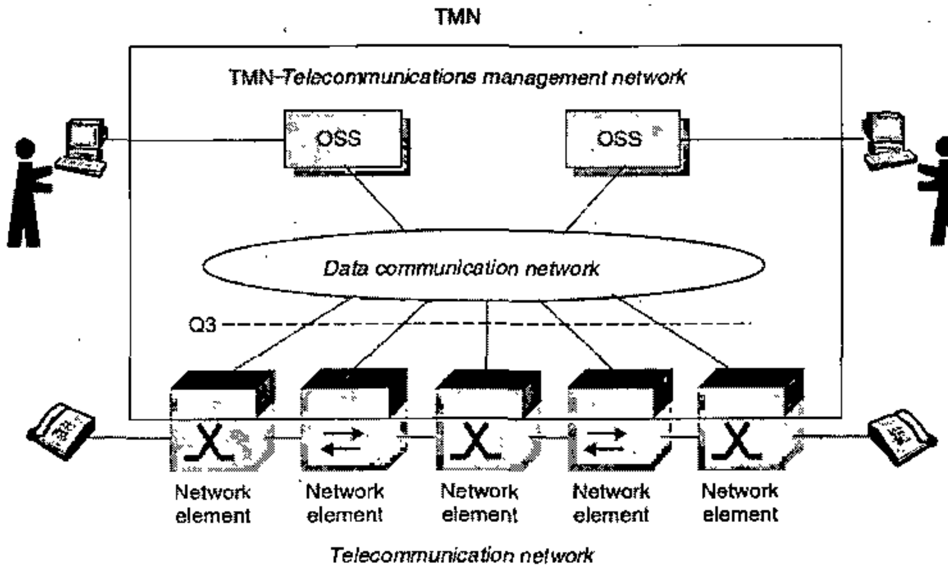

Fig. 1.5: An illustration of the TMN model (OSS: operation support system)

Datacom: Within the IP environment a flat management structure was used, based on the SNMP protocol for agent–manager communication. No intermediate hierarchical levels were devised. The communication was based on the TCP/IP protocol suite with FTP (file transfer protocol) for file transfer. IP standards based on inherent network topology learning capabilities became a main tool that gave relief to the network administrators. Much of the traffic routing activities then became autonomously handled by the network elements by means of dynamic configuration.

A rather interesting paradox is that TM network technologies (data communication network, servers, etc.) strongly evolve towards IP, while the system structure becomes closer to the hierarchical TMN (OMCs and NMC) mainly due to the increasing size and diversity of managed networks. A short summary of terms associated with both approaches on management is given below:

Enablers and Terminology

TMN — Telecommunications management network

NMS — Network management system

NMC — Network management centre

OMC — Operation and maintenance centre

OSS — Operations support system

NE — Network element

ITU–T = International telecommunication union-telecommunication

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MO — Managed objects

SMI — Structure of management information

MIT — Management information tree

CMIP — Common management information protocol

FTAM — File transfer access and management.

'Internet' Standards

NEs, managed objects and MIT (as for TMN, but Q3 interface usually not mentioned)

SNMP — Simple network management protocol

Web protocols – HTTP (Hyper text transfer protocol) and HTML (Hyper text mark-up language)

FTP — File transfer protocol

LDAP — Lightweight directory access protocol

RADIUS — Remote access dial in user service

L2TP and L3TP — Label 2/3 tunnelling protocol

IP security.

Standards from IT Industry

CORBA — Common object request broker architecture

EDI — Electronic data interchange

XML — Extensible mark-up language

SSL — Secure socket layer

SQL — Simple query language.

Network Elements, Managers and Agents

When talking about TM we are referring to managed networks. Managed networks consist of a number of network elements or *managed devices* and a manager. Managed devices collect and store management information for the centralized management entity or manager (TM system). They can be routers, access servers, switches, cross-connects, computer hosts, etc.

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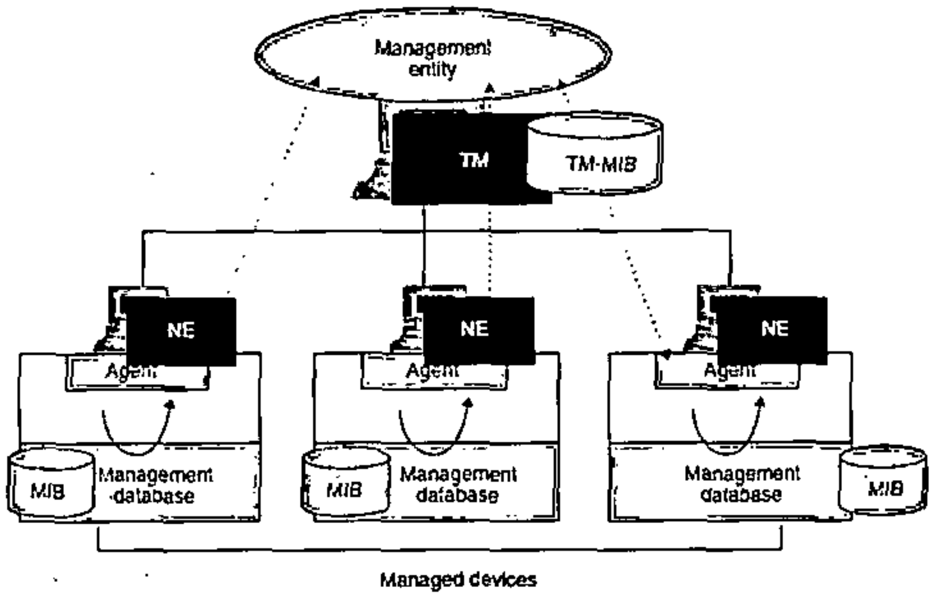

Fig. 1.6: TM basic structure

Each managed device has an agent. The *agents* are software modules residing in a managed device that handle local management information within the device. Managed devices can contain several managed objects. Hardware, configuration parameters and statistics can be *managed* objects, if referring to the IETF definition. Managed objects are directly related to the operation of the device. They are arranged in a virtual information database called a management information base (MIB). See Figure-1.6. The manager or management entity executes applications *monitoring and controlling managed devices*. Management entities provide most of the processing and memory resources required for network management. C++ is used for 'agents' and 'managers' programming. CORBA is a standard for 'managed object' definition and all-to-all manager–agent communication. It is well suited for distributed systems running on different platforms (even written in different languages).

This feature opens the possibility to integrate different vendor equipment and management systems in a managed network. CORBA has a drawback, though: the managed object definition is not fully compatible with TMN and IETF definitions. CORBA can be seen as a 'software bus' used by clients and servers. All CORBA objects are described in an interface specification enabling other objects to communicate with them. It is used in OSS components handling traffic measurements, charging etc.

SNMP is a very simple protocol. It has a short list of commands, which basically are only read or write. It is used just for communication or data interchange between the managed objects in the management information base and the management entity (or manager). The job to translate the information set on the MIB into commands for the NEs or reports for TM, is performed by agents and manager, respectively.

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TM Network Structure in the Distributed Dimension

Technically, TM extends all over the network like a spider, collecting charging information and information about the traffic conditions through agents and information databases.

Configuration and corrective commands are sent in the reverse direction. The fundamental technical plans are a guiding tool. Updated subscriber data is sent to servers/databases. See Figure 1.4. The basic management structure based on managers, agents, managed objects and MIBs, was simultaneously adopted both by IETF and ITU-T, during the early 1990s. This network model might induce one to think of a flat management network, without intermediate levels. As a matter of fact, this was the initial approach in the IP world, and still endures to some extent today.

As mentioned, technology convergence is leading to bigger IP-based telecommunication networks but with hierarchical network structures (such as in TMN). The move towards IP in management communication is both the result of the Internet and packet switching success and improvements in IP security.

The UMTS management network in Figure 1.7 illustrates this evolution. It has three different network management systems at sub-network level (radio access, core network and legacy GSM network). A simple management structure of a GPRS network is shown in Figure 1.8.

TM Internal Architecture in the Layered Dimension

The architecture can be presented as divided in three layers as shown in Figure 1.9.

1. The **presentation layer** takes care of the interface with the operator providing a user-friendly environment and easy network-handling capabilities. Internet presentation technologies are used, with Java included to support application portability on different IT platforms.

2. The **service layer** is responsible for the real interaction between manager and agents through the scheme command issuing or managed object parameters setting, and events or statistics collection. SNMP, CORBA and C++ have been explained before.

3. The **information layer** performs the administration of the manager and NE's management information base. SQL (simple query language) is a typical database administrator.

LDAP handles the secure access to the databases and to the system and JDBC (Java data base connectivity) handles databases via Java coding.

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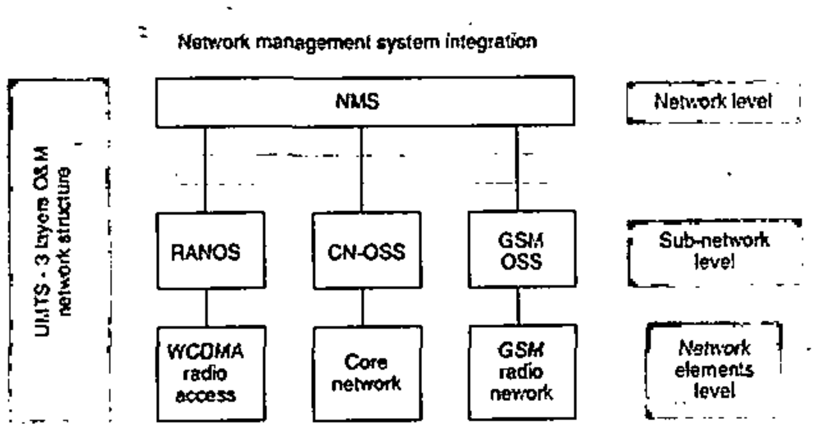

Fig. 1.7: Example of management structure of a 3G system (RANOS: radio network operation system)

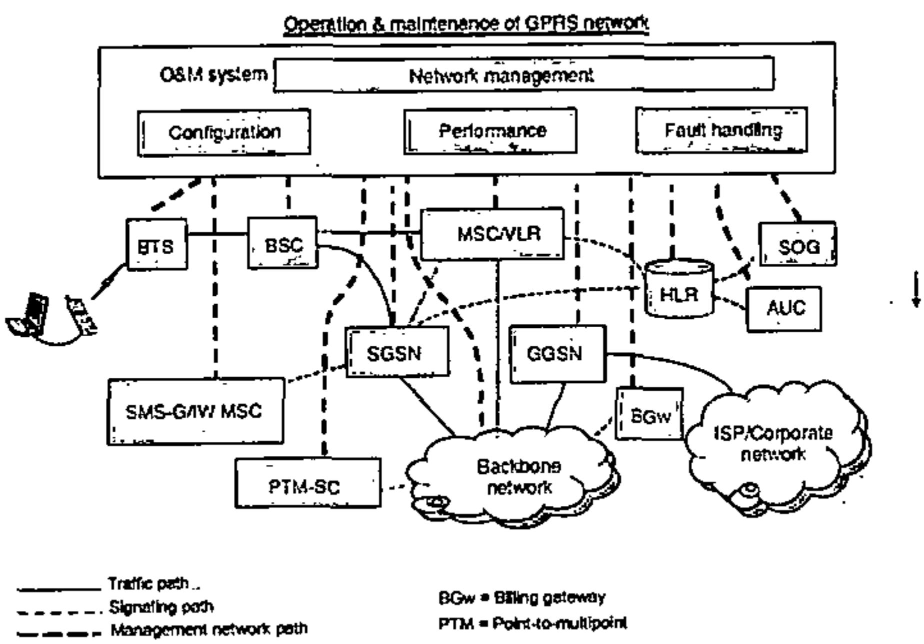

Fig. 1.8: *Management structure of a GPRS system, also showing some different types of management processes*

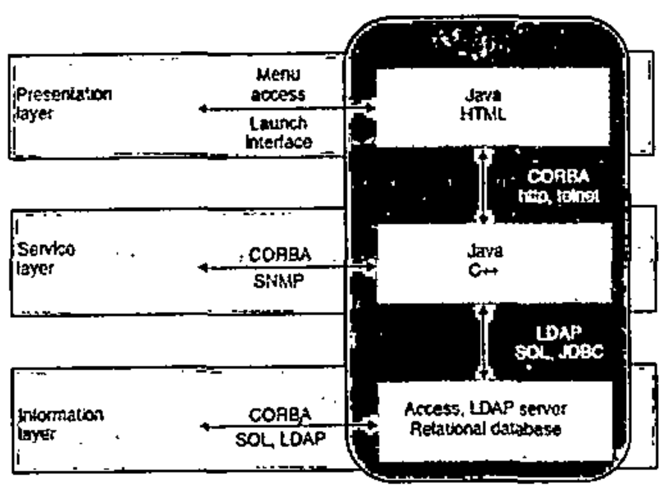

Fig. 1.9 : TM architecture including some enablers

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The *overall goal* of the TM operations area is business oriented. ROCE, ROI, revenue, CAPEX and OPEX represent such goals. The target is to manage the network for the best ROCE or ROI. The ROCE impact is substantial, indeed, since TM is costly.

Organizational matters are not considered here but a significant congruence between organization and the traffic system is certainly valuable. The processes are a crucial part of TM. The Telemanagement Forum, the TOM and ETOM processes and the

1.3 BASIC PROCESS PART

Processes play a very important role in defining, establishing and handling telecom management. Analysis, descriptions and management of processes pave the way for the introduction of IT support aids and applications that are becoming an integral part of modern telecom management systems. The contribution of the process approach may be summarized in the following points:

- Both customer satisfaction and telecom business greatly benefit from a clearly defined process environment, which also allows continuous improvement.
- The processes guide the operator's personnel, preventing damages derived from wrong operation or lack of knowledge. They provide an environment more independent of single personnel experience and expertise.
- The processes deliver continuous and clearly defined measurements on effectiveness and QoS, and provide proven methods for continuous improvement.

See Figure 1.10. The traditional heading of a chapter like this one used to be 'Operation and Maintenance' or possibly 'Network Management'. However, the scope has increased to embrace areas such as service management, customer/end-user management, business impact, management interconnection and much more.

The chosen heading 'Telecom Management – Operations' is a way to retain the word 'management' in the title. Telecom management as such without the elucidation operations' might also be interpreted in a wider sense.

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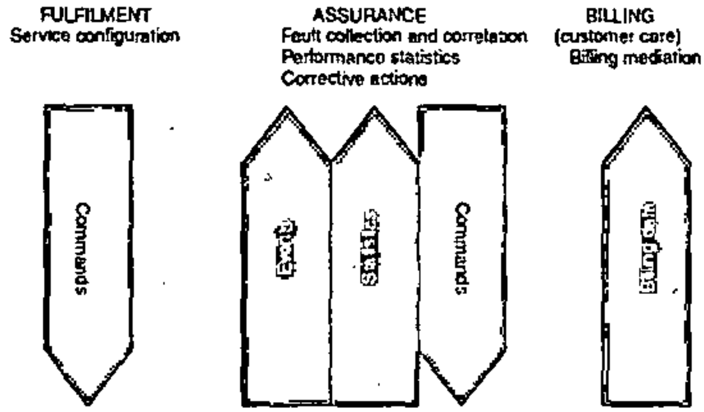

Fig. 1.10: The main tasks within the TM area – the FAB operations

The ETOM (enhanced telecom operation map) corresponds to a wider approach. It includes the:

- operations area
- strategy, infrastructure and product (SIP) area
- enterprise management area.

The operations + SIP interpretation of telecom management corresponds roughly to the complete process cycle shown in Figure 1.11. Observe the considerations on investments regarding *new or existing type solutions.* When referring telecom management to reference models in the book, operations proves to be interface oriented. See the slightly darker *area of Figure 1.12.*

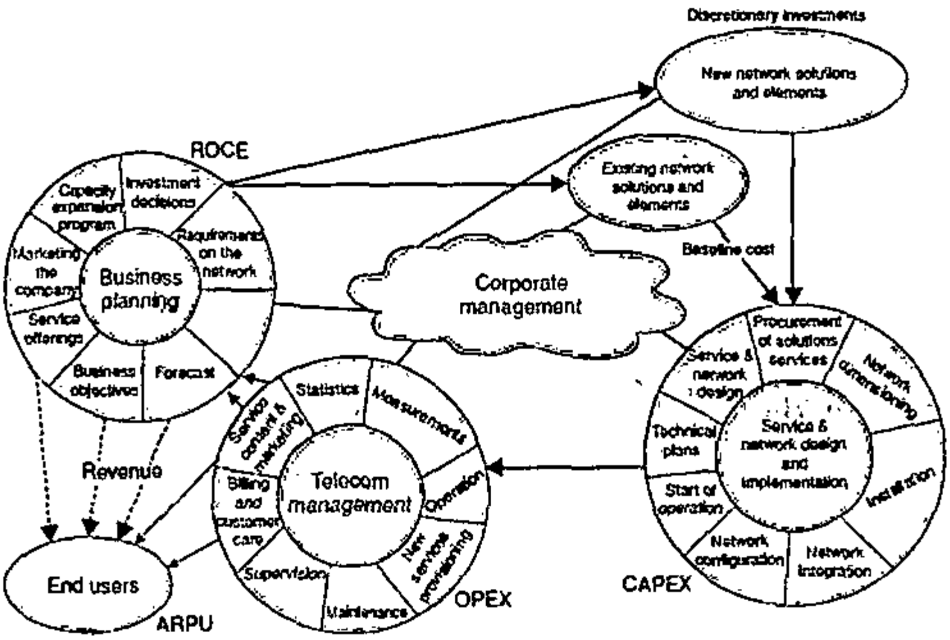

Fig. 1.11: Telecom actor process cycle example

Overall telecom management interfaces like FAB, service management, network management, investments, QoS, and SLA are treated in this

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chapter. As related to telecom management, investments may need further clarification. In the view adopted in this book there are two kinds of investments: discretionary cost concerning new techniques or technologies introduction, and baseline cost (single network expansions). Only baseline cost belongs to telecom management. The ultimate management–network interface is sometimes called the Q3 interface. The brighter elliptical area of Figure 1.12 is more internal. It falls roughly within the SIP area.

Regarding the interfaces, there must be a dialogue with the end users in order to sell, deliver, maintain and charge services with sufficient end-to-end QoS, security and vailability, at attractive prices. The potential of new services in the new systems (including the service network) must be taken care of to increase the income. Marketing will play a key role here.

Towards the network telecom management becomes clearly dependent both on technologies used in the network and in telecom management systems. There must be a dialogue with the network in order to configure, upgrade, activate services, and to get information such as alarms, billing information, network load and statistics. This dialogue costs money in staff and in a management network. It requires control possibilities and agents in the traffic-handling network elements. The brighter elliptical area of Figure 1.12 is more internal. It falls roughly within the SIP area.

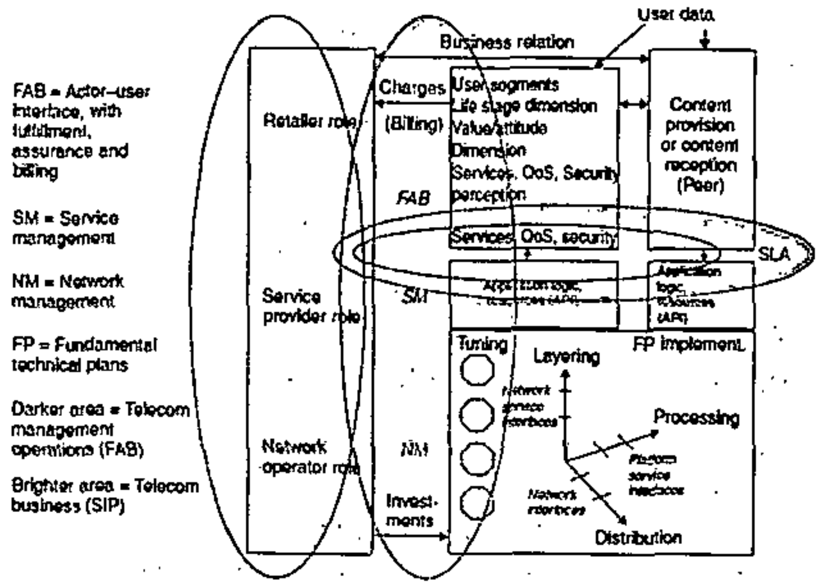

Fig. 1.12: The main TM operations area in relation to one of the reference models

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1.4 HANDLING OF VIRTUAL PRIVATE RESOURCES

Within an overall network run by an actor there are normally a number of resources which belong to, or are reserved for corporate intra-company networks. Common solutions are Centrex, call centres leased lines and virtual private networks based on IP (like the intranets).

The enterprises have natural reasons to take care of the business critical areas themselves, such as competition between the end users (in this case the enterprises). What areas are considered business-critical depends on the enterprise, but they might include streamlining the connections, managing a call centre and monitoring things like the QoS or the call-completion rate.

Therefore, large enterprises may need to control these resources in the same way as the operator. See also customer network management in Figure 1.1. Summing up, the ability to create effective, highly automated processes for operation and service delivery, together with a pragmatic approach to technology choices is crucial.

1.5 TMN FUNCTIONAL AREAS

The TMN functional area segments follow the well-known network management model from ISO. The management functions are frequently known by the acronym FCAPS, which refers to:

- Fault management
- Configuration management
- Accounting
- Performance management
- Security management.

Fault management covers all the necessary functions to show the network fault status in real time. It is known that a fault originating in one network element may lead to an avalanche of alarm indications. This is due to the incidence the original fault has on other network elements. In spite of working properly, they are not able to carry traffic due to the original fault, and therefore they are detected as faulty. For instance a transmission repeater fault may lead to fault indications at different levels on the transmission system, a rather high number of declared faults on associated routes, and also fault indications on switching devices utilizing those routes. The process through which the original fault is obtained from a rather high number of alarm indications is called alarm (or fault) correlation. Alarm correlation becomes more complex with network heterogeneity and increased number of network elements. Some systems have the possibility to learn from previous network faults experiences and from network expert indications, to improve alarm correlation. Suppression of secondary alarms is a recognized method. Fault management has advanced alarm correlation tools, which allow the operator a better understanding of the real alarm situation, and leads to shorter times for service recovery and fault repair.

Performance management portraits the network performance through diagrams and reports, either standardized or specially selected by the network administrator. The network status in each moment is usually compared with the performance corresponding to some level of network activity defined as a reference.

This reference consists of the network status when working without network element's faults and with normal traffic conditions. The reference is often mentioned as the 'network baseline' or the 'network normal condition'. Also comparison of the network status with the baseline raises alarms when the measured traffic or workload goes over certain threshold values, defined by the network administrator.

In this case, alarms are emitted to alert the network operator about abnormal traffic conditions. This information permits the operator to act in advance to any possible problem. The operator can then utilize the network management tools to solve or mitigate the congestion and its associated effects, or eventually plan new network expansions before the situation becomes critical.

Performance management is a key function to verify end-to-end QoS and network availability to the end user. It is extensively used to verify SLA compliance and to detect and measure possible SLA deviations. It also provides information about network performance and congestion levels, allowing fault detection. Finally it facilitates network re-engineering, monitoring on network element life cycles and network capacity supervision. All this gives the necessary input to future building and implementation activities, both for decision making and design.

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Billing mediation or accounting management take care of the collection, buffering and delivering of information from the network elements or call control servers, either for billing or accounting purposes. Accounting management could be illustrated by means of an international call. If a Swedish subscriber calls a friend in the UK, the Swedish operator sends the bill and gets the full income. However, the call has also passed the network of the British operator, and it may even have been transited through networks belonging to other operators. The call income must then be shared among the operators involved. This is called accounting. How the money is shared is strictly defined by interconnection agreements. The accounting management takes cares of data collection in order to produce the call accounting and assist the income distribution among the different operators, either through accounting determination or checks.

Configuration management and corrective measures are downstream functions, based on command execution. The previous functions were based on event collection. Configuration management plays a major role when trying to set the network behaviour. Examples are configuration of installed equipment, capacity extension on a path and network protection configuration. Configuration commands are issued to agents acting on the network elements, which are able to control the network behaviour. The control points in the network elements are called management control points.

For ordinary voice-type networks configuration is performed by commands on the central processor to introduce routing tables, charging tables, end of selection cases, etc., often in order to support the call control function. This may be represented by management functions performed by management agents handling resources in the traffic plane and interconnected to it via management control points. The management actions are in this case ordered by centralized management functions. IP networks are different. They handle packets rather than calls. IP networks are based on connectivity control, which is distributed in almost all network elements in the network.

In IP, many control functions are autonomous. The typical case is routing where the IP routers learn by themselves the network topology to build up their routing tables. Similar principles are used by PNNI in ATM networks. This case corresponds to decentralized management functions handling a given network resource through a management control point. This autonomous management performed in the network elements does not require central manager intervention.

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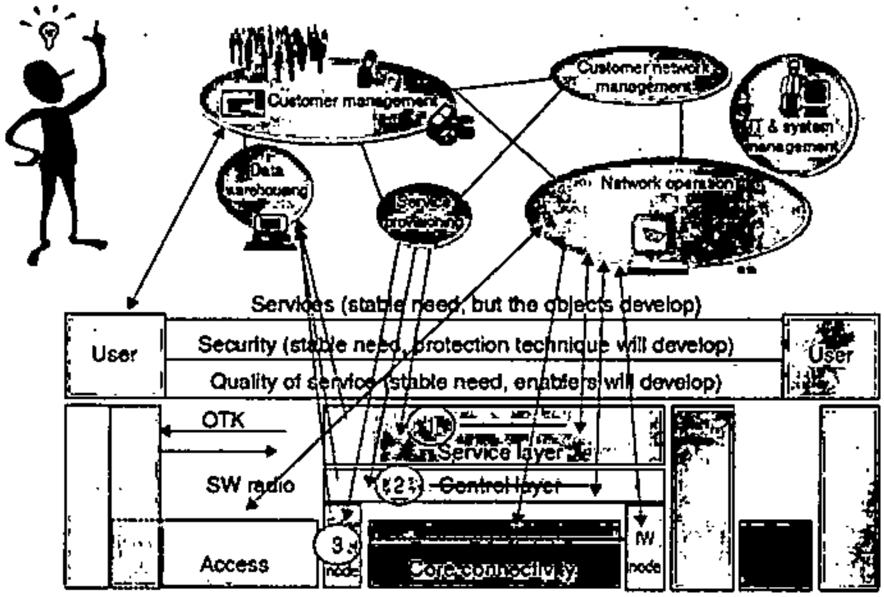

Fig. 1.13 : Configuration management handles configuration of services in different layers for IP, voice and services beyond voice (3, 2, 1 respectively)

These facts might mislead us to the thinking that neither centralized management functions nor management control points exist in IP networks, apart from the ever-existing static programming possibilities. This is far from the truth. Control and central management certainly do exist in IP networks, although they do not address the same functions. Figure 1.13 summarizes the section on configuration.

1.6 SERVICE MANAGEMENT

This section is a bridge between the process-oriented part and a more business-oriented part. The user perception has a direct impact the service layer development. Centralized management for service provisioning becomes a key factor for increased operator agility and profitability. See Figure 1.14.

Server platforms are built to deliver services and media contents irrespective of the IP host's access type. Most future services beyond voice will be developed and driven into the marketplace by content-based servers.

The expression *service management* is used for service provisioning and service data management. The managers that handle personal end-user service provisioning and service management are sometimes called personal service environment managers. It is an end-user contact point for managing his/her personal service environment.

The personal service environment contains secure personalized information, stored in user profiles, defining how subscribed services are provided and presented to the end user. QoS and security become important prerequisites in the overall service management. QoS (and security) is a layered feature. Therefore the overall QoS, as perceived by the end user, is a result of the network QoS and the upper layer QoS protocols in the server and user equipment.

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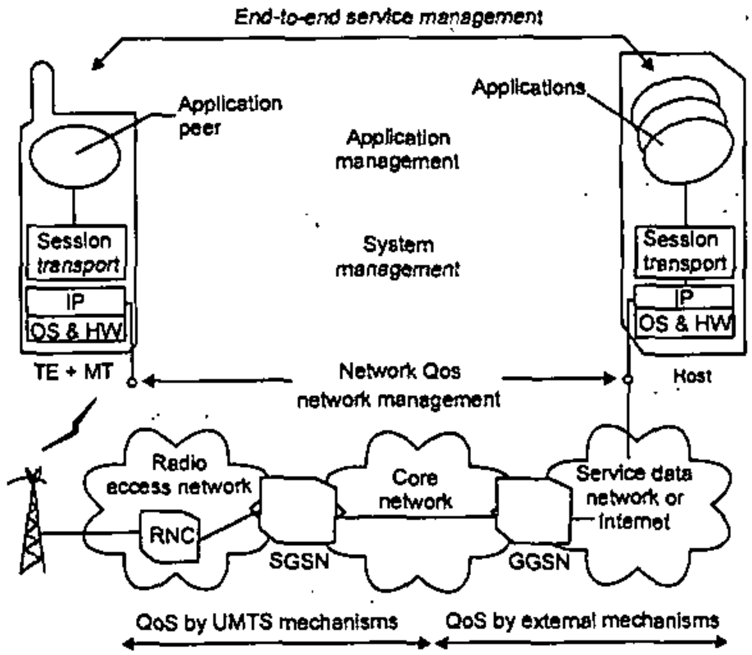

Fig. 1.14: An end-to-end, all-layer view is necessary for service management

Since the service portfolio is a competitive tool, service creation, configuration, implementation and management are critical competencies. Service creation and management are possible areas for partnership. Telecom management performs the whole FAB (fulfilment, assurance and billing) processes necessary to provide the service to the end user.

The service layer includes vast possibilities but also particular problems and challenges. The overall goal is to capture revenue from new services 'beyond voice', with such cost of deployment, operation and management that the business case becomes attractive. Among targeted services are MMS, news, video calls, interactive messaging, games, music, entertainment and positioning services. It is a new area and the environment is in many aspects more complex and heterogeneous than the control and connectivity layer environment.

As mentioned before:

- *There are many players and a growing number of applications.*
- Messaging services and transactional services require much support from the service layer.

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All these demands are considered as success factors or prerequisites if you like. The factors have the stringent conditioning of being required end to end. In multi-operator environments this is not an easy task. A single failure in a link in the chain can spoil the whole service as perceived by the end user.

End user needs and behaviour are not static. They usually change over time. Many new service offerings will come thanks to the new network capabilities. The network itself changes, either due to scheduled extensions/ new services and replacements or to unexpected events. This stresses the importance of telecom management as an integrator able to adapt to different end-user and telecom business environments.

A fast service provisioning is particularly important today. Two of the main competition issues frequently addressed in telecom business literature are TTM (time to market) and TTC (time to customer), which clearly demand actor agility. Old service provisioning involved heavy costs because of manual, non-standardized or non-integrated procedures. See Figure 1.17.

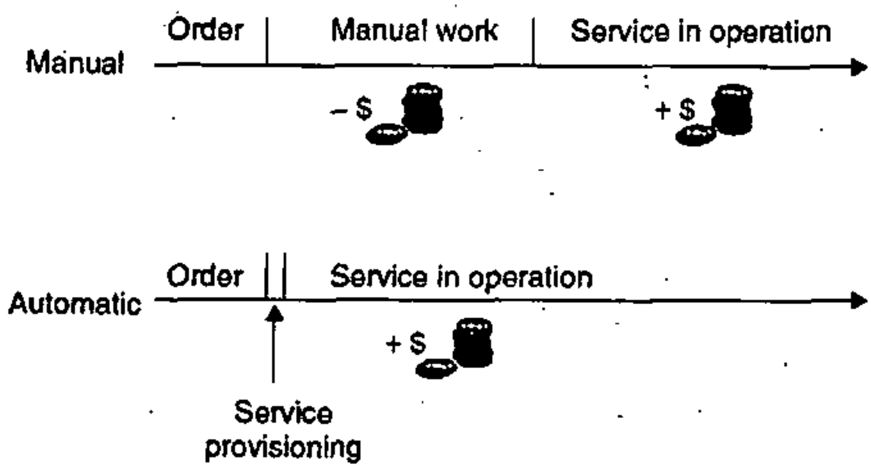

Fig. 1.17: Automation is a key in reducing time to customer

It was quite complicated to connect a subscriber to a network or a new service, and data had to be set in several independent system databases (access network, local switch, billing, IN node, etc.) Also manual work or proceedings were often necessary. Telecom management allows fully automated and standardized service provisioning. This is achieved in a user-friendly environment and from a single point in the network. This leads to satisfied customers, short TTC and faster time to revenue, favouring increased profitability.

For the operators themselves a fast and efficient handling of the billing makes a very strong impact on their result. The handling cost of one bill might well be in the range of \$10–20, so being able to send a single bill to each customer instead of maybe three or four (e.g. fixed telephone, mobile phone, cable TV, Internet connection) saves money. Telecom management also contributes to revenue generation via what is called billing mediation. Billing mediation takes care of the collection, buffering and delivering of information from the network elements or call control servers, for billing or accounting purposes. Telecom management could possibly also assist in the detection and prevention of fraud, by capturing information on selected network element events, and through statistics and network management capabilities. *Heavy cost elements* are marketing, network management and billing. See Figure 1.18.

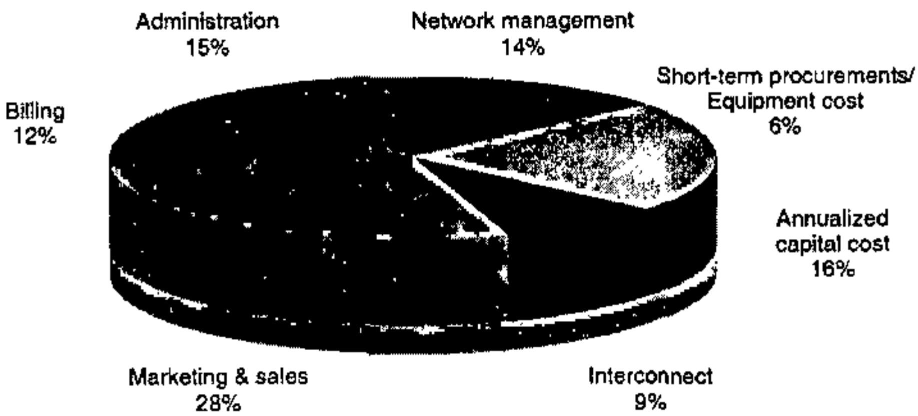

Fig. 1.18: Example of cost elements for a network operator

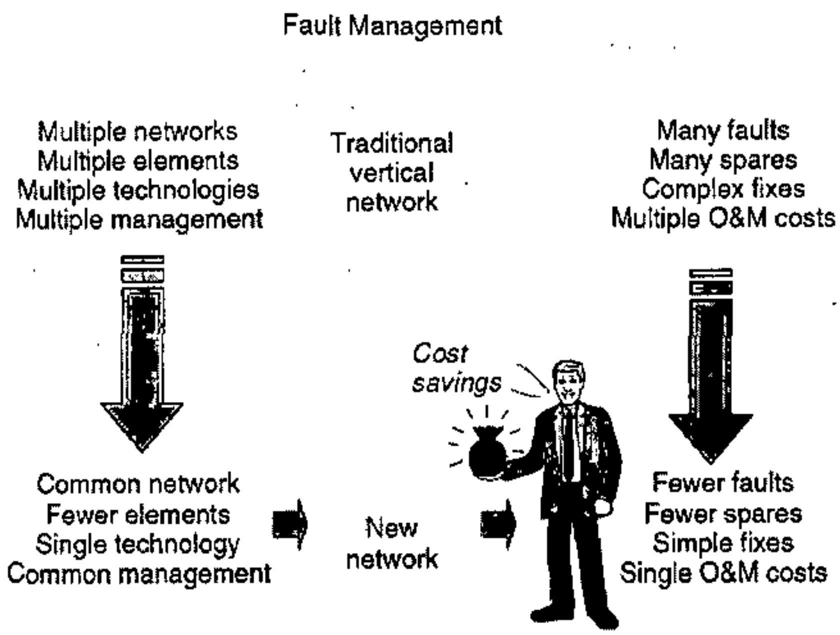

Fig. 1.19: Fault management comparisons

Cost reductions are achieved due to the sharing of common activities (surveillance to mention just a simple one). Let us here exemplify by means of fault management. Fault management cost element savings are depicted in Figure 1.19, as a contribution to a better ROCE. There are reasons, however, to include an increased fault management cost

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at the point in time when the new network is taken into operation and until other technologies have been phased out.

The *capital employed* term is a little more complex to explain. Let us use the telecom management activity traffic management as a tool. In a given network situation an improved traffic management allows higher traffic handling, enabling a postponing of network expansions. Telecom management may be considered then as reducing the tied capital or network assets. Telecom management spare handling is another possible means to reduce capital employed through better administration, for example sharing store holding with suppliers.

1.8 CUSTOMER CARE AND DATA WAREHOUSING

Billing and Customer Care

Customer care is important in winning and keeping customers, as it can be the differentiator in the marketplace. As more services are added to the operator portfolio the demands on customer care become more complex, involving more systems, more interfaces and more procedures. This complexity can severely inhibit the TTM goals. Often customer care systems are the last to be developed or upgraded to cater for new products and services. The infrastructure and software for the new services are frequently available long before the customer care systems and procedures can be updated to handle them. This causes delays in launching the new services in the marketplace.

Billing is a vital area for operator business, since collection of billing revenues and customer billing satisfaction can build up competitive advantages. The position of billing at the end of the process chain is shown in Figure 1.20.

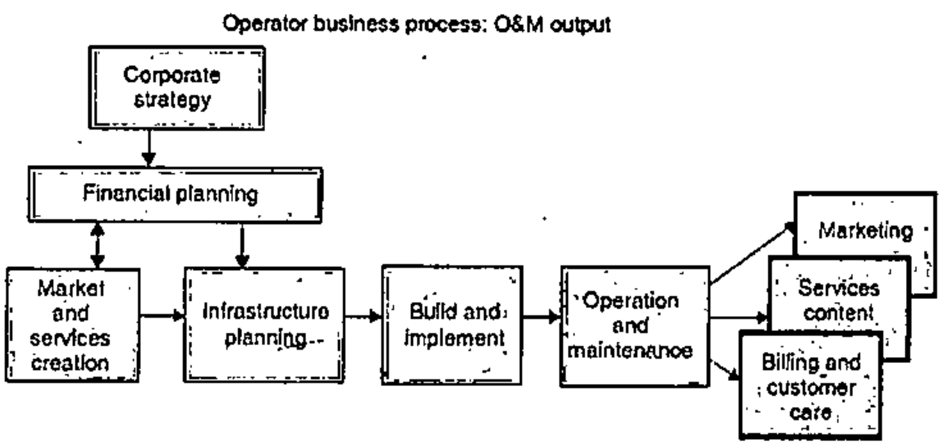

Fig. 1.20: Revenue-related management

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The IT development costs for a rapidly evolving operator is a dominant expenditure. It can even be greater than expenditures on the network infrastructure. Huge costs are frequently involved in adapting billing systems to new technologies and services. Furthermore, the billing adaptation can lead to fatal errors resulting in end-user annoyance. Therefore it is usual that most operators shudder when there is even a hint of a change on billing systems. Network evolution process must consider this, creating an environment as simple as possible, and preventing adaptations and redevelopment as far as possible.

Telecom management systems are the main input for billing and customer care, as they concentrate all the information available regarding status and events on network elements and call control servers. This theoretically opens the possibility to use any type of charging method or philosophy that might be imagined. Even if often limited in reality, there is a high degree of flexibility in defining the ways of charging that may be found suitable for customer billing satisfaction and business profitability.

Billing/accounting is based on event collection. All the events in the network, either call control or network element information, associated with billing are defined and informed via the telecom management system and sent to the billing mediation platform and to data warehousing. A common billing term is CDR (call detail record). The CDRs are sent to the billing mediation platform for reformatting (required if different vendors have different formats of the CDRs). See Figure 1.21. CDRs are also sent to data warehousing for further analysis of customer telecom habits etc.

The information received is processed to generate the actual bills. It can also be sent out directly to the customer for billing purposes. This feature is known as hot billing. Hot billing enables itemized call-charging information to be sent to, for example, a teleshop as soon as the call is finished.

For calls passing through different operator networks, billing information is also used by the accounting function regulating the flow of money between the operators.

It is worth mentioning the existence and discussion of two different philosophies regarding billing, as illustrated in Figure 1.22. The type of control, already treated in configuration management, also has important effects in terms of telecom business.

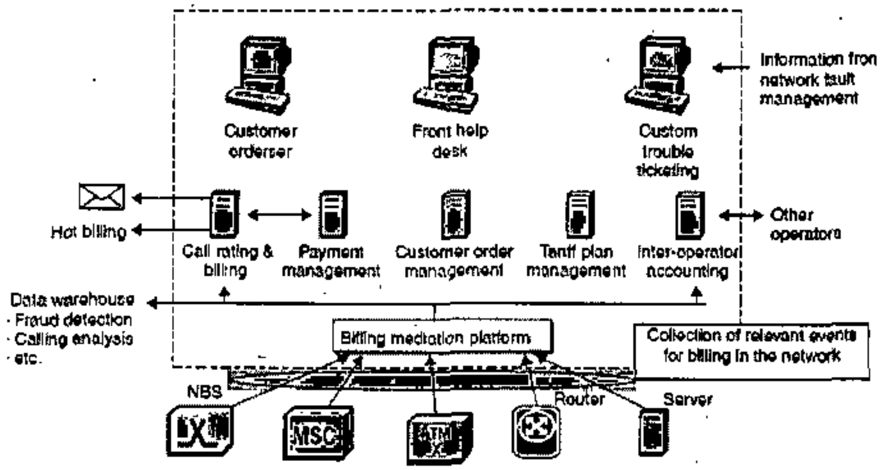

Fig. 1.21: Billing mediation

The use of pure call control or pure connectivity control in the network has important effects on billing methods and philosophy, as can be seen in Figure 1.22. Connectivity-based technologies like IP have had limited capabilities regarding call control, which leads to a billing model not very attractive to many network operators. On the other hand smart billing requires a sophisticated call control, to clearly identify the different calls or sessions and to store the data associated with them for detailed billing.

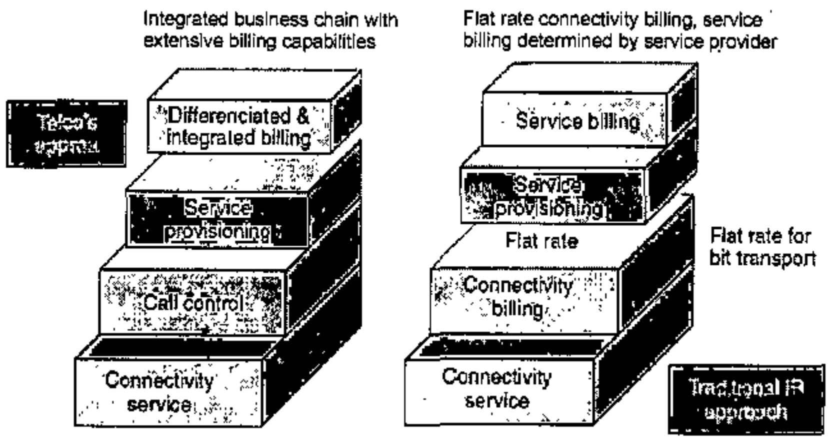

Fig. 1.22: Typical billing principles in Telco and IP approaches

As already said IP is now evolving towards an increasing use of call control, where the deployment of SIP may play a very important role. What will be the prevailing charging philosophy today remains an open question. The convergent environment may be particularly beneficial regarding billing and customer care processes. When all services are provided on one common platform it is easier to migrate customers from one service to another, both in terms of procedures and of physical changes. It is no longer necessary to disconnect the customer from one network and reconnect her/him to another network.

This is especially relevant to keep operational costs (OPEX) down, particularly when hands-on intervention is required on remote or no longer manned network elements.

Data Warehousing

The term data warehousing means that lots of data are stored and post-processed to find many particulars about the subscribers and the network. As a strategic marketing advantage, modern marketing trends known as 'personalized marketing' or 'marketing one-to-one', collect *information about customer activity* on the network and use it to promote particular offers suiting end-user needs and personality.

Examples are use of individual applications and their geographical distribution. Usually, most of the data originates from the CDR. CDR analysis can show many different things, ranging from the end-user call destinations and times (suitable to promote personalized telecommunication plans), to the existence of illegal practices like fraud. A *lot is won if the operator* can discover customer needs or act upon problems before the customers or competing operators discover them. This will prevent other operators from seducing the customers with an attractive personal proposal.

This type of information, just as the customer database (customer management), is business critical. Therefore it is normally not outsourced, but handled by the operators themselves.

1.9 SECURITY MANAGEMENT

Security in telecom management usually addresses two different issues: *telecom management systems* intrinsic security and security management of end-user traffic. Telecom management security is of particular concern for telecom operators regarding intentional damage and fraud detection and prevention. Telecom management has access and configuration capabilities to any network element in the network and is therefore an access point for *security attacks. SNMP v3 provides an interesting* set of security services, which include encryption to assure privacy, and manager–agent authentication to guarantee sender identity and message integrity.

Both telecom management internal security and end-user security make use of two different types of protection.

Protection Against Unauthorized Access

This protection is performed through AAA (authorization, authentication and accounting) servers in the control layer, and it is addressed via password handling, access databases, authentication and encryption.

The main enabling technologies are LDAP allowing secure database access to the telecom management or the telecommunication system, and RADIUS, mostly used for cellular user access authorization in mobile systems.

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Data Transfer Protection

Data transfer protection is mainly addressed through zonification, tunnelling and encryption. Zonification is the determination of different boundaries between network segments called security zones. They usually correspond with natural boundaries observed in the network data flow or the network topology.

The traffic flowing between different security zones is tunnelled using protocols like L2TP and L3TP. The tunnelling process encapsulates the TCP/UDP or the IP datagram providing special means of protection against spoofing (injection of hacker's IP packets in the data flow). The data can also be encrypted in the tunnel using IPsec.

Before entering a security zone data contents of the traffic flow may be controlled at security inspection points. In these points there may be a firewall, a filtering router or even an IP security end-point aimed at control data integrity and privacy. The existence of security policies, covering not only IT security, but general corporate security is essential to assure the system integrity. Security violations frequently come from sources not usually taken into account, such as employees' information, trivial or unchanged passwords, and even physical security attacks.

Security violation attempts have to be alarmed, reported and consistently analysed in order to prevent future damages. Integration between the telecom management alarm and performance management and the global security systems should be desirable although it is not always feasible.

1.10 QOS MANAGEMENT

The rather crowded Figure 1.23 exemplifies some of the ongoing initiatives and controversy around QoS. Delay and jitter are annoying to the end user for multimedia synchronous (isochronous) services, like voice or video. The associated and necessary QoS management consists mainly of:

- Admission policy (possibly shaping).
- Assignation of specific paths for isochronous real time traffic (preventing the competition from long IP data packets).
- Prioritization (certain packets can be dropped in case of congestion).

The isochronous traffic is identified at the entrance node (edge router or MGWs), eventually marked and allowed to flow through a special path, where the delay may be kept within acceptable values. Differentiation of traffic at certain entrance points is therefore a common procedure on modern networks. For all differentiation of traffic (quality, security etc.) there is a need for a policy. A policy server is a common solution.

The server provides mapping facilities for services, business and network configuration concepts. QoS bearer service provision, secure tunnel configuration or IPsec configuration can easily be specified in high-level terms. Example: 'Provide GOLD service for all SAP traffic from site A to site B'. The policy server creates logical rules on how this can be realized in the network, permanently or temporarily.

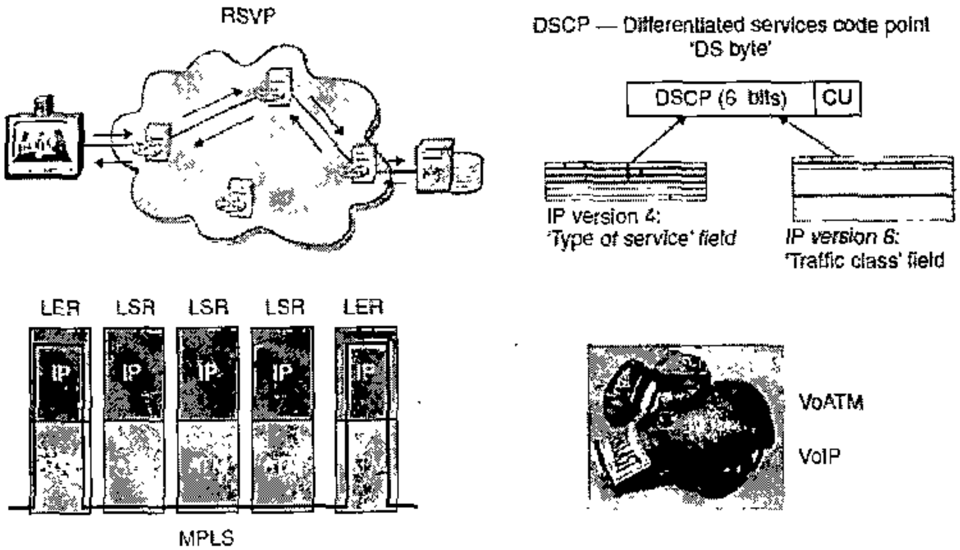

Fig. 1.23: Some *QoS standards and issues*

If a particular link fails, or QoS demands are not met under normal conditions, underlying network resources can be reconfigured, or low-priority connections can be dropped.

RSVP, MPLS and Diffserv are important QoS standards. RSVP, through *resource reservation*, MPLS through label switching or DiffServ with a defined per hop behaviour in each router, have the same goal, which *is to open a differentiated* lane for voice/video communications through a possibly congested area (the heavy traffic highway assigned to best-*effort traffic*).

The combination of IP and ATM contributes to QoS as IP can rely on the powerful ATM QoS handling capabilities. However, new standards offering interesting QoS alternatives are evolving for IP networks, such as MPLS and GMPLS.

Thus, telecom management plays a very important role in the satisfactory development of the network QoS. Performance management may lead to different traffic engineering initiatives and configuration management sets the admission policies, handles the establishment of special paths and fixes the prioritization rules within the network.

1.11 TERMINAL MANAGEMENT

Terminals are becoming one of the most relevant elements when considering end-user capabilities. The increasing distributed processing power has created terminals (typically PCs) with high processing power and management capabilities. However, dumb terminals are still frequently used.

Management of Terminals

Most networks take care of the resources on terminals, but this requires some distribution of management functions and entities. The distribution is performed between the network and the terminal, allowing centralized and/or autonomous management. It also addresses the need to handle different type of terminals, ranging from intelligent to dumb, which require maintenance functions on the network with different degrees of assistance.

The cooperation in management functions requires the existence of management protocols between network and terminals. Compare the CC/PP protocol.

Management from Terminals

A modern trend in telecommunication business is to allow and favour the end-user configuration of different services and network attributes. This provides extreme agility on service provisioning. The end user can also choose tailor-made solutions, selected from a defined menu of alternatives, on service implementation.

This is an increasing trend that will be subject to further development, to provide additional configuration facilities to the end users. This can be done either through the corresponding network and its traditional terminals, or via dedicated terminals capable of more complex configuration capabilities and information interchange.

Typical existing examples regarding this last case are operator's Internet pages, which allow service selection and configuration to the end users.

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1.12 ACCESS NETWORK MANAGEMENT

The access networks are often decisive for the overall service quality. Access is one of the most dynamic areas in telecommunications today, showing a strong growth, involving high levels of investments (often more than 50 % of the overall investment cost) and a myriad of promising technologies. Solutions for the 'last mile' to the subscriber have been a constant subject of debate in telecommunication forums for a long time. Figure 1.24 describes a very likely state in the network development, where the core backbone will have to interconnect with many different types of access networks. This is what 'Agnostic Access' means. Most likely no one type of access technology or media will clearly prevail, and many different types of access will be selected and coexist, at least in the short run. Hybrid systems will also appear, such as UMTS-WAN.

Telecom management will have to manage a large number of different networks assuring seamless integration among all of them. They might be different access networks, existing legacy networks and the stratified core network. The proper and easy integration of the O&M activities on access, within the operator's telecom management, will then become a key element for assuring both business and operational success.

1.13 MANAGEMENT OF LAYERED AND SERIAL INTERWORKING

The complexity of modern networks, handling many different technologies simultaneously with a considerable number of layers and a fast pace of technology development, creates difficulties in acquiring a proper telecom management understanding and management competence. The two considered cases are: single operator with many layers or many interconnected technologies, and interworking operators in layers or interconnected.

The interfaces and protocols are far more complex in interworking than in integration. The interworking protocols have to support the distribution along all planes (traffic plane and management plane) and layers (OSI-ISO layers) of the interconnected networks. In other words, they have to assure that the interconnection is held along all the layers composing the different networks, and that both traffic and management plane interconnection are included.

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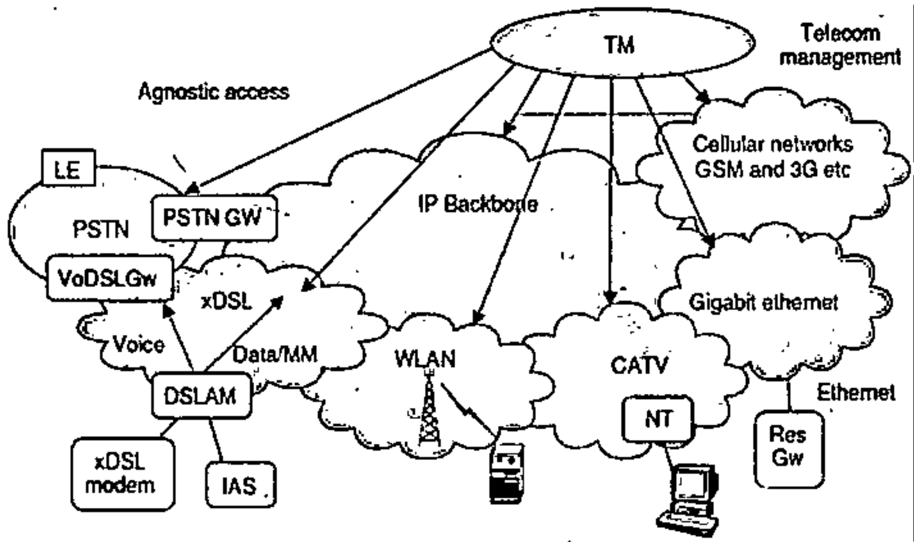

Fig. 1.24: Access network management overview

The complexity is even greater when the two interconnected networks do not provide exactly the same services (mobile and fixed telephony, LAN and WAN, X25 and IP, PSTN and VoIP). In this case the gateways have to be able to handle the asymmetries in service as well.

Why is my computer getting so slow when downloading files from the Internet? The origin of the problem could be located either in the PC, the corresponding interworking modems, the copper, cable modem or wireless access network, the ISP and finally in the different nodes on the Internet network. Its determination will not be a simple management task, particularly considering that many operators are involved in the Internet communication and that they may have a null or at least very limited cooperation among their management systems.

1. The ITU-T (telecommunication management network – TMN) and the IETF (simple network management protocol – SNMP) approaches on network management, although based on similar principles, finally became pretty different (different protocols, different managed objects definitions, different terminology, etc.).
2. Usually isolated management systems already exist, either for particular layers, group of vendor's equipment or vendor's networks, or any combination of them.
3. Some vendors' equipment and networks, particularly old legacy networks, use proprietary management systems not based on the manager–agent principle.
4. Configuration management is frequently addressed by other means such as Telnet, proprietary CLI, FTP/FTAM for bulk transfer, and DHCP and LDAP in cases related to server or server-based configuration.

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SUMMARY

- Performance management is a key function to verify end-to-end QoS and network availability to the end user. It is extensively used to verify SLA compliance and to detect and measure possible SLA deviations.
- Telecom management security is of particular concern for telecom operators regarding intentional damage and fraud detection and prevention.

REVIEW QUESTIONS

1. Explain the management system for telecomm.
2. What are the different tasks of the management system?
3. Explain Network Elements, Managers and Agents.
4. Explain TM Internal Architecture in the Layered Dimension.
5. Explain the TMN functional areas.
6. Discuss QoS management.

CHAPTER 2 TECHNOLOGY TRENDS AND THEIR IMPLICATIONS FOR TELECOM REGULATION

★ STRUCTURE ★

2.0 Learning Objectives
2.1 Introduction
2.2 Microelectronics: An Economic Catalyst
2.3 Progress and Prospects of Optical Transmission
2.4 Wireless Technologies: The End of the (Local) Line?
2.5 Telecom Software: A Major Concern
2.6 Conclusion: Regulation for Technology Success
- *Summary*
- *Review Questions*

2.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- describes the consequence of VLSI for telecom.
- discuss the progress and prospects of optical transmission.
- explain the information and communication technology.
- know about the microelectronics are economic catalyst.
- differentiate between the GSM and PCS.
- define the telecom management network.

2.1 INTRODUCTION

The relative importance of technological innovation and government policy reform as drivers of successful development of public services has been a subject of constant debate for many years. Recall the anecdotal minister who tasked his legal staff to write a White Paper on airline regulation just after the Second World War. In the spirit of international co-operation in those days, the legal experts' draft set out as follows: "Civil aviation is based on international law established by modern nations in order to regulate international traffic." However, when the ministry's technical staff got wind of this, a counter-proposal was tabled with the following opening statement: "Civil aviation is based on the aerodynamic laws of nature which permit man to fly in vessels heavier than air."

This chapter does not defend a purely engineering approach to public telecom arrangements. Such approaches have prevailed in virtually all of the monopolistic telecom operating companies in Europe and former European colonies, as well as the common carriers in North America. Still, neither makers of telecom policy nor new independent regulators of the behaviour of national network operators and service providers can neglect the (im-) potencies of different modern technologies when considering the rights and obligations of telecom operators and their customers. Novel transmission and switching technologies presently change the economy of networks entirely from inside, even if gradually. When new technology shifts traditional benefits and costs to different user communities, or to other parts of communication networks, changes to regulated tariff structures and entirely new arrangements for public control of telecom firms become necessary.

Recently, advanced computer and network technologies have also created new types of business users with special commercial requirements. Such users do not accept to be treated as standard subscribers to a national universal service; they wish to have a choice of the most recent and cost-effective communications technology to reach their particular markets at home or abroad. They stir up political discussion about market entry of specialised telecom providers and about the appropriate legal and institutional frameworks, and also force regulators to consider more detailed technical choices of standards, frequency bands and service-quality grades than in the past.

Thus, technological (r)evolution constantly challenges the classical civilized policy objective of a single universal service to everyone, everywhere. Many governments appear to waver between their desire to create adequate industrial and labour policies to foster more knowledge-based employment and higher economic welfare, and their adherence to vested arrangements for distributing welfare in a fair and equitable manner. The national and international discussions of appropriate regulatory frameworks for the so-called "information society" reflect several dilemmas in appropriately (re-)allocating the benefits and costs of telecom. What remains constant, is new information and communication technology (ICT) as a prime mover of telecom firms, and of their customers: both network (infrastructure) evolution and service (market) developments are affected.

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This review of ICT focuses on a few major technological driving forces in modern telecom:

- the generic impact of microelectronics, due to the rapidly changing
- price/performance ratio of very large scale integrated (VLSI) circuits, both on the common network infrastructure and on customer equipment;
- the role of optical techniques in *bulk* information transmission over long distances;
- the increasing role of radio technologies in reaching *individual* users over shorter distances ('wireless local loop', cellular systems); and
- the intrusion of special computer platforms and networks into the infrastructure for the plain old telephone service (POTS), in order to create and manage more advanced services ('intelligent networking').

It is not the aim to go into any engineering detail in these areas, or to cover ongoing major system developments. For instance, digital switching based on the asynchronous transfer mode (ATM) or multiplexing of digital circuits based on the synchronous digital Hierarchy (SDH) will not be discussed, since the purpose here is not to assist in systems engineering of modern telecom. What is intended in this survey, are illustrations of the inherent dynamics of modern enabling ICT, and how this appears to affect some of our most cherished traditions of public telecom policy. An attempt to (re)design such policy purely on the basis of the legal and political conventions of, say, public administration, would face the considerable economic and cultural risk of neglecting the empirical evidence of modern ICT as a radical and permanent change agent inside telecom – and in the society to be served by telecom.

2.2 MICROELECTRONICS: AN ECONOMIC CATALYST

Capabilities of VLSI Technology

Powerful communication and computing functions and terminal devices have become economically viable thanks to the electronic revolution of integrated-circuit (IC) technology. This enabling technology allows a large number of electronic components to be etched into a minute 'chip' cut from semiconductor material. The vast majority of VLSI circuits use silicon chips. When the author studied engineering some 25 years ago, the opinion of leading semiconductor experts was that much more sophisticated and costly compound materials (e.g., gallium arsenide) would soon become necessary for high-frequency circuits, e.g., to meet the demands for smaller radio sets. However, the ongoing development of silicon technology since then has allowed extension of its practical frequency ranges by orders of magnitude. Today's hand-held mobile telephones are based on cheap silicon VLSI chips working in the 900 or 1800 MHz bands (or even in both bands, in new 'dual mode' terminals required for roaming between different mobile networks based on different technical standards such as GSM, DCS1800 and DECT).

This is one of the chief reasons for the spectacular drop in the prices of mobile radio handsets, which has stimulated the mass market for mobile telephony. VLSI technology appears to evolve in accordance with a rule of thumb postulated in 1965 by Gordon Moore, one of the founders of the leading US chip maker Intel. Standard chips come in families with the generations separated by a couple of years, in order to reap the major economies of scale in industrial mass production. Broadly stated, 'Moore's law' predicts that the maximum number of transistors or other minute components on a state-of-the-art VLSI chip doubles in 18 months, so the cost per component halves between successive mass-produced generations of chips. In retrospect, the component number on state-of-the-art chips has indeed increased by a factor of 100 in less than 10 years! This has shown up in both prices and improved storage capacity of random access memory (RAM), for instance in personal computers. The maximum operating frequencies of silicon chips continued to break perceived barriers, too. This benefited not only the output signal frequency of electronic systems, but also the internal 'clock' frequency by which transistors are switched on and off, when working in the binary mode used in digital telephone exchanges and other computers. In 10 years, the clock frequency of typical PC microprocessors has gone up by a factor of about 40. As a result, the total processing power of a standard microprocessor chip has increased by some 100 × 40 = 4000 times per decade! Sometimes this is restated as a growth rate of 1.5 percent per week, but this can be misinterpreted in view of the longer lives of chip generations.

Consequences of VLSI for Telecom

Consider the different performance trajectories sketched in Figure 2.1 for three main sectors of the electronic manufacturing industry, namely, for consumer products, computers, and telecom equipment. Clearly, the cost benefits of mass production are far larger in consumer electronics than in the professional sector of telecom equipment (switches; multiplexers, etc.). Telecom subsystems come in much smaller series and must also be more reliable over a longer operational life. Hence they are more expensive – though not necessarily more complex – than the standard electronic products bought by consumers, such as video recorders, televisions

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and radio sets. The industry performance/price ratio for mainframe and large mini-computers also lies well below that of the consumer electronics industry, but above that of telecom manufacturing. A digital telephone switch is essentially a special-purpose computer, with exigent requirements for nearly permanent availability. For a central computer used for financial bookkeeping or other off-line purposes, an hour of weekly servicing every Monday morning might be routine, whereas a telephone exchange could not be allowed any comparable downtime.

Between these evolutionary "beaten tracks" of industrial VLSI development, three significant new revolutionary cross-over branches between these trajectories are included in Figure 2.1. Two of these branches represent the advent of the personal computer and of the hand-held mobile telephone, respectively. These innovations have become the most important new telecom terminals in the last ten years. Both the PC and the digital mobile telephone illustrate cost-effective confluence of the powerful tradition of information processing developed in the computer industry, with the scale benefits and global price competition found in the consumer electronics industry. These two powerful low-cost terminals have engendered some of the most impressive traffic growth rates ever in telecom, as enjoyed by Internet service providers and digital mobile network operators (GSM and PCS), respectively.

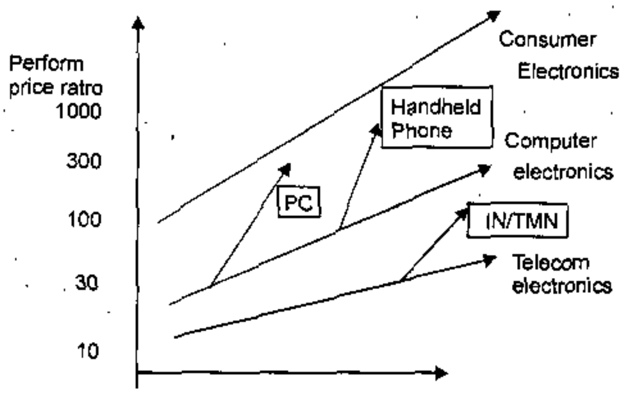

Fig. 2.1: Electronic product performance

The third cross-over branch shown in Figure 2.1, that between telecom and computer electronics, arose from a need felt by many network operators to deliver new or improved telecom services to increasingly demanding professional users. Better services can be introduced using the two concepts of the intelligent network (IN) and the telecom management network (TMN), which are based on implanting entirely new computer platforms into the nervous system of the classical public network, its signalling system.

In this way, much lower equipment costs are incurred than if the expensive central switch equipment itself were to undergo upgrading or complete replacement. Moreover, inevitable software risks can be kept separate from the standard switch software. Innovative telecom operators are invoking the IN to support delivery of new services (whether offered by themselves or by third parties) and the appropriate flexible billing schemes for such services. The TMN, on the other hand, can be used to reconfigure the existing network capacity more flexibly in response to the rapidly changing user needs, e.g., due to user mobility or other less foreseeable shifts in traffic patterns. In both cases, the introduction of computer platforms enhances the capabilities of the more expensive telecom equipment, at the much lower cost of computer hardware suggested by Figure 2.1.

Limits to Growth of the VLSI Impact on Telecom Markets

Will Moore's law continue to apply indefinitely, and so produce ever increasing dynamic changes – if not turbulence – in the markets for telecom terminals and services? Two probable limitations should be mentioned briefly.

The principal limit to further growth of VLSI capacity and functional capabilities arises from the fact that the transistors on present generations of silicon chips are already very closely packed. In the near future, the spacing between transistors on one chip will become so minute that the effects of quantum physics will start to affect individual electrons. These will probably then 'tunnel' through the walls separating individual transistors or be disturbed by individual atoms or impurities in the semiconductor material. In either event, the result will be unreliable transistor performance. With millions of even slightly unreliable transistors on a single chip, this would become useless. Avoiding such problems already now leads to exponentially increasing costs of factories for new chip generation; this affects the manufacturing paradigm of the benefits of mass production, unless production volumes in each successive generation would also increase exponentially. Probably, the cost of a VLSI chip will, in the future, no longer be dominated by its marginal cost, but by the tremendous fixed capital costs of each new chip factory (at present, several billion USD). This problem could be mitigated by cooperative teams (cartels?) of competitors, or by accepting longer lifetimes of each chip generation, but the assumptions underlying Moore's law would cease to apply.

A second economic problem of the present microelectronics chip supply in distinct generations is the inherent creation of a commodity market, with cyclical fluctuations in price and demand, resulting in mercantilist pleas for import regulations and protection of national producers (*The Economist,* March 23rd, 1996). As experienced with agricultural policy, this may lead to less efficient markets and, consequently, yet another perturbation of Moore's law.

Despite such changing climates of microelectronics, its revolutionary crops are far from completely harvested by new systems and service sectors. For instance, many observers and investors believe that storage and individual delivery of compressed multimedia information, such as digital video on demand, will soon receive an impetus from low-cost VLSI-based platforms and consumer terminals. Systems based on microelectronics will continue to be agents for change in public and private telecom for years.

2.3 PROGRESS AND PROSPECTS OF OPTICAL TRANSMISSION

Capabilities and Limitations of Photonic Technology

The (re)invention of optical fibre technology in the 1960s and the development of solidstate lasers generating infrared light have, in combination, probably already had a greater impact on telecom networks than the electronic revolution discussed above. Specifically, this 'photonic' technology has enabled broadband transmission systems. In the area of long-distance high-capacity transmission, optical systems have completely outperformed coaxial cables and permanent satellite links within one decade.

A standard performance figure-of-merit for an optical fibre link is the product of its data transmission capacity (in megabits per second) and the transmission distance bridged (in kilometres). The first commercial systems in 1976 had figures-of-merit of about 20 (Mbit/s km), corresponding to conveyance of 30 digital voice channels over a distance of 10 km. Since then, the performance figure of state-of-the-art optical links has continued to grow exponentially at a rate of some 75 percent per annum, passing 2000 Mbit/s km in 1984, and reaching 2 million Mbit/s km in 1992.

The cumulative transport capacity of transatlantic submarine cable systems went up from 24 voice channels in 1956 (coaxial cable) to well above 100,000 channels in 1992, thanks to the shift to optical technology in about 1987. This indicates why satellite links can no longer compete on such high-density routes. By 1996, considerable spare capacity on the Atlantic cable routes between Western Europe and North America has built up. More significantly, the transatlantic cable cost dropped from seven million USD per deployed voice channel in 1956 to some 6000 USD per voice channel in the TAT-9 optical cable deployed in 1992 (USD 1992 level).

Just as for VLSI chips, a quantum limit would seem to curse future performance jumps of photonic transmission links. This theoretical limit of the performance figure lies at about one billion Mbit/s km per optical fibre and may be approached a few years after the turn of the century. However, the total transmission capacity can still be increased beyond the single-fibre limit, simply by including more fibres into one cable. This hardly increases the laying costs of the cable.

2.4 WIRELESS TECHNOLOGIES: THE END OF THE (LOCAL) LINE?

Cellular Technology: Avoiding Natural Barriers and Natural Monopolies

Like most other technologies, wireless communication was initially developed in our classical human endeavour to overcome *natural* barriers. When Guglielmo Marconi bridged the distance between Cornwall and New Foundland in 1901 by dispatches of telegrams – so-called "cables" in American English – without using any physical cables or wires, it caused a sensation. Eight years later, he was awarded the Nobel Prize in Physics, a telling testimony of the public appreciation of an achievement then seen as falling under the Natural Sciences.

Marconi's innovative skills were indeed based on his perception of the physics of electromagnetic waves and electrons. However, it should not be forgotten that his British patent No. 7777, filed in 1900, was the first milestone on the important road to *shared* use of the radio spectrum. Frequency tuning was proposed as a way to allow several users to share the radio spectrum, without causing unacceptable interference to each other. This was the first step towards a novel cultural discipline required for wireless networking, namely, multiple-access air interfacing of several local users. By exploiting this discipline, modern local radio networks are seldom limited in performance by the random natural noise on individual links. Rather, the effectiveness of the user culture (Arnbak 1993, 74-82), *as embodied in joint multiple-access protocols* and other public standards, in general determines the overall network performance and capacity.

In a young wireless technology, evolving since the 1970s under the name 'cellular radio', our engineering ambition to overcome nature's noise limits by brute-force increases of transmission power has been deliberately reversed, simply to reduce the mutual interference between many users located in fictitious cells inside a service area.

With less transmission power used on each individual link, the cumulative

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traffic capacity in the area can be increased. Reduced transmission power (and, hence, smaller coverage area for each *single* cell) makes it possible to increase the total number of users over all the cells in the service area of a network operator. Cellular networks interconnected to fixed networks offer us the perspective of personal communications services (PCS) for a virtually unlimited community of mobile users, each linked to the fixed network infrastructure by a wireless link, granted to active subscribers only for the duration of their call. As soon as a call ends, the frequency of the supporting wireless subscriber loop must be surrendered for use by somebody else in the cell.

Obviously, temporarily assigned wireless local loops have variable costs and so differ fundamentally from the fixed cost of the twisted pair of wires which has permanently connects each telephone subscriber, irrespective of actual use, since the days of Alexander Graham Bell. Apart from the radio terminals, the access network and notably its cost can be dynamically shared by all users in a cell. Moreover, except for the radio base station centrally located in each cell, the wireless access link is intangible and seemingly gratis. It does not have to be entrenched in ducts or mounted on poles.

These factors entirely change the cost structure of a public network. The dominant investment is no longer required for static transmission plant to all individual subscribers, but in automatic equipment to handle the dynamic procedures for:

- activity management, to support (only) users calling or moving between cells; and
- dynamic transmit power control, to prevent harmful mutual interference between active users.

Accordingly, standard economic and policy arguments for the need to subsidise fixed local loops by (monopoly) profits made elsewhere within the public telephone network are invalid in cellular networks. Cellular technologies reverse the costs of providing user access, which become proportional to the actual individual use, and to the number of users in a given area. In particular, access networks are cheaper in thinly populated areas than where higher network revenues can be collected by an operator. Due to this cost structure, cellular networks are not natural monopolies, and thus they can be developed and sustained under competition. It is hardly accidental that telecom network liberalisation in most European nations was introduced by admitting a duopoly of public mobile networks, using the GSM standard. An appropriate (inter)national context of regulation and standardisation of public cellular systems and a suitable choice of spectrum policy9 increases the market size for candidate network technologies. Establishing the proper collective 'radio culture' maximises the public utility of mobile systems, notably in terms of system capacity, cost reduction and unhindered user roaming across the borders between different operators and/or countries.

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Mobile Services – A Functional System Model

Figure 2.2 suggests a generic model of the market provision of telecom. It is divided into four layers of service facilities, in a way similar – but not identical (Sapniol, et al. 1995, 20-33) – to the well-known open systems interconnection (OSI) model. The bottom layer is where radio engineers find their challenges: the provision of the wireless link between a customer terminal moving in a cell and the base station covering that cell in which different numbers of terminals will be located from time to time. Moreover, Layer 1 includes the (generally fixed) transmission links connecting base stations (BS) to their corresponding controllers (BSC) and the mobile switching centres (MSC).

Layer 2 comprises the BSCs and MSCs with the associated network intelligence required to control, route and tariff the traffic to and from the appropriate radio terminal. Mobility management is exercised by the network operator at this layer, both for his own subscribers moving across the cells in his service area, and for roaming customers paying temporary visits from other network operators' service areas.

Most public network operators offer access to specialised communication services at Layer 3, provided by themselves or by service providers, as selected by the user. Typical examples in the area of mobile networks are voice-mail boxes, mobile computing, and fax gateways. Finally, Layer 4 provides content services, such as travel information, news, and other on-line data services. On average, mobile users are more likely to demand such value-added services than are subscribers to the classical public switched telephone network (PSTN). This is not merely caused by the early adoption of wireless services by the most demanding and affluent ('leading-edge') customers. Generally, the typical circumstances of users on the move, away from their office facilities and from home, generate requirements for more advanced features. Accordingly, the technological ability allowed for supporting services in the upper layers is instrumental in commercial and regulatory plans for introducing public wireless networks.

Note that the mobile terminals themselves are absent in the service model in Figure 2.2. An alternative layered model, which better reflects the engineering disciplines and the manufacturing industry supply of mobile communications products, would contain the following four levels:

- Intelligent network level (service/network control);
- Transport network level (transmission and switching in fixed

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networks, within the mobile system itself or interconnecting this to PSTN or ISDN);

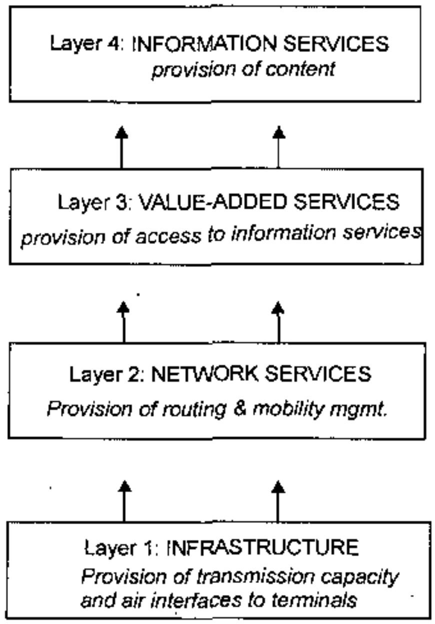

Fig. 2.2: A generic telecommunications model for the provision of transmission capacity and services to mobile customers

- Wireless access level (air interface equipment); and
- Terminal level (user transmit/receive interface).

However, from a regulatory viewpoint, this layering according to system technology appears less useful than that in Figure 2.2.

2.5 TELECOM SOFTWARE: A MAJOR CONCERN

Compared with VLSI and optical technology, the progress of software technologies is considerably slower. This is an important shortcoming, since the programming cost of software dominates the cost of all major network facilities with the exception of fixed subscriber loops. Especially, the cost of switch software has now risen to a substantial fraction of new telephone exchanges, typically 75-80 percent of the overall cost of a switch. Obviously, this lag is partly emphasised by the rapid performance/ price improvements of hardware discussed above (see Figure 2.1), but it nevertheless reminds us of the general fact that broad human creativity and total systems understanding are more difficult to muster than greater production efficiency and expertise at the physical level of components and subsystems.

One of the consequences of the key role of software in modern telecom systems is the increasing impact of inadvertent programming errors, occurring in rare operational situations almost never accounted for or discovered in acceptance testing of public switches. Even the type approvals of the first digital handsets for the GSM mobile networks in Europe in 1992 became a protracted affair, leading to delays in the market supply of user equipment and, hence, loss of operator revenues in countries which had implemented GSM networks early. In fact, formal testing of a few of the GSM conformance requirements was waived, until the problems were resolved.

A modern intelligent nodal switch requires far more complicated software than does GSM-terminals. Testing a switch under all feasible operational conditions is wellnigh impossible; test programmes tend to concentrate on vital functions, plus the more commonly observed error risks. Hence seemingly minor, but undiscovered software 'bugs' or viruses in telephone exchanges can lead to serious errors. If such errors propagate through the signalling system and its associated TMN or IN networks, their impact may be catastrophic. Such an error propagation occurred some years ago in New York, leaving all of Manhattan and Newark airport without telephone service for a considerable period.

Conceivably, such problems and security 'firewalls' form two reasons why strictly separated, dedicated computer platforms are increasingly introduced in support of intelligent networks. In this way, IN or TMN software problems and the proper switch software problems may become easier to distinguish, identify and resolve.

Some New Regulatory (Pre-)Occupations

Successful introduction and operation of new network technologies require adequate public policies, e.g., for granting frequencies and the right to interconnect with the fixed telephone network(s) to mobile operators on fair terms. Comparison of the evolution of mobile networks in different parts of the World suggests that there is a public interest involved in ensuring common standards, in order to allow mobile users to roam between operators and to purchase their terminals from the largest possible mass market. Last, but not least, there is strong international evidence to suggest that competitive provision of network and value-added-services (Figure 2.2, Layers 2 and 3) and terminals is beneficial, in terms of more rapid introduction and lower pricing. Nevertheless, regulators should oversee the new competitive markets. There is a need to maximise network externalities by stimulating interconnection between competitors, but also to prevent dominant suppliers from abusing their market power in interconnection arrangements.

To illustrate the significance of regulation in the event of mobile interconnection under the european open network Provision (ONP) rules, the layered model in Figure 2.2 can be expanded into three dimensions (Arnbak, et al. 1994) (see Figure 2.3). Thus, competitive facilities offered at a given layer can be shown as duplicated symbols

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in that service plane. The (potential or real) competitors are spaced apart in one direction; the hierarchical delivery chain in networks is shown in the other direction of the resulting 'interconnection space'. Selecting the best path through this space is a classical technical and economic problem faced by all telecom operators when procuring equipment and (re-) configuring their network in response to market needs.

With monopolistic supply of network resources in the past, a single national firm (typically a PTT) supplied all facilities between the international gateway (at the far right in Figure 2.3) and down to – and often even including – the user terminal at the extreme left. Such 'external' network points were generally the only interfaces accepted for interconnection, and hence also the most widely standardised. Between these extreme interfaces, the classical PTT as the sole provider of PSTN facilities and services was both vertically and horizontally integrated, and used its own proprietary internal interfaces.

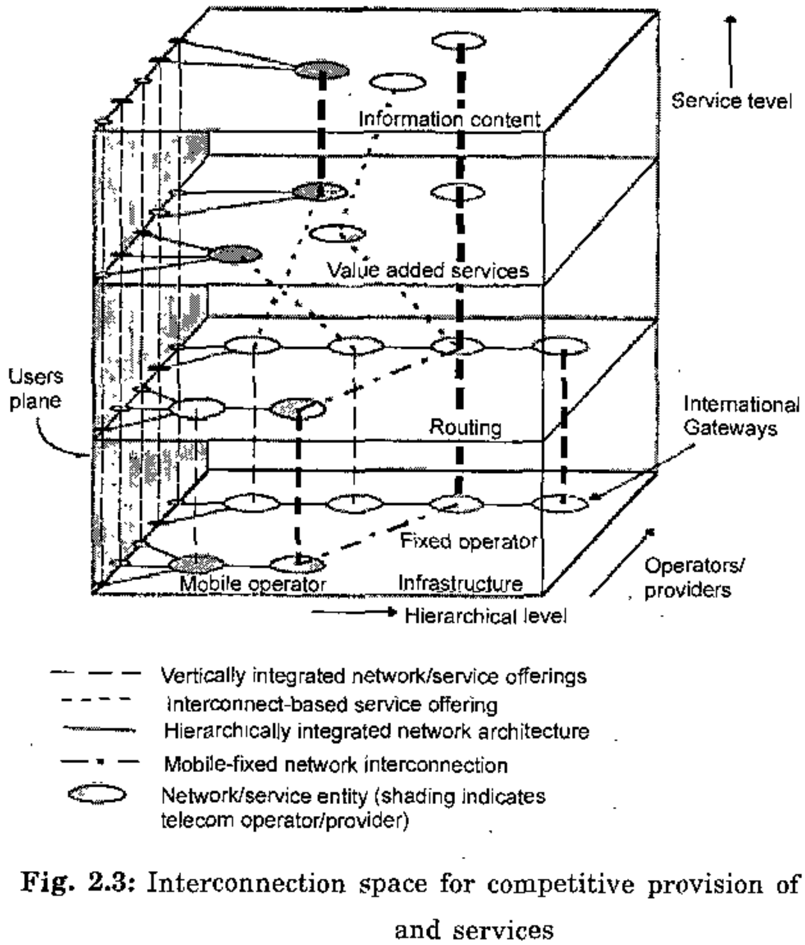

Fig. 2.3: Interconnection space for competitive provision of networks and services

In a regulatory regime allowing interconnection by a mobile operator (shaded in Figure 2.3), an MSC will be interconnected to the PTT's switching hierarchy. The mobile operator may also interconnect its signalling system with the PTT's. Independent service providers (at higher layers) may interconnect to the PTT to receive lower-layer transport services. These new paths in the interconnection space often represent innovative technical relations in terms of interface standards, management of security or mobility, allocation of service quality levels, etc. Such new paths also involve entirely new economic transactions between organisations, with private and public costs and benefits yet to be determined.

The policy issues facing a regulator are to decide to what extent the *costs and benefits of a particular path through the interconnection* space can be discovered—and allocated—by a free market, or if regulations are required to enforce desirable interconnection paths. For instance, regulatory intervention might be deemed necessary to open appropriate paths by standardisation of crucial interfaces, such as GSM air interfaces or interfaces to the international Signalling System No 7. Paths which depart from overriding public-policy objectives, for instance by wasteful use of radio spectrum or violation of user privacy, may be subjected to financial charges or be completely barred by the regulator.

2.6 CONCLUSION: REGULATION FOR TECHNOLOGY SUCCESS

A key success factor for the rapid international acceptance and continued evolution (Mouly and Pautet 1995) of the GSM networks in more than one hundred countries has been the fact that the GSM standard does not restrict itself to the radio subsystem and its air interface between terminals and base stations. GSM caters for all crucial aspects of interworking with fixed public *telecom networks* (PSTN *and* ISDN). This approach was chosen in Europe, because the majority of mobile calls or data applications will, in the foreseeable future, continue to originate or terminate in a fixed national network, often with proprietary national interfaces. The resulting problems of ensuring adequate interworking and mobility management have been much less for mobile systems in Japan and in North America, despite the present competitive multi-operator environment in the USA. The omnipresent "Bell System", owned and operated by AT&T throughout the USA until formal divestiture in 1984, has ensured a much wider uniformity of the network interfaces and engineering practices than in Europe's multitude of different PTT organisations.

The operational need for the GSM-system to interwork with the European patchwork of national networks, and to manage user mobility across technically and operationally incoherent European territories, enforced common frequency bands and the joint development of a mandatory mobile-network standard for the entire European Union. Moreover,

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this standard includes the use of the international Signalling System No. 7 (SS7), for instance to identify and authenticate users away from their own operator. However, the initial costs of this arduous effort have now been earned back with ample interest. In the author's opinion, it may be the most important reason for the unchallenged ability to deploy GSM-based systems so fast world-wide.

An ubiquitous network standard based on SS7 has another advantage, namely, the ability to create and support sophisticated applications. The higher-layer GSM services in Figure 2.2, such as intelligent voice messaging, information services and the Short- Message Service (SMS, unlike a paging system, provides confirmed delivery of texts of up to 160 characters) can be managed internationally through SS7. This also allows flexible customer care and billing, tailored by an operator or service provider to meet its particular commercial plans. This approach has proved a major asset in competitive mobile markets, where it may be commercially important to attract demanding leading edge users prepared to pay the marked-up price of value-added services. Mobile telecom management networks (TMN) based on SS7 may also take advantage of the benefits of the recent technology branching shown in Figure 2.2, by adding the benefits of the most recent, high-performance computer platforms. Such platforms range from affordable PCbased systems for a minor service provider or capacity reseller, to sophisticated multiprocessor systems required in the IN of a major operator.

By exploiting all three technology branch effects shown in Figure 2.1, a digital mobile system becomes empowered to outperform a standard fixed PSTN in terms of the service features available to users of affordable terminals, anywhere and at any time. This provides scope for direct competition with incumbent operators of fixed networks. In the Nordic countries of Europe, the time when effective mobile competition on price and service features will start to deprive the former monopolists of their fixed telephone subscribers, may no longer be far away. It is illuminating to compare the mobile subscriber percentages for Sweden and the USA. While these two rich countries are very comparable in several important respects, both economically (average income and fixed telephone density) and geographically (population density, landscape), Sweden has substantially outperformed the very country where cellular radio was invented. Can this perhaps be construed to be a consequence of a more coherent mix of public policy objectives and new technologies in Sweden than in the USA?

The Scandinavian trend towards parity of wireless public networking may also provide a perspective for some less privileged countries where the fixed national telephone network has not yet reached a high penetration. Given the present development in performance and cost of wireless and wired network technologies (both terrestrial and satellite-borne (Westerveld 1996)) and user terminals, policies based on the best mix of technologies for leap-frogging towards universal service provision of telephony should be carefully considered.

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SUMMARY

- Powerful communication and computing functions and terminal devices have become economically viable thanks to the electronic revolution of integrated-circuit (IC) technology. This enabling technology allows a large number of electronic components to be etched into a minute 'chip' cut from semiconductor material.
- Like most other technologies, wireless communication was initially developed in our classical human endeavour to overcome *natural barriers*.
- Conceivably, such problems and security 'firewalls' form two reasons why strictly separated, dedicated computer platforms are increasingly introduced in support of intelligent networks. In this way, IN or TMN software problems and the proper switch software problems may become easier to distinguish, identify and resolve.
- The omnipresent "Bell System", owned and operated by AT&T throughout the USA until formal divestiture in 1984, has ensured a much wider uniformity of the network interfaces and engineering practices than in Europe's multitude of different PTT organisations.

REVIEW QUESTIONS

1. Discuss Microeletronics in the area of telecom.
2. Discuss progress and prospects of optical transmission.
3. Discuss telecom software.
4. Differentiate between the PSTN and ISDN.
5. Explain the open network provision.
6. Define the BSCS and MSCS.

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CHAPTER 3 DESIGNING NETWORKS TO CAPTURE CUSTOMERS: POLICY AND REGULATION ISSUES FOR THE NEW TELECOM ENVIRONMENT

★ STRUCTURE ★

3.0 Learning Objectives

3.1 Introduction

3.2 New Telecom Environment

3.3 Competing for Control: Strategy and Policy

3.4 Strategic Consequences

3.5 Policy and Regulatory Choices

- *Summary*
- *Review Questions*

3.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- describe controlling access of the customer and marketing information.
- define the infrastructure capacity and investment strategy.
- describe the police and regulatory choices.
- explain the new telecom environment.
- know about the employment consequences.

3.1 INTRODUCTION

Innovations in electronic information and communication technologies are creating exciting and challenging opportunities for new commercial and non-commercial activities. These innovations are of significant economic interest and have many social, cultural and political implications for all aspects of commercial and everyday life. They are calling into question virtually all the conventional wisdom about how markets for the production and consumption of new information and communication products should be organised. Governments around the world are adopting policies and regulations for the future information superhighways. In Europe the goal is to stimulate investment and to ensure that European equipment and service producing companies attain a leading position in global markets.

In the face of rapid technical change and the restructuring of markets, a central problem for government policy is to navigate a route between monopoly power, network integration and political interference, and competition, network fragmentation and government indifference to social consequences. Major issues are confronting policymakers and regulators in the face of the convergence of telecom, computing and audio-visual markets, and the introduction of competition in the telecom market. This chapter focuses on changes in the nature of control over the ownership, operation, and use of the telecom infrastructure and services and the implications of these changes for policy and regulation.

3.2 NEW TELECOM ENVIRONMENT

Businesses, governments, consumers and labour representatives cannot help but be aware of the powerful trends in the telecom industry on a global level. These trends have major implications for the suppliers of networks and services and for customers. The opportunities created by technical innovations are resulting in a contest between the Public Telecommunication Operators (PTOs) who now must operate in liberalized markets and many new entrants from the computing and audio-visual sectors (OECD 1992). There are three significant pressures for change: 1) internationalisation of telecom supply; 2) competition within national markets; and 3) the termination of monopolies on the provision of voice telecom services as, for example, will occur in the European Union in January 1998 (Council of the European Commission 1990). In response to these pressures, regional and national government policy responses seek to implement policies to create incentives for new entry in the market and to ensure that incumbent PTOs operate on a commercial basis as the result of privatisation or greater independence from direct governmental influence. In all cases, policies and regulations must be introduced in a very uncertain environment. Uncertainty is present on both the supply and demand sides of the market.

Part of this uncertainty is the result of rapid changes in the evolution of communication networks and the services they support. Distinctions have been drawn historically between content and carriage and between infrastructure (all means of transporting information using analogue or digital techniques) and services (transporting and routing traffic,

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managing networks and making connections over the underlying infrastructure). Different policy frameworks have applied to three spheres of activity: telecom, broadcasting and cable television.

As visions of national and global super-highways begins to become a reality as a result of investment in networks with high capacity that can carry two-way switched traffic of all kinds, the convergence of cable television, telecom and radio-based networks is creating the potential for overlap between traditionally distinct industry sectors. For example, from a technological point of view:

- cable operators will be able to offer telephone service;
- broadband video, High Definition Television and multimedia services can be offered over a broadband (e.g., optical fibre) switched network, over upgraded cable television networks, and over broadband wireless networks;
- broadcast distribution can be provided by cable operators, public broadcast networks and satellite broadcasters; and
- point-to-multipoint data downloading (data casting) can be provided by broadcasters, satellite broadcasters and the PTO.

Many foreign and domestically-owned suppliers in the telecom, cable television, broadcasting, publishing, computing and software industries are seeking to secure their future revenue streams through ownership or control of the infrastructure and/or the content that will reach into the homes and offices of the 21st Century. They can choose to invest large amounts of money in upgraded networks before there is clear evidence of strong business and consumer demand for new services. Alternatively, they can wait to commit financial resources until they have a better understanding of the conditions under which customers will be prepared to pay for advanced information and communication services.

As telecom markets are liberalised, the transformation of the PTOs is taking a number of distinctive forms. In some cases a parent company will include a number of smaller operating companies and related units and the telecom service operator has a strategy for transforming the organisation into a profitable and flexible private company.

In others, a vertically integrated structure embraces all the telecom related activities. In both cases, newly privatised companies are promoting a culture of decentralised power and of competitiveness. The PTOs are becoming involved in webs of alliances and their diversification strategies are intended to meet the requirements of corporate customers, increase the scale and quality of operations, and explore investment opportunities outside national markets (Cave and Shurmer 1995).

National fixed telecom infrastructures generally are controlled by network services divisions within the PTOs. Their strategies focus on strengthening their positions in home markets through strategic partnerships, joint ventures and co-operation with other companies. Most of the PTOs are modernising their networks but they are reluctant to substitute copper wire with optical fibre which reaches the wall socket in the home because, in many cases, existing network are capable of delivering new service applications and the strength of demand is uncertain.

The traditional PTOs are facing competition in some segments of their markets and not in others. Licences are being granted to competing mobile telecom operators and, in many countries, there are initiatives to encourage electricity and railway companies to build competing fixed networks. Cable television operators are experimenting with new services and diversifying into the provision of video-conferencing, video telephony and fax services, often through acquisitions and joint ventures. New Digital Audio Broadcasting, Digital Video Broadcasting, and data casting services are being developed by broadcasters and direct satellite broadcasting companies are forging alliances with information content providers to offer an array of new services to businesses and individual consumers (Mansell et al. 1995).

There are two basic scenarios for the way these changes are influencing developments in the market. The first, as shown in Table 3.1, is an *Idealist* scenario which envisages the emergence of full competition in the market. The second is a *Strategic* scenario in which an oligopolistic market structure emerges where a few dominant players vie for success in the market (Mansell 1993). The first scenario implies only a minimal role for regulatory authorities as the market performs according to the expectations of outcomes in a perfectly competitive market (High Level Group on the Information Society 1994). The second, much more likely scenario, implies that the need for regulation will increase. However, it does not imply that regulatory measures which have been effective in the past will continue to be so in the future.

Table 3.1 : The New Telecommunications: Policy and Regulatory Challenges

Full Competition Scenario (Idealist)	***The Dominant Player (s) Scenario (Strategic)***
Permeable seamless networks	Fragmented networks
Universal Services	Reduced universality of services
Demand-led telecommunication industry	Supply-led industry, multinational user pressure

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Open systems, common interface standards	Weak stimuli for competition
Co-operative partnerships, transparent network access	Rivalry, non-transparent network access
Minimal regulation	Increasing regulation

Some of the new players in the market are municipal groups, researchers and small businesses with the expertise to experiment with the Internet and other advanced services. Others are extremely large and active throughout Europe and globally. The technical means exist to *unbundle* multimedia and other advanced information services and applications from the physical transport infrastructure. However, a parallel pattern of *bundling* of infrastructure and service provision is emerging among powerful industrial conglomerates. These often involve content providers and international telecom service providers— such as BT-MCI-BBC and Bertelsmann-Canal Plus-Deutsche Telekom- France Telecom. Foreign telecom operators are leasing capacity in multiple domestic markets to launch new services and they are building data networks for international value-added services.

As the PTOs face greater competition, national governments are responding to pressures to separate operational functions and policy and regulatory functions. These pressures may take the form of directives promulgated by regional authorities (European Commission 1987) or by observations of influential organisations such as the OECD (1994) or the World Bank as to best practice in the organisation and operation of telecom. In many countries, questions are being raised as to whether there is a need for radically new legislative frameworks which abandon the industry sectoral distinctions of the past.

Existing broadcasting, telecom and cross-sectoral competition legislation may be inappropriate in the light of technical convergence, the need to address market concentration, and to ensure consumer protection. Institutionally, telecom policy issues are becoming interdependent with those regarded as the concerns of other ministries in government. However, different public administrative organisations within government give varying weights to social, cultural, and economic issues, and to the priorities and objectives which are expected of network and service operators in the domestic market as compared to objectives for their success in international markets.

The policy and regulatory issues are more far-reaching than visions of the superhighway suggest. The information super-highway concept is an inappropriate metaphor because it focuses attention on information carriage or distribution as an end in itself. More important goals relate to the knowledge and information produced and consumed as a result of the distribution process. The fundamental issues for policy and regulation concern how initiatives by governments will affect how people interact with electronic media of all kinds in the future. They concern individual rights to privacy, democratic processes, industrial development, and competitiveness.

3.3 COMPETING FOR CONTROL: STRATEGY AND POLICY

In countries where governments have begun to permit new entry there is evidence of investor interest and limited market entry across the spectrum of networks and services. In theory, with all this activity, competition might be expected to flourish to the benefit of all the suppliers and stakeholders in the user communities. In practice, the strategies of the corporate actors on the supply side of the market interact with policy and regulatory measures in ways that are not necessarily consistent with social and economic policy objectives. Some of these inconsistencies come to light as a result of detailed investigation of the ways technical innovations, changes in policy, and the structure of markets are affecting the nature of control over the design, operation and use of networks and services. In effect control is being redistributed among the major suppliers in the market and there is little evidence that the Idealist scenario for the market is likely to predominate.

Controlling Access to the 'Network of Networks'

The interconnection of the components of the telecom infrastructure is sometimes regarded as a purely commercial and technical arrangement. Competitors requiring access to each others' facilities are expected to negotiate in the light of full information about the technical characteristics of networks and the likely structure of demand. However, a dominant incumbent operator can use a variety of strategies in a bid to retain and extend market share (Office of Telecommunications 1995a). Interconnection disputes have proven difficult to resolve with respect to leased and switched infrastructure facilities.

In markets where interconnection is required to enable new entrants to compete, policymakers and regulators initially encourage parties to reach agreement without intervention by the state. When parties fail to reach agreement, then provisions are made for a representative of the state (within a ministry or an independent agency) to mediate and/or to mandate a solution. In the initial stages of market liberalisation, solutions generally are reached on a case-by-case basis. With experience, standardised publication of charges for interconnection calculated using a transparent methodology is adopted.

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Delays in reaching agreement on interconnection are common. This creates uncertainty and influences the assessment by new entrants as to whether to invest in new capacity or to buy capacity from existing operators. Achieving interconnection and interoperability between the services offered by adjacent and willing network operators often requires new investment and co-ordination to ensure that networks are linked together in a transparent way. Interconnection of trunk and local networks belonging to alternative infrastructure operators, including utilities, the cable operators, and mobile service providers, and the incumbent PTO is a major bottleneck to effective competition.

Transparent rules for interconnection are needed and must be interpreted consistently (Council of the European Communities 1990). Experience indicates that there will be substantial gaps between the perceptions of incumbent operators and new entrants as to what is a reasonable outcome. A purely commercial arrangement can be disadvantageous for new entrants if the structure of charges is used to create unequal competitive conditions. Thus, failures to reach agreement on network interconnect issues may be an illustration of opportunistic behaviour on the part of new entrants, or they may be an 'early warning' signal of anti-competitive behaviour on the part of the incumbent operators. The policy and regulatory challenge is to distinguish between the two possibilities since time is likely to favour the incumbent.

Controlling Access to the Customer

There are several ways that the dominant players in the market are seeking to gain control over access to customers. From their perspective, if the customer can be 'captured', it is more likely that investment in innovative networks or services will result in revenues and potentially increased market share. Standardisation can be used as a strategic tool to strengthen the position of network and service operators (Hawkins et al. 1995).

Departures from fully open systems reduce compatibility among network and service interfaces. This may be in the interests of all suppliers and users if it creates incentives for innovative activity. Alternatively, it may be in the interests of only some suppliers and users in the market and provide another signal of anti-competitive behaviour.

Many of the dominant PTOs are being pressured by national governments to conform with regulatory provisions requiring them to implement open systems which allow transparent access by new entrants to the underlying network infrastructure. These operators generally argue that they favour open systems and transparency at this level of the network. In the newly emerging Internet environment there are signs that the largest players are achieving market dominance as a result of their control of access to the Internet backbone infrastructure (Cook 1996).

Changes are occurring in the strategies of the incumbent PTOs and other players as they seek to ensure secure control over access to the customer. The focus of many of these players is shifting away from the underlying network infrastructure to the interface between the customer, the multimedia or content provider, and the network operator. In this area, open system standards have yet to be agreed in areas that concern broadband switched networks and services and subscription service development using existing networks is at an early experimental stage.

For example, one of the most significant challenges in the convergent content/carriage marketplace is the introduction of the 'set-top boxes' and related decoding and billing equipment. This equipment will offer users 'conditional access' to new services. It will also incorporate encryption techniques to prevent unauthorized access. Developments in this area are being designed to secure a measure of control over the choices available to the subscriber and to influence the structure of the market.

In effect, conditional access systems are becoming the *gatekeepers* of access to networks in a similar way that a gatekeeper might control access to a bridge or the private property of a landowner. The systems are designed to ensure that programming and services are paid for in advance by end-users and in some cases by advertisers. The software embedded in conditional access systems enables the recording of consumer behaviour. When this information is embedded in a proprietary system it can create barriers to entry by prospective service suppliers. The software can be located in a 'settop box' or within the network infrastructure provided by the incumbent telecom operator and by cable network operators if they are permitted to offer an array of subscription and other services on a commercial basis.

Thus, the incumbents-and larger new entrants in the market are exploring new ways of gaining control of the access to the customer. The PTOs are intending to implement more transparent ways of ensuring that access to the underlying network infrastructure is possible, but they are finding very innovative ways of bypassing these measures which weaken their control of supplier and user options to access the network by introducing proprietary software based systems which intervene between the underlying infrastructure and the use of services provided by the network.

Controlling Access to Market Information

The players in the market also are engaging in behaviour which can give large conglomerates and the incumbent telecom operators unfair advantage in the acquisition of new competencies and the knowledge required to succeed in the market. Informal exchanges of information

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are an important part of the innovation process. From the perspective of vertically and/or horizontally integrated companies, these exchanges are part of the learning process and they contribute to competitive advantage in the market.

But to those excluded from these ways of sharing information, such information exchanges can be perceived as anti-competitive exclusive dealings among companies, subsidiaries or divisions that have a common interest. There are many examples of this kind of behaviour.

- Subsidiaries of national PTOs may gain access to infrastructure capacity on terms that are advantageous to their own businesses and a lack of transparency makes it difficult to determine whether other operators are being disadvantaged.
- Spin-off companies in the multimedia and other advanced services markets (e.g., internet access) may benefit by building on the knowledge acquired by the parent company, or the parent may benefit from early experimentation by its subsidiary. The issue is whether these opportunities give undue advantage to the incumbent operator thereby reducing entry possibilities by other players in the longer term.
- Mobile network operations are often provided by a division within the PTOs. This enables transfers of information, staff and funds within the organisation. The incumbent operator can benefit from the familiarity and goodwill that it has built up among its fixed service customers.
- In the cable television industry, valuable information is exchanged among the developers of services within the PTO-owned subsidiaries if they exist and between employees involved in other areas.

These examples suggest that conclusions about the viability of competitive entry in liberalising markets cannot be based on economic and technical considerations alone. Organisational structure, the culture of information sharing can enable knowledge transfers that are needed to build up the competencies required to address new markets. Such transfers are likely to be more frequent among companies that are vertically or horizontally integrated in new convergent markets.

In many cases, what is being acquired in these relationships is important information about what services customers will be willing to pay for. This can prove to be highly valuable commercial information and a source of market power. It is also virtually impossible for regulators to require disclosure of this kind of market information. The issue for policy and regulation is whether the relationships that do emerge are suppressing competition in the domestic market and whether this development is consistent with national policy goals.

Another important aspect of control over market information that arises in the presence of vertically and/or horizontally integrated enterprises facing competition concerns information needed by intermediate users of networks and end-users to evaluate alternative service offerings. They experience increased difficulty in accessing information that enables them to make informed choices. Regulatory initiatives are needed to promote transparency and a reasonable flow of this kind of market information.

3.4 TRATEGIC CONSEQUENCES

The outcome of the strategies adopted with respect to each of the above control issues is important in three key areas:

1. infrastructure capacity and investment strategy;
2. employment; and
3. universal service.

Infrastructure Capacity and Investment Strategy

The timing of investment in advanced information and communication technologies—fixed and radio based—is one of the most controversial issues in liberalising markets.

Governments and private sector investors do not want to be confronted with underutilized facilities if projected growth fails to materialise. The problem of determining the appropriate timing of investment in digital facilities and/or fibre optic links is exacerbated by the fact that investors must consider whether to: use existing infrastructure which may not fully meet their functional requirements; build new infrastructure to specifications similar to their competitors; and/or build new infrastructure to new specifications taking advantage of technical innovations.

Actual investment behaviour is linked closely to how the policy environment affects private investor decisions. Government policy needs to consider the reasons that private investors might seek to build over-capacity or to limit capacity using new or existing technologies.

Optical fibre technologies now offer a cost-effective way of meeting demand projections including the delivery of conventional broadcast channels and interactive information services and the migration towards High Definition Television. However, incentives for investment are influenced by the degree to which players in the market are able to *bundle* aspects of their activities together in a bid to protect their investments. In the search to establish up-stream and down-steam linkages, companies are looking for new ways of monopolising markets.

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The most effective strategy is uncertain and is influenced by whether companies can successfully win control over network access, access to customers and to market information as discussed above. These are key factors that will influence investment choices. Thus the challenge for policy is not to determine the appropriate timing of investment in new capacity, but to determine who has access to control over capacity investment decisions.

Control over the design of the technical aspects of the information highways is located with a small number of manufacturers and network operators. At the periphery of these networks there is a shift in control away from traditional operators. However, many of the new companies who are seeking to gain control are linked with traditional players. This could provide a basis for the emergence of new forms of market dominance and suppress new entry.

Employment Consequences

The employment consequences associated with technical change and market liberalisation are of growing concern. If competition flourishes, there is the possibility that some of those who become unemployed will be taken on by new entrants. PTO employment levels are declining and there have been changes in the skills mix, employment and working conditions, and the organisation of union representation (Trade Union Advisory Committee to OECD 1995). Most of the PTOs around the world have yet to experience the full force of competition and the number of employees is likely to continue to decline. The success of these companies in related domestic and foreign markets also will influence employment levels. Research has shown that there tends to be a five year lag between the initial liberalisation of national markets and the rapid decline in PTO employment levels. During this period, there are opportunities for collaborative initiatives by public and private sector actors to introduce re-training programmes to prepare employees for new jobs in a more competitive market environment (Mansell and Tang 1996).

Dynamics of Universal Service

Voice telephone service using copper wire twisted-pairs was relatively slow to achieve the universality it enjoys today, but it has reached a high level of penetration in many of the industrialised and newly industrialising countries, as has the penetration of coaxial cable systems in a few countries. Innovations in network and service technologies in recent years have raised concerns about the rate of diffusion of the new super-highways.

The Universal Service Obligations (USO) that could be imposed on one or more telecom network and service suppliers are generally discussed in economic terms, that is, who should pay for the extension of upgraded networks and access to more advanced services. At present, universal individual access to broadband switched networks is not being considered as a USO. In Europe, for example, universal service continues to be understood as individual access to the network via analogue or digital switches for the provision of voice telephony (Office of Telecommunications 1995c). However, there is concern about whether access to this 'basic' service will be sufficient in the information society. There are also concerns about whether cable operators should be subject to 'must carry' channel rules.

There is a shift away from policy discussions about access to networks and towards debates about the availability and affordability of information applications. A distinction between 'basic' access to networks at reasonable prices and 'basic' access to information needs to be made. The issue is whether network operators and service suppliers who control the gateways for accessing customers should be permitted to screen out certain kinds of information that may be regarded by public policy as essential to the conduct of business and everyday life. Decisions are needed on whether provisions need to be made to ensure access to certain kinds of public information (e.g., health, education, transport, government information) and whether the governments of member states or the European Union should underwrite the costs of ensuring that this information is accessible.

3.5 POLICY AND REGULATORY CHOICES

There is a continuing role for public policy and regulation to negotiate an appropriate balance among the interests of suppliers and users in a complex market which is characterised by the Strategic scenario. In this case, the role of government as a policymaker and regulator is three fold:

1. To constrain the market power of dominant operators where their activities are anti-competitive or exclusionary;
2. To create incentives for new market entry when market liberalisation and competition are given political priority;
3. To ensure co-ordination and among multiple actors in the supply of complex information and communication systems to meet a variety of social objectives (including consumer protection) and economic objectives.

Table 3.2 shows the key areas in which policymakers and regulators need to focus their resources. In the full competition scenario, there would be no need to be concerned with network interface standards; software embedded in networks would be used to enable the unbundling

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of the functionality or 'intelligence' embedded in networks; product differentiation would be strong across all the submarkets in the convergent communication market, there would be strong competition in service delivery; transparent access to network infrastructure and control of the access points or gateways would be evenly distributed among all suppliers are users.

Table 3.2 : The new telecom: policy and regulatory challenges

	Full Competition Scenario (Idealist)	**Dominant Player (s) Scenario (Strategic)**
Network interface standards	Open	Some propriietary
Unbundles intelligeuce	Yes	no
Product differentiation	strong all submarkets	supficial strong in some submarkets
Service dompetition	strong all submarkets	superficial, strong in some submarkets
Network dccess	open	closed
Network control	all suppliers & users	some suppliers & users

In the case of the dominant players scenario, however, the situation is different. Policy and regulation needs to consider the impact of the implementation of proprietary network interface standards, and whether it matters that network functionality is bundled together precluding its use by some suppliers and users. They also need to consider the implications of continuing monopoly control of some segments of the infrastructure and service markets and of the closure of network access possibilities. In effect they need to evaluate the impact on social and economic goals of the uneven distribution of network control among a few oligopolistic players in the market.

In many countries, the political process which enables governments to carry out these roles is not satisfactory. For example, it is perceived by potential new entrants as being slow and lacking in transparency. Difficulties are experienced in resolving conflicts of interest among economic and social actors. The existing decision-making apparatus also makes it difficult to respond effectively to the implications of technical convergence because of the fragmentation of legislative and policy/regulatory responsibility.

A wide range of views on the need for an 'independent regulatory agency' is commonly expressed within countries. However, as long as the suppliers in the market are not competing on a 'level playing field' and are developing strategies that will allow them to 'capture the customer', there is a need to devise effective ways of regulating their behaviour. By focusing on content and carriage issues in a coordinated way there is a greater likelihood that social and economic goals will be addressed.

Many countries have yet to implement a telecom-specific 'independent regulatory agency' model. These countries could lead the way by establishing integrated institutions that would allow regulators to build the expertise needed to address issues across the spectrum of advanced network infrastructure and services. An 'independent' agency which is autonomous from national ministries, would enable regulators to focus on a manageable number of critical problem areas. These problem areas are associated with 'competing for access'.

The majority of customers over the next ten years in many countries will be linked to two main access points to networks—telecom and cable. The penetration of radio technologies (mobile and satellite) will increase but they are likely to complement terrestrial systems rather than to substitute for them. Public policymakers and regulatory authorities have an obligation to private investors to provide clear signals for investment and to ensure that, whatever strategies are chosen by private concerns, the outcome for customers is as efficient and equitable as possible. In the present environment, there is often little transparency and business units are being *bundled* together (local, long distance telephone, data, and other services, cable, mobile, and interests in content production). This is occurring at the same time that technical innovations are making it possible to *unbundle* the provision of infrastructure and services. The central issues for policy and regulation concern the characteristics of control over the information gateways by domestic and foreign-owned companies.

Controlling the Information Gateway

Control over the 'information gateway' can be achieved by controlling access to the underlying infrastructure; the customer at the level of service applications; and access to market information. If national governments and regional authorities choose to promote competition they have little choice but to do so through the effective implementation of measures that tilt the market in favour of opening and diversifying access at all three of these levels. This will mean favouring new entrants. The regulatory apparatus can be used to influence the nature of control in the three critical areas.

1. *Access to the Underlying Infrastructure*: Network interconnection can provide a focus for regulation around which related issues

including universal service obligations, numbering, 'must carry' rules, etc., can be addressed. Incentives for investment, wider geographical distribution, accessibility and affordability of advanced networks and services can be created through the innovative use of interconnect arrangements.

2. *Access to the Customer at the Service Level*: Control of the software that supports billing systems and results in the collection of customer-generated information about transactions can be used to advantage to determine preferences for new services. Therefore, action with respect to open systems standards implementation is essential.

3. *Access to Market Information*: The *bundling* of the chain of relationships between infrastructure and service providers under a limited number of large corporate structures creates opportunities to learn more effectively about what services customers will be willing to pay for. If these relationships are not discouraged they are likely to benefit the major players and to reduce opportunities for entry into certain segments of the market.

The issues of control over access to networks and services all involve the new information gateways (or toll booths) of the information society. They are the important issues for public policy and regulation. They affect business and consumer freedom of access to, and use of, information and they are fundamental to the future of democratic processes.

SUMMARY

- Businesses, governments, consumers and labour representatives cannot help but be aware of the powerful trends in the telecom industry on a global level.
- The second is a *Strategic* scenario in which an oligopolistic market structure emerges where a few dominant players vie for success in the market (Mansell 1993).
- In effect, conditional access systems are becoming the *gatekeepers* of access to networks in a similar way that a gatekeeper might control access to a bridge or the private property of a landowner.
- The *bundling* of the chain of relationships between infrastructure and service providers under a limited number of large corporate structures creates opportunities to learn more effectively about what services customers will be willing to pay for.

REVIEW QUESTIONS

1. Discuss the new telecom environment.
2. Discuss the different strategic consequences.
3. What may be the different policies and regulatory choices in telecom?
4. Differentiate between the strategy and policy.
5. Explain the Dynamies of universal service.

CHAPTER 4 COST AND DEMAND CHARACTERISTICS OF TELECOM NETWORKS

★ STRUCTURE ★

4.0 Learning Objectives
4.1 Introduction
4.2 Cost Structure of a Telecom Network
4.3 Transmission/Long-Line
4.4 Trends in Investment Costs
4.5 Changing Demand Conditions
4.6 Conditions for Effective Competition
4.7 Size and Flexibility of Investment
4.8 Demand-Related Factors
4.9 Role of Technological Innovation
• *Summary*
• *Review Questions*

4.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- distinguish the monopoly and competition.
- explain about the cost structure of a telecom network.
- define the residential market and business customers.
- describe the conditions for effective competition.
- know about the changing demand condition.
- explain the trends in investment cost.

4.1 INTRODUCTION

One of the main reasons to undertake sector specific regulation of telecom markets has been the unique characteristics of cost and demand structures within the telecom sector. This chapter examines some general characteristics of cost and demand for telecom services, and on this background discusses how these affect possibilities for creating competitive telecom service markets.

One important economic reason for regulation is to help achieve the optimum level of production from a societal point of view, i.e., to ensure production of the desired products and services in the desired quantities and at appropriate prices for all consumers desiring them. The need for regulation depends on the ability of the market to create this situation by itself. The first basic question is whether production should be organised as planned production with possible corrections by the market, or production should be determined by the market with possible corrections from planners or regulators.

Historically, service production in the telecom sector has been organised by a monopoly network operator, selling its services on a market. In many cases the operator has been a part of the public sector and financial profitability has been only one of several objectives. The role of regulation in this situation has been to ensure that the monopolist behaved in accordance with the public interests and did not misuse its monopoly position.

The primary economic argument for this institutional set up was that a single operator would be able to provide services at lower rates and with a wider coverage than a market with a number of competing operators. A single operator is in a better position to dimension and plan the construction of the network (technical efficiency) and to avoid duplications of investments and excess capacity. Thereby economies of scale can be fully utilised to the benefit of all customers. In addition a single network operator can better ensure compatibility of all parts of the network, and technical and administrative costs related to network integration and interconnection can be minimised.

The experience with this institutional set up has been rather mixed. In practice it has been very difficult both to control tariffs and to ensure high productivity. And the pressure to allow new operators into the market has increased, especially in a situation with rapid technological advances and development of new products. The monopoly operators often have proved unable to meet customer demand in a satisfactory way. Competition sets a downward pressure on tariffs and encourages operators to avoid organisational slack. In addition, competition will motivate operators to innovate, to become more efficient and to be the first to introduce new services. It is argued that competition can ensure development of telecom services much better than attempts at strict regulation of a monopoly.

The disadvantage is that the above mentioned advantages of technical efficiency, economies of scale, and low interconnection costs at least partly will be lost. The economic balance between the advantages and disadvantages of more competition (depicted in Table 4.1) has been the main conjecture in telecom regulation for decades, but there is now a general consensus in favour of more competition. Today government policy and regulatory authorities in almost every country aim to introduce more competition into their telecom industries.

Table 4.1: Monopoly vs. Competition

Monopoly	Competition
Economies of scale	Organisational efficiency
Technical efficientcy	Pressure on tariffs (prices)
Low interconnection cost	Innovativeness
Public Interest Objectives	New Service Development

The question is how more competition can be realistically obtained that is likely to bring beneficial results. A fully liberalised market will not necessarily by itself lead to more competition. This depends very much on supply and demand factors that shape market conditions. This chapter examines these conditions and their potential impact on the competition that is likely to develop.

4.2 COST STRUCTURE OF A TELECOM NETWORK

The telecom sector is characterised by very large investment costs. The precise percentage of total costs attributed to investments depends of course on the definition of investments and of telecom activities (e.g., whether research, marketing or similar activities are included). Although some sources claim investment, and investment-related costs to be as much as 90 percent of the costs of productions, most estimates based on financial data, however, vary between 60 and 75 percent.

Thus, by all measures the telecom sector is comparatively capital intensive. To illustrate, Table 4.2 provides a cross sector comparison of wage shares in the Danish economy. The remaining share is almost all attributable to capital expenditures. Table 4.2 demonstrates that primary activities (agriculture and mining and quarrying) are the most capital intensive. In telecom and other network based utilities (electricity, gas and water) wage shares are at about 1/3 (and therefore capital shares at about 2/3), while all other industry groups are having substantial higher wage shares.

For an assessment of the cost structure's impact on market conditions, more than the level of investments in telecom is relevant. The type of investments is also important. A notable part of the investments are what economists refer to as "sunk costs". These are long term investments which can be used only for specific economic activities. An example is a fixed access network providing subscribers' access to the local exchange. This investment only has value for the supply of telecom services in this particular local area. Once the investment is made the operator can only exit this particular market at considerable costs. Other investments have a shorter time horizon and/or can more easily be applied for other activities. Investments in telecom networks divide into the following functional elements:

- Terminal equipment
- Access Network
- Switching
- Transmission/Long line
- Other (buildings etc.)

Table 4.2 : Wage Shares by Kind of Activity

Industry	**Wages as % of Contribution to GDP**
Minning and quarrying	8.9
Agriculture	23.5
Electricity, gas and water	29.7
Telecommunication	37.4
Market services (incl. telecom)	46.1
Manufacturing	67.1
Construction	78.3
Non market Services	94.4
Total	385.4

Terminal Equipment

Once telephones were, for the vast majority of users, the only type of customer terminal connected to the network. These were all provided by the operator and rent was included in the access charge. It was part of a bundled service. Today a wide range of terminals are connected to the network in addition to telephones (faxes, PCs, PABXs etc.), and customers are now allowed to buy their own terminals, either from the network operator or from other suppliers. These terminals are owned by the customers and are not a part of the operator's fixed capital. This allows users to become more independent of the operator, but it also reduces the network operator's requirements for investments.

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Terminal equipment is now, in most countries, unbundled from the telecom network, and for many purposes is not considered part of it.

Access

The local access network connects the customers to the national and international networks. The most common form of access is a twisted pair of copper wires from the user's terminal to a local switch. Coaxial cables provide more bandwidth than twisted pairs and are most common in cable TV-networks. Optical fibres are used for certain broadband services, but are mainly used in the interexchange network, where its higher levels of capacity can be used more efficiently. Investments in cables are long term investments with a lifetime of more than 20 years. Moreover the investments are very immobile. Once investments in the access network in a certain area are made, profit must be generated through communication services provided to customers located there. It is extremely difficult, if not impossible, to move investments to other maybe more attractive markets.

The access network is by far the most expensive part of the network. It covers between one-third and one-half of the investment costs. As access network assets have a relatively longer than average lifetime their significance on costs is even greater. The main cost components are cables and construction work related to the laying of cables.

Switching

The switching function is performed at the exchange by automatic, computer controlled equipment (or in older offices by electromechanical switches). Next to the access network, switching is the most expensive function. According to an Australian study, percent of the switching costs are in local exchanges. Major portions of the investments made in local exchanges, however, can be attributed to long distance communication or special services. The major part of the upgrading of the telecom network involves an upgrading of switching capability, especially with the conversion from analogue to digital technology.

4.3 TRANSMISSION/LONG-LINE

This type of equipment includes cables, radio-links and satellites connecting transit exchanges, as well as transmitters, repeaters, etc. It provides the capacity to provide all kinds of long distance services. Although new technologies have reduced long distance transmission costs dramatically in recent years, they are not really as significant in the total cost picture as access and switching costs.

Detailed cost data that disaggregates network costs among the different parts of the network are quite difficult to obtain and compare. A recent OECD study of national PTOs in the OECD area analysed 1992 expenditures on switching and transmission infrastructure as a percentage of total capital expenditure. Although it showed large variations among PTOs, suggesting different accounting procedures, it revealed that together the PTOs mostly spend between 60 to 80 percent of their capital expenditure on switching and transmission infrastructure (OECD 1995, p.52). In most OECD countries, the major investments in the access networks were completed long before 1992.

The OECD study also notes that drawing a boundary between switching and transmission functions is becoming increasingly difficult because both are converging towards software based systems. Some experts suggest the software cost of developing a telecom exchange could be 80 percent of the total cost, and the software may be upgraded several times over the working life of the exchange.

Table 4.3 summarises the results of four comprehensive studies on network costs made in different countries covering different time periods. The first two studies from Germany and Japan are made as studies of investments over a longer time span; the Australian and Canadian studies are made for the purpose of costing services as a guideline for pricing and only provide detailed data for a one year cycle. The categorisation and definition of network components also differ from study to study and comparisons must therefore be made with caution. However all studies establish access and switching as the main cost elements. The reason for the variation between figures from Bell Canada and from other operators arises primarily because certain local switching functions are included in the costs of the access network.

Table 4.3 : Network costs by network components (in %)

	Germany 62-71	**Japan (NTT) 52-90**	**Aystralia 87-88**	**Bell Canada 1993**
Terminal equipment	7	–	–	–
Access	40	35.5	34.5	50.1
Switching	30	29	25.0	13.9
Transmission/ Long line	30	11	11.5	18.8
Other	–	24.5	29	22.2

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4.4 TRENDS IN INVESTMENT COSTS

The most important factors of input to investments in telecom networks are electronic equipment, cables and wires. Prices for electronic equipment have decreased rapidly and are expected to continue declining in the future. This affects in particular the costs of switching but transmission is affected also.

Improved cable technology, and in particular the introduction of optical fibres, as reduced costs of cables substantially. Prices for copper wires are relatively stable, but new compression techniques are increasing its capacity. Optical fibre cable provides significantly greater capacity, and price reductions now make it competitive with copper cables for installation of new access networks on greenfield sites in some locations.

However, at present it is not economical to replace installed copper cables. In the access network the laying of cable and wire constitute as much as 90 percent of the costs (Falch 1993). Thus the cost of the cable itself plays a diminishing role. But in the transmission network, where the increasing capacity of optical fibres can be utilised more advantageously, fibre cable will have a substantial impact. A forecast from Cambridge Strategic Management group estimates that by the year 2000 (Forge 1995) the costs of raw capacity of submarine cables will fall to just one percent of the costs in 1987.

Although investment goods are becoming cheaper, the level of investments in telecom services is growing rapidly and capital costs still constitute a substantial share of total costs of production. The historical development of the cost profile for telecom services can be illustrated by US cost data. The FCC has published cost data for US common carriers going back to 1950. Changes in accounting principles complicate comparisons for the years after 1987, but capital related operating expenses (depreciation and amortisation) in 1994 were reported to be 24 percent of total operating expenses.

Thus it can be seen from Table 4.4 that the proportion of capital related operating expenses has since the 1960s remained fairly constant. If the cost of capital and capital related taxes are added, total capital costs would at least be doubled, representing 40 to 60 percent of total annual economic costs. On the other hand, dramatic decreases in traffic related expenditures, due to automation of switching functions and the beginning of the increase in commercial expenses as more resources are allocated to marketing and advertising can be seen in Table 4.4.

Table 4.4 : US Common Carrier Operating Expenses (in%)

	Maintenance	Depreciation and Amortisation	Traffic	Commercial Exp	General Offece	Other	Total
1950	29	14	28	12	9	7	100
1960	29	22	19	14	10	7	100
1970	31	24	14	12	9	10	100
1980	32	21	8	15	10	14	100
1987	25	28	5	16	12	13	100

Technological improvements have changed the balance between services quite dramatically. *A study made on the cost structure on a fibre-optical* network indicates that bandwidth and distance will play a smaller role for costs in the future (Table 4.5). Further advances in compression techniques will add to this development. The reason for this is that with optical fibre the costs of cabling are almost independent of capacity needs.

Table 4.5 : *Distribution of Costs in a Fiber Optic Network*

	Costs in% of Total Costs
Access related costs	71
Distance related costs	13
Capacity related costs	16

However, one important reservation has to be made to these figures. The distribution of costs is estimated on the basis of current services and does not take the network requirements of future services into account. The cost of services demanding more bandwidth are much more sensitive to distance than, for example, the costs of a telephone call. The reason for this is that the capacity of the access link is often underutilised.

A Japanese study by the Ministry of Post and Telecommunication on the investment costs of a B-ISDN network serving 50 million subscribers forecasts the costs of long lines equipment (which must be categorised as distance related costs) as 38 percent of the total (Table 4.6).

Table 4.6 : Forecasting of Investments Needed for a B-ISDN Network with 50 Millions Subscribers

Items	Predicted Amount B USD	% of Total
Subscriber Line	126	41
Local Switches	63	21
Long Line Facilities	116	38
Total	305	100

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This indicates that demand for new types of services may have a substantial impact on the future cost-profile of network operators. New services will also affect the cost profile in another way. In some services, the basic network provision itself will only be a minor part of the service delivered. Value added network services and intelligent services both add new activities and introduce new types of costs to network operators. Some of these costs such as development costs will be usage independent fixed costs, but they will not be regular sunk costs, which are tied to service provision in a specific geographical area.

There are other implications on the cost structure. Decreasing cost trends for equipment reduce the economic lifetime for installed network capacity. This implies that investments must be depreciated at a faster rate and profitability requirements must be raised. It also increases the barrier to exit as "old equipment" will have less value in alternative uses. Another important factor is the possibilities of substituting cables with satellite and cellular technologies. As these new networks compete with cable networks and become part of hybrid networks, the cost profile will continue to change.

4.5 CHANGING DEMAND CONDITIONS

As a large proportion of the costs of telecom can be attributed to long term investments in the access-network, careful forecasting of network requirements is essential for cost effective provision of telecom services. In the OECD area, high growth rates in revenue in the mid-1980s have been followed by more moderate growth rates in the 1990s. A part of the explanation is decreasing tariffs as the decline in growth rates in the number of mainlines has been less pronounced (Table 4.7). Still, the slowdown indicates the market may be reaching saturation level in basic telephony services faster than new value-added services are stimulating new growth.

Table 4.7 : Growth in Public Telecom in the OECD Area

	CAGR 1982-87 (%)	CAGR 1987-92 (%)
Revenue	7.22	3.44
Mainlines	3.90	2.33

Although many new services have been introduced and present impressive growth rates in number of subscribers, telephony is by far the most important service. In Table 4.8 the revenue for Tele Denmark by service is depicted. The most important of the new services is mobile telephony. This service contributes 5–10 percent of the total revenue inmost OECD countries. Only in Sweden and Finland has the revenue exceeded 10 percent. However, with the present growth rates, mobile services can be expected to be more important in the future. Data-services and leased lines represent very small markets compared to telephony services. Therefore it is not surprising that patterns of demand have been studied most intensively for telephony service, and that a large number of econometric studies estimating key parameters have been prepared. On the other hand, new services have been studied much less intensively and very little is known about patterns of demand for these services.

Table 4.8 : Tele Denmark revenue by activity (in % of total)

	1994
Domestic telephony	40
International telephony	16
Mobile telephony	8
Leased lines	5
Sale and installation of Terminal equipment	14
Phone books	3
Datacommunication	2
Cable-TV	2
Others	10
Total	100

Demand for telephony has a very low sensitivity to changes in tariffs, but more expensive services such as long distance telephony tend to be more sensitive than local telephony, which is more of a necessity. Another characteristic for both telephony and many other communication services is the positive externalities created by the service. A completed telephone call requires the participation of a second party, which in most cases also is benefiting from the call (call externality). Another externality arises when a new subscriber is connected to the network. This will benefit all other subscribers which possibly could have a need to communicate with the new subscriber (access-externality).

This point is very important for the introduction of new services. New services need to establish a critical mass of network subscribers before they really can become useful and the market can unfold.

Telecom services are offered to two distinct groups of customers with quite different patterns of demand, business and residential customers. The distribution between these two groups varies from country to country. In general the residential sector is most important in countries with a high penetration of telephones. Sweden, for example has near universal service with 78 percent of the lines connected to residential

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subscribers. For countries with underdeveloped telecom systems the vast majority of lines are connected to business users (ITU 1994).

If we examine the money spent on telecom, the business sector becomes much more significant in all countries. Although Denmark has near universal service with the great majority of lines supplied to residential customers, calculations based on Danish national account data indicate that two thirds of the communication revenue originates from business customers.

Business demand is not equally distributed among the different sectors of the economy. Telecom is used most intensively in the services sector—especially trade and finance—and of course telecom services (Table 4.9).

Table 4.9 : Average Telecom Expenditures as % of Total Costs (US, 1984–89).

Industry	
Telecommunications services	2.26
Wholesale and retail trade	1.50
Finance	1.21
Other services	1.06
Transportation services	0.83
Other manufacturing	0.55
Paper and Painting	0.53
Machinery	0.46
Construction and related	0.29
Metals	0.23
Broadcasting and utilities	0.20
Food and tobacco	0.17
Agriculture and mining	0.16
Transportation equipment	0.14
Chemicals, plastics and related	0.14

An important point in relation to the need for regulation is that the demand profiles of these groups are quite different. A few decades ago all customers were demanding the same service – namely telephony. Business customers were generating more traffic but the service demand was basically the same. Today many business customers are demanding a wide range of communication services, which only a few residential customers consider to be relevant for them. On the other hand cable TV is only of limited use for business customers and other infotainment services primarily directed toward residential customers are being developed. Therefore, there is a growing segmentation between different user groups in terms of markets, services and interests.

The main differences between these two markets are summarised in Table 4.10. These differences result in different cost and market structures for the different customer groups. For the residential market the availability of an access network is particularly important. As the load of traffic per connection is relatively low, the needs for capacity have been more stable in residential markets than business markets. Most residential customers have needed only an ordinary telephone line to meet their demands. Therefore, *the need for investments to upgrade the network* have been most apparent in business districts.

Table 4.10 : Demand Characteristics for Residential and Business Customers

Residential Market	Business Customers
• Homogenous market	• Heterogeneous market
• Many small customers	• Both small and large customers
• 1-2 lines per customer	• Some customers with many lines
• Limited load of traffic per line	• More traffic per line
• Telephony and cable-TV *dominant services*	• Demand for wide range of *serviece*
• Limited use of advanced service	• Many customers with special needs

Some business customers, especially larger firms and financial institutions, *have in recent years* demanded still more advanced services. These are the customers benefiting from the latest technological advances being implemented in the network. They may require new network facilities and tailor-made solutions developed by the incumbent network-operator or other service providers.

4.6 CONDITIONS FOR EFFECTIVE COMPETITION

In economic theory, the notion of perfect competition is used to characterise an unregulated market where the forces of competition drive down prices to the level of production costs, and both price and production develop in such a way that the societal welfare is optimised. Such a market can be established if the following conditions are met: sufficiently large numbers of independent suppliers; sufficiently large numbers of independent consumers; free and easy entry and exit of suppliers; and full visibility of market conditions. It is not at all clear whether the telecom markets are likely to get close to meeting these conditions. If all these conditions are not fulfilled, the market cannot by itself optimise

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production. In this case it may become necessary to develop regulatory measures, which can "help" the market function more closely to the optimal condition.

In telecom the first condition is clearly the most problematic. It is obvious that this condition is not fulfilled today. In most areas - especially in the residential market - typically only one supplier is available. The major reason for this is that most countries have government regulatory restrictions, but in countries without such restrictions the market still has been dominated by only one supplier. This indicates that the characteristics of the market also have provided restrictions on the number of suppliers.

The point of departure in national telecom markets is one incumbent operator. In theory, other suppliers will arrive at the market as long as tariffs are high enough to permit them to do so profitably. This will result in competition and a downward pressure on tariffs. This process will take place until tariffs have reached a level where they reflect the efficient cost of production and no more suppliers are attracted.

However, it may be very difficult for new suppliers to enter the market. The most important barriers to entry which restrict the number of suppliers are:

- Economies of scale
- Economies of scope
- Economies of density
- Size and flexibility of investment.

These factors affect both newcomers to the market and small companies that may already be present in the market. These factors do not play the same role in all network segments or in all market segments, as cost structures vary from segment to segment.

Economies of Scale

Economies of scale reflects the opportunities for reduced unit costs with increased output. They provide efficiency advantages for large units of production and new entrants will find it difficult to compete with already well established firms with large scale production. If production of a certain service involves considerable economies of scale, new firms will find it difficult to compete with existing firms that have a well established large scale level of service supply. Furthermore smaller companies will tend to merge into larger units to remain competitive. Therefore, an unregulated market is likely to result in a very limited number of large scale suppliers.

There has been considerable disagreement on the extent of economies of scale in the telecom services industry. It has even been argued that operators above a certain size will experience decreasing returns of scale, partly due to increased administrative costs related to co-ordination of activities in a large organisation. The data on network costs presented above indicate the presence of some economies of scale but do not by themselves demonstrate economies of scale significant enough to make competition unworkable. The major part of the costs can be attributed to the access network.

Therefore, there is only a limited scope for pure techno-economic benefits related to a wider coverage going beyond the level of the local exchange, e.g., the establishment of a single national operator. In a review of 20 cost-based studies based on figures from AT&T and Bell Canada almost all studies indicate some degree of economies of scale. However, such studies do not take into account that the analysed cost structures have evolved under a regulated monopoly. Large operators will tend to invest in technologies where technologies of scale apply. Thus it is not correct to presume that the cost structure that has emerged under one market structure would have emerged under an alternative market structure (Wenders 1992).

If economies of scale are significant, one might expect it to be exhibited by increased productivity in large scale operators. In Figure 4.1 the results of one measure for productivity of PTOs in OECD countries are present ed., i.e., mainlines per employee. In order to illustrate the possible implications of scale the national operators are ranked by size (smallest to largest). Although a very slight trend towards higher productivity with increasing size is illustrated, there are notable exceptions (Turkey and Luxembourg especially). The data is consistent with the hypothesis of scale economies, but it does not prove the case as the productivity data is influenced by other factors as well, and once again the scale of the economies indicated are not sufficient to make competition unworkable.

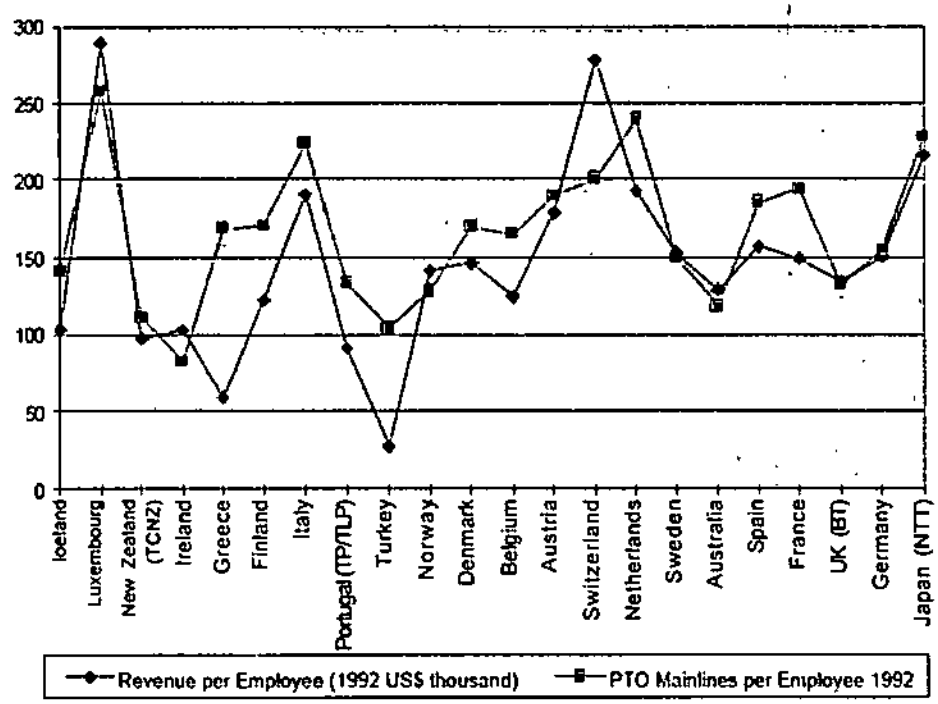

Fig. 4.1: Productivity Indicators for PTOs

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In addition, although the presented evidence indicates a degree of economies of scale for delivery of telecom services as such, economies of scale do not necessarily apply for all parts of the service. If the various service components are produced separately, there will be areas where economies of scale are even less pronounced. For example, when the telecom handset and other terminals were separated from the network, a terminal market was created where scale effects are less significant and small independent suppliers can compete with the large operators in the supply of many kinds of terminals. In many countries the PTOs have lost most of the terminal market to competitors. Nevertheless for network services economies of scale remains a significant but not controlling factor.

Economies of Scope

Economies of scope are defined as cost savings related to supplying a number of different services by the same company. Economies of scope can be a barrier against smaller companies only supplying a limited range of services. This could be a local operator or an international carrier. Three different types of economies of scope can be distinguished:

- economies of horizontal integration (e.g., telephony and data);
- economies of vertical integration within the network; (e.g., local and long distance); voice and value added network services (e.g., call forwarding); and,
- economies of vertical integration beyond the network (e.g., information production and distribution).

Traditionally, the incumbent operators have produced all telecom services themselves. However, digitalisation has improved the technical possibilities for vertical separation of different service elements. In addition, decreasing costs of transmission give more flexibility for the location of value added services such as voice-mail and other intelligent network services. Digitalisation also improves integration of transmission of different services in the same network. However, the extent of economies of scope related to provision of narrowband telecom and CATV services are still under debate (Stolleman 1993).

Economies of scope can also arise in billing and customer relations. Operators supplying a full range of services can offer their customers one stop shopping and one stop billing. This gives an advantage compared to service providers specialising in a few areas. It is a factor influencing global alliances in telecom to meet the demands of global transnational corporations.

Economies of Density

Economies of density is related to the fact that network costs per connection decreases with increasing density of connections. The primary reason for this is shorter access lines and better capacity utilisation of the network. Economies of density implies that it is very difficult for newcomers in an area to compete with a former monopolist, where local networks with a high penetration already have been established. This is of course particularly important in the residential market, where the revenue per customer is much lower than in the business sector.

A newcomer may either build its own infrastructure from scratch or buy parts of its capacity from the incumbent operator. In some instances a duplicate network infrastructure can be built on top of other types of infrastructures e.g., local cable-TV or electric power networks. But even in these cases considerable investments must be made before sufficient economies of density in supplying interactive network services can be achieved.

From a regulators point of view the barrier created through economies of density can be overcome either by supporting the building of alternative infrastructures - e.g., right of way access, tariff regulations, taxation of the incumbent operator or other approaches. Or regulatory measures can be enforced in order to ensure competitors fair access to existing network facilities. The first solution may promote short run competition most directly. But if there are significant economies of density it may be a costly solution as it implies a substantial duplication of network investments. Furthermore it is probable that this competition will be eliminated in the long run as the competitors are driven toward more efficient arrangements for meeting consumer demands.

4.7 SIZE AND FLEXIBILITY OF INVESTMENT

The barriers of entry and exit in telecom are related both to size and lack of flexibility in investment in facilities. The large amounts of investment and the demand for technical capability makes the market for telecom infrastructure development quite exclusive. Companies in this sector must command considerable financial strength. But more important is the lack of flexibility in investments already made. A fixed network cannot be moved and can only serve communication between certain specific locations. Manufacturing industries can sell their products at different markets without major changes in production equipment. However in telecom this is not possible. Investments in telecom assets are for a large part called sunk costs – investments in relatively long-lived assets ear-marked for a specific activity. Once the investment is made it will be very difficult to leave the market without major losses.

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4.8 DEMAND-RELATED FACTORS

Demand for telecom services evolves from a core demand for a homogenous output—basic telephony— for which pure transmission is the common ingredient in a wide range of services, where transmission often is combined with other service functions.

Increasingly these services are offered by service providers other than the provider of the basic transmission services, usually the incumbent PTO. Other producers may be foreign telecom operators, computer companies or companies from another industry. Cost structures differ for different services, and market structure depends a great deal on the type of service demanded. Cable based transmission intensive services with a low level of processing involve relatively higher sunk costs than processing intensive services, where substantial value is added to the basic transmission.

So far, increased demand for new services has tended to change the overall coststructure in the direction of a reduced share of costs for transmission and an increasing share on processing and value added components. This implies a decreasing role of sunk costs and better conditions for stimulating competition at least in the value-added segment. Advanced services provided for large business customers are less dependent on services from the network operator. If special facilities are needed, special network solutions can be designed on a network of leased lines.

This development may not be feasible for services designed for residential customers. Advanced residential services must rely on transmission facilities as defined by the local network operator. As the existing cost structure implies that basic residential services is the area where there are the greatest barriers to developing effective competition, diffusion of such services may be restricted to a pace determined by the local PTO.

Positive externalities related to usage and access imply that consumers depend not only on the network operator but also on the behaviour of other consumers. Call and access externalities give telecom services the character of a public good. Therefore, a free market may result in production and usage of services below the social optimum. This problem is partly addressed for basic telephony by imposing on the operators a universal service obligation, but the problem may be more acute in relation to new services where obtaining a critical mass large enough to make the service attractive can cause difficulties. This barrier can be overcome by public initiatives, such as the generation of public demand and standardisation. However, it may be difficult beforehand to foresee which services deserve public support.

4.9 ROLE OF TECHNOLOGICAL INNOVATION

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Technical innovations have contributed to a reduction of barriers to competition in several ways:

- *Changing Structures of Network Costs:* Reductions in transmission costs limit investments needed for delivery of the same services. In particular the unit costs of the interexchange network capacity are being reduced continuously.
- *Development of Broadband Services* is closely related to reductions in costs of transmission. However, substantial demand for broadband services will multiply the demand for transmission capacity, and the costs of both the access and interexchange network will increase as a result of this major network upgrade.
- *Lifetime of Equipment is Reduced:* With rapid technological innovations old equipment becomes obsolete more quickly. This increases capital costs (a faster rate of depreciation is needed), shortens the planning horizon and increases the risk.
- *Digitalisation* increases economies of scope for provision of facilities, but reduces economies of scope for service provision. If effective interconnection rules are established, digitalisation improves the conditions for service providers without their own physical infrastructure.
- *Satellite and Cellular Services* can provide alternatives for some local exchange network services. The cost structure of air-borne services involve fewer economies of density than wired services. Therefore a degree of infrastructure competition can be introduced at lower costs. Although satellite and cellular services cannot be complete substitutes for wired based services they do reduce the monopoly power of local exchange operators somewhat, and provide an alternative for some business and residential services and customers although far less than a majority.

SUMMARY

- *The local access network connects the customers to the national* and international networks.
- Technological improvements have changed the balance between services quite dramatically.
- The barriers of entry and exit in telecom are related both to size and lack of flexibility in investment in facilities.

- This development may not be feasible for services designed for residential customers. Advanced residential services must rely on transmission facilities as defined by the local network operator.

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REVIEW QUESTIONS

1. Discuss the cost structure of a telecom network.
2. Discuss the present trends in investment costs.
3. Discuss the conditions for effective competition.
4. Describe the economies scale.
5. Differentiate between economies of scope and economies of density.
6. What is size and flexibility of investment?
7. Explain the role of technological innovation.

CHAPTER 5 PRICE REGULATION AND ITS IMPLICATIONS

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★ STRUCTURE ★

5.0 Learning Objectives
5.1 Introduction
5.2 Standards for Judging Reasonableness
5.3 Regulation: Institution and Methods
5.4 Applying the Efficiency Standard: Rate of Return
- *Summary*
- *Review Questions*

5.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- discuss about the standards for judging reasonableness.
- define the efficiency and improving performance.
- describe the institution and methods.
- what are important parts of cost implication? Explain in it.
- explain the incentives of cost-plus regulation.
- know about the applying the efficiency standard the note of return.

5.1 INTRODUCTION

Both historically and currently, the topic that has attracted the greatest attention in the field of regulated industries has been the reasonableness of prices. As a monopoly, or a dominant firm with significant market power, the regulated firm has a market incentive to charge monopolistic prices for a public necessity service. One important task of regulation has been to ensure that the prices charged to consumers are reasonable. This has led to a search for standards by which the reasonableness of prices can be judged. A particular focus of regulation has been on establishing maximum prices for monopoly services. Presumably the maximum prices are the maximum reasonable prices.

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Historically, different standards have been used to judge the reasonableness of prices and to establish maximum prices. The methods selected have depended in part on the particular circumstances in which the reasonableness of prices must be assessed. This chapter surveys the major methods, analyses the experience in applying them and outlines future pricing issues that telecom regulators will have to face. Regulators have attempted to judge the reasonableness of prices in telecom and the other public utility industries by evaluating "reasonableness" from four different perspectives or levels of analysis:

1. specific individual prices, e.g. the line charge for a residential telephone;
2. relations between specific prices, e.g., a residential telephone line compared to a business line or an ISDN line. This raises issues of appropriate rate relations, the design of the rate structure and price discrimination;
3. the revenue level of a specific class of service involving several specific services, prices and rate structures, e.g., local telephone services; and
4. the overall revenue level of the company for all of its regulated services. Each approach attempts to develop standards and information that will permit an informed judgement about the reasonableness of prices.

Recognising the inherent imperfections of all real world assessments, reasonableness is sometimes viewed as encompassing a range of possible prices, with maximum prices for monopoly services being judged as the top of the range of reasonableness. As competition has become more significant, claims are sometimes made that the monopoly PTO is charging prices for special services subject to competition that are too low. In this circumstance regulation and competition authorities are sometimes required to make judgements about minimum reasonable prices.

5.2 STANDARDS FOR JUDGING REASONABLENESS

Equity

If basic telecom services are judged to be a public necessity to which everyone should have reasonable access, then any standard of reasonableness must satisfy that primary objective. In light of people with low income levels and of the special needs of certain groups in society, such as disabled people, a standard of reasonableness based primarily on equity considerations such as "need" and "ability to pay" has been used to determine maximum prices for a limited number of specific services. These relate primarily to network access and minimum levels of usage. This normally represents a small proportion of the total number of services and prices offered by any PTO.

The effectiveness of such prices is judged by the extent to which universal service is achieved, i.e., the number of people, or proportion of the population excluded from network access at any particular price level. The prices for these basic services should be set low enough so that as few people as possible are excluded from access to the network on the grounds of need or ability to pay. In the case of people with special needs, this may require investment in special equipment. Although this sometimes involves setting some prices below cost, studies in the US, Canada, UK and Australia indicate that this cross-subsidy from other services typically represents only about two percent of total revenues (and sometimes less) in developed economies. In many developing countries the cost of implementing equity pricing can be significantly greater, but is difficult to assess in light of totally underdeveloped telecom systems. For the future, as information society development policies are put into effect in many countries, higher levels of telecom service may become essential for public access to and participation in information society services. If there is to be a universal access policy for basic information society services, the equity standard of reasonableness might require higher levels of cross-subsidy in the future in all countries.

In defining and implementing any equity standard for pricing essential public services, an assessment of the benefit and cost implications must be an important part of the analysis. If equity benefits are to be maximised, they must be implemented efficiently. If equity policies are not justifiable, affordable and sustainable as a beneficial allocation of society's resources, their implementation is likely to fail. Policymakers and regulators cannot avoid assessing the cost of implementing the equity standard of reasonableness.

Efficiency

For the vast majority of PTO services, the standard of reasonable prices is the cost of supplying them. The cost standard has an equity justification. It is generally perceived as unfair for a public utility monopoly to charge the public more than it costs to provide a public necessity service. But the primary justification is economic. It is inefficient to do so. It is a misallocation of society's scarce economic resources. The economic standard of cost is derived from the economic theory of efficient resource allocation, and in particular the standards of optimal efficiency in theoretically perfectly competitive markets. Clearly if prices are

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set below cost, there will be no incentive to supply those services in private markets. Either people would be denied services they were willing to pay for, or there would have to be a transfer of economic resources from other important areas so as to subsidise their supply. Historically, PTTs in some countries have set telecom prices significantly below cost, thereby stimulating an enormous demand. But this did not generate the resources to invest in satisfying the demand and governments were unwilling to transfer resources from other important areas. The result was an ever growing waiting list for service. By attempting to apply the equity principle, but ignoring cost and resource requirements, these PTTs could not come remotely close to achieving their equity objectives. If costs are defined to include all resources, including the cost of attracting investment capital, then there is no need to set prices any higher than cost. This would simply deny the service to those people willing to pay the cost, but not the higher price, and would require a transfer of extra resources from consumers to the PTO for no extra benefit. Consumers would be better off if they could spend the extra money buying something else they wanted. Therefore economic cost, including the cost of attracting capital, is the theoretical standard of economic efficiency.

However, cost is not an easy standard to define or implement. The cost of production by one firm may be a lot higher than another for producing the same service. Clearly society is better off if the service is supplied by the firm that can do it best. Competitive markets provide a powerful incentive for firms to be efficient and to seek ways of improving their efficiency. If a firm is the most efficient competitor it may earn extra profits for a while until the competitors catch up. If it is the least efficient competitor, it will suffer losses and may be driven out of the market. In a perfectly competitive market, the competitive pressure is at a maximum. No supplier produces a significant share of the market, or has power at all to set or control prices. Each competitor must accept the market price and reduce its costs so as to be maximally efficient at that market-determined price. Thus the relevant cost for the efficiency standard is not necessarily the actual cost to a PTO of supplying services, but the cost of supplying them at the highest levels of efficiency. This principle has been illustrated in the behaviour of many PTTs and PTOs in preparing for the introduction of competition. They have reduced their costs significantly, indicating that their former costs were not the cost levels of an efficient supplier.

Cost is often seen as the magic standard for resolving many of the key issues in regulation, including reasonable prices for consumer services and interconnection. Unfortunately this is not the case, as on closer examination one discovers many different cost concepts, definitions, interpretations and methods of measurement, ensuring many active debates.

Cost analysis can be shaped to serve a variety of objectives. In reality many attempts to determine cost-based prices in a regulatory setting turn out to be detailed calculations of price-based costs. Costs are used more often to justify prices already selected than to set prices. Thus, on implementation, one cannot avoid the equity dimensions of cost analysis.

Improving Performance

In recent years many countries have taken up the task of reforming PTTs which, by reference to international best practice, were inefficient and lagging significantly in their response to improved technologies and expanding demand. Most already have been, or are to be corporatised or privatised. The primary objective is to get these national PTOs to improve their performance dramatically in a sustained manner over an extended period. The effort is not only to reduce costs to an efficient level, but also to stimulate investment in network upgrading, improved customer service and new service development. Competition is seen as a stimulus, but competition can hardly be expected to cover the entire market, or to provide residential basic service subscribers with competitive market options for a long time. Moreover the PTO often needs time to reform itself to become an efficient, market responsive competitor. In the transition from a monopoly to a competitive market, the key factor is the transformation of the PTO. The objective is to drastically reduce the PTO's monopoly power while at the same time turning it into an efficient and effective competitor.

In this environment it is known that the PTO can reduce its costs significantly if it strives toward international best practice. It is also known that the new technologies being produced in the equipment manufacturing sector provide a foundation for continuous reductions in PTO unit costs. The problem is determining how the PTO can be stimulated to take maximum advantage of these potential efficiencies.

5.3 REGULATION: INSTITUTION AND METHODS

There is a great similarity between what is today called "price cap", or in some jurisdictions "social contract" regulation of public utility services, and the method of price regulation applied in the very earliest days of public utilities (more than century ago), particularly in the US. Before regulatory commissions were created, regulation was applied by employing social contracts and price caps. US state legislatures negotiated agreements (*i.e.*, social contracts) with the utilities on a

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specific structure of maximum rates. The utilities then charged that particular rate structure for a contracted period. The specific rates were maximum rates and were capped as part of the social contract.

It was the collapse of this system that led to the establishment of regulatory commissions, where experts presumably could examine the complex pricing issues on a continuous basis; develop criteria by which the reasonableness of rates could be judged; and deal with the necessary day-to-day price changes under changing industry and market conditions. ("Experts" would be those working with newly created independent regulatory commissions.) Regulation by independent expert commissions was established to bring an improvement on the legislative application of social contracts and price caps (Bonbright 1961).

The fundamental reason legislators abandoned the social contract method of price capping was the magnitude of the task. It was far too complex and time consuming for legislative bodies to get involved for each proposed change to specific utility prices. The task required informed judgement about the industries, their costs, and consumer requirements. Legislators did not have the knowledge, expertise or time to make these judgements effectively. A second reason was the necessity to gather and analyse the detailed information required to justify that particular price changes were reasonable. Some standards or guidelines for judging the reasonableness of prices, and proposed price changes, had to be developed. Then evidence had to be gathered by which one could judge whether any given set of prices was reasonable in accordance with that standard.

The regulatory legislation in almost all countries is very similar with respect to telecom and public utility price regulation. It uniformly says that it is the specific rates charged to consumers that must be reasonable and not unduly discriminatory. It says nothing about regulating a utility's profits, assessing its rate of return on investment, nor about forecasting productivity improvement in judging the reasonableness of its prices. It is only the specific rates that ultimately must be reasonable. The particular method for judging reasonableness is not specified.

Most regulatory agencies in North America rapidly shifted the focus of their attention from examining the multitude of specific prices to examining the overall profit level, *i.e.,* the rate of return on investment. This was not required by any change in legislation, but grew out of experience. The change in regulatory method came about for the same reasons that prompted legislators to pass the task of judging reasonable prices to regulatory commissions in the first place.

The tariff structures of PTOs and other public utilities are extremely voluminous. There are often hundreds or thousands of different prices in the overall rate structure. If one were to try to make an independent decision with respect to the reasonableness of every particular price and proposed price change, an enormous regulatory bureaucracy would be required. An overwhelming amount of complex and detailed evidence would be required. It was recognised fairly early in the history of regulation that the method of attempting to judge the reasonableness of each individual price simply was not a practical method of regulation. It was too costly, too detailed and required the regulator to become too involved with management issues.

If the historic method of direct price cap regulation was not possible in practice, then what was an acceptable proxy? What was an alternative method for at least getting a rough handle on the problem? There were two main concerns: 1) ascertaining the criteria for judgement in respect to reasonableness; and 2) obtaining relevant information which would allow the criteria to be applied on a continuing basis in a consistent and uniform manner.

As indicated above, economic theory on the issue has been clear and unequivocal for a very long time. The reasonableness of prices is judged in reference to their costs. Prices should be set to cover all economic costs in order to attract the necessary resources. This includes the cost of attracting capital, i.e., a rate of return on investment equal to the firm's cost of capital. Prices in excess of economic costs are unnecessary to serve consumers efficiently and simply result in monopoly profit. Therefore if one is to judge the reasonableness of prices in reference to their costs, how does a regulatory body obtain the necessary cost information upon which to make its assessment?

One approach would be to seek very specific detailed cost information *to associate with each individual price*. But if that is unrealistic in practice, application of the economic principle at the level of the firm rather than at the level of individual prices would be more manageable and would still allow for an informed judgement on the overall reasonableness of prices. Regulators could examine the aggregate level of revenues, expenses, investment and profit as a first step in judging the overall reasonableness of the general level of rates charged by the regulated utility. After examining the overall level of profit for reasonableness, as a second step, attention could be paid to those particular details of specific rate structures which might need attention, such as the reasonableness of prices for basic residential telephone service, which would represent only a small fraction of the total number of individual prices.

5.4 APPLYING THE EFFICIENCY STANDARD: RATE OF RETURN

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Incentives of Cost-Plus Regulation

Throughout the history of regulation in the US, a system of price (or rate) regulation has evolved in which the reasonableness of prices is judged primarily by the reasonableness of the overall profit level for the aggregate of services within the regulatory jurisdiction.

Debates about the criteria to be used for judging the reasonableness of profit of public utility monopolies and the appropriate information to be used in measuring the rate of return on investment have taken place throughout this period before regulatory bodies and the courts. Ultimately, the US Supreme Court has had the final word as to which standards for judgement applied by regulatory authorities are acceptable.

One of the first issues tested was whether the return on investment standard was legitimate as a standard for judging the reasonableness of a utility's prices. The standards selected by the regulatory authorities were required to be within the limits of the law, justifiable in logic and supported by evidence. Return on investment was accepted by the Court as a justifiable standard. In essence the regulator would examine a utility's financial performance in the most recent "test year", make adjustments if necessary to its revenue, expense, investment or income accounts, calculate the rate of return on investment actually earned and compare it with the utility's cost of capital or reasonable rate of return. If the rate of return actually earned in the test year was 15 percent and the cost of capital determined to be ten percent, rate reductions sufficient to reduce the rate of return to ten percent, on the test year data would be required. The utility would not have to give back the extra profit it made in the past, but regulation would require reduced rates for the future.

Historically, there have been protracted debates over the interpretation and implementation of the rate of return standard. During the 1910-1930s era, regulation was criticised for engaging in rate cases that went on for years, in which there were seemingly endless debates about how the investment (or rate base) ought to be valued, which expenses would be included or excluded as legitimate costs, how depreciation would be calculated, how the reasonable rate of return would be calculated, and a number of other factors. Indeed, this was an era when the implementation of rate of return regulation was quite inefficiently implemented because of a lack of clear standards, definitions, concepts and information sources.

Over time the process of applying rate of return regulation became streamlined in several ways. First, a specific methodology came to be accepted for measuring the investment, or rate base. The original cost of investment actually undertaken by the utility for the provision of utility services was adopted by almost all jurisdictions for calculating gross investment. Uniform and consistent depreciation practices were adopted. Rules came to be accepted for the treatment of specific revenue and expense items which would be included in the calculations. Perhaps the most significant contribution to the streamlining process was the establishment of a uniform system of accounts during the 1930s that provided consistent accounting practices and the necessary data to enable regulatory agencies to make informed judgements (Garfield and Lovejoy 1964).

When one examines the process of implementing rate of return regulation today, in most respects it is very efficient. There is very little debate over most issues. And generally it is a simple matter of auditing the information, applying it and engaging in relatively few debates at the margins of interpretation over amounts of money that are important to the participants, but hardly consequential for the survival and growth of the firm or the long-term development of the industry.

The major item of active and extensive debate in US rate of return regulation today is measuring the cost of equity ownership capital. The financial analysis community is busy with voluminous and complex cost of equity capital studies for inclusion in rate of return cases before regulatory agencies. Yet this element too could be more streamlined, especially when one recognises that the range of difference in the debate is generally more narrow than the standard error of estimate in any of the different measurement methods. The significant issue here is not that the rate of return method is an extremely costly form of regulation to implement. In itself it is not costly. Regulatory proceedings are seldom unduly lengthy or costly when applied by the better regulatory commissions. However, weak regulation can make the process costly, as it can under any regulatory standard, by allowing itself to be manipulated by parties with a vested interest in delay. This, however, is not the fault of the regulatory standard.

The more fundamental issue of concern relating to rate of return regulation is the perverse incentives created by a method that, when applied routinely to a monopoly utility at the level of the firm's overall regulated services, becomes little more than costplus regulation. As such, it provides incentives to inflate expenses and undertake inefficient investments; to subsidise competitive services with monopoly revenues; and to use the full extent of the PTO's monopoly power to destroy or restrict efficient competition. In the US and Canada, rate of return became a form of cost-plus regulation that actually rewarded inefficient investments, encouraged anti-competitive behaviour and did not necessarily protect consumers of the basic monopoly service from having to pay excessive prices (Melody 1989).

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If one examines studies of AT&T, before divestiture, there is substantial evidence that there was over-investment and "gold plating" in the system. Additionally, there is evidence of a substantial surplus of people, particularly observable in the enormous number of lobbyists and monitors of legislators, regulators and other participants in the regulatory process. But following divestiture, there were massive cost reductions by AT&T, by its manufacturing affiliate (recently spun off as Lucent Technologies) and by the Regional Bell Operating Companies (RBOCs). Divestiture and increased competition, it would seem, has had a significant effect in overcoming the perverse efficiency incentives created by rate of return regulation. Whether the perverse efficiency incentive remains a significant issue in today's more competitive US telecom environment is, of course, a debatable point. It is clearly a lot less significant now than it was before the AT&T divestiture. However, it may still be a powerful force for the RBOCs which have retained a monopoly over local telecom services which will remain until the Telecommunications Act of 1996 can be fully implemented.

Anti-Competitive Cross-Subsidy Incentive

In contrast, the cross-subsidy incentive provided by rate of return regulation clearly exists today. It may even be more significant in a more, but not fully, competitive market environment. As long as the dominant carrier (e.g. AT&T, the RBOCs in their respective territories; or most national PTOs) is regulated on a rate of return basis, it can reduce prices in competitive markets with impunity, knowing that the profit, which otherwise would have been lost to the company, will be made up from its monopoly markets immediately. In fact, such a pricing policy can be expected to help protect market share from competitive inroads, require increased investment and provide justification for a higher absolute level of profits. The perverse cross-subsidy incentive remains a serious problem.

In the US, regulators have been trying for the last 30 years to do something about this problem. The FCC has undertaken a series of cost studies over the years attempting to allocate AT&T's aggregate costs among its major service categories. This would extend regulation beyond the overall rate of return to a more detailed level of return by major service categories, of which some are monopoly and some are competitive. This allows rate of return regulation to be applied on a service-by-service basis, thus going a long way toward neutralising the perverse cross-subsidy incentive and also having a beneficial effect on the efficiency incentive.

One of the first major cost of service studies of this kind in telecom was completed by AT&T for its interstate services subject to FCC regulation.

The study analysed AT&T's interstate services in seven classes for 1964. The results showed that AT&T's basic public monopoly message telephone service was earning at a rate about 40 percent greater than the maximum allowable overall rate of return (10.50% v. 7.25%), and that several of its special services where consumers had alternative possibilities (e.g. bulk capacity transmission for large organisations) were suffering losses. This study led to a series of investigations and studies by the FCC which addressed cost principles, methods and data, and the development of cost of service accounting manuals. But the FCC did not follow through and establish these accounting and reporting systems as part of its on-going regulation of maximum rates for the basic public telephone service.

During the 1970s, the FCC adopted an alternative policy of "structural separation", by which it would require AT&T to establish separate subsidiaries, divisions or operating units for its competitive services. This, it was believed, would simplify the cost analysis and pricing assessments. The basic method of regulation on the crosssubsidy issue would be to require a formal separation of competitive and monopoly activities. It was hoped this would avoid many of the problems of cost allocation.

However AT&T found the functional separation to be cumbersome to implement and claimed it imposed inefficiencies on the company, especially as services would shift from monopoly to competition as market conditions changed. During the 1980s, the FCC decided to give up on its structural separation policy and return to cost of service standards as a basis for attempting to judge the reasonableness of prices for particular categories of service, but limited the number of service classifications to four broad categories as a means of simplifying the cost allocation problem and making the process more manageable. However, the categories are so broad that they are not an effective tool for identifying and preventing pricing below cost for competitive services, or above costs for monopoly services (Melody 1989).

The India regulatory experience in telecom has exposed the limitations and weaknesses of rate of return regulation as a basis for judging the reasonableness of prices.

In addition, it confirms the longer term experience in regulation generally, that attempts to apply any standard for judging the reasonableness of prices at the level of detail and precision that theory would require, have been ineffective. Whether this is due to the limitations of the theory for real world application, the weakness of the regulatory institutions, or both, is a matter for serious analysis in the design of new regulatory structures.

NOTES

SUMMARY

- Historically, different standards have been used to judge the reasonableness of prices and to establish maximum prices. The methods selected have depended in part on the particular circumstances in which the reasonableness of prices must be assessed.
- The primary objective is to get these national PTOs to improve their performance dramatically in a sustained manner over an extended period.
- There is a great similarity between what is today called "price cap", or in some jurisdictions "social contract" regulation of public utility services, and the method of price regulation applied in the very earliest days of public utilities (more than century ago), particularly in the US.
- Experts" would be those working with newly created independent regulatory commissions.
- The tariff structures of PTOs and other public utilities are extremely voluminous. There are often hundreds or thousands of different prices in the overall rate structure.
- As indicated above, economic theory on the issue has been clear and unequivocal for a very long time. The reasonableness of prices is judged in reference to their costs.

REVIEW QUESTIONS

1. What are the different standards for judging reasonableness in telecom?
2. What are benefits of equity? Explain indetails it.
3. Explain the regulation of the institution and methods.
4. Distinguish the PTOs and PTTs.
5. Discuss about the regional bell operating companies.
6. Describe the anti-competitive cross-subsidy incentive.
7. Explain the improving performance.

CHAPTER 6 QUALITY OF SERVICE

NOTES

★ STRUCTURE ★

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6.2 History
6.3 Combination of Voice and IP
6.4 Perception of QoS: Service Requirements
6.5 Telephony
6.6 Data Communication
6.7 Moving Image (Video)
6.8 *Multimedia (Video + Audio)*
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6.10 UMTS QoS Classes
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- *Summary*
- *Review Questions*

NOTES

6.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- discuss about the combination of voice and IP.
- distinguish the security and realiability.
- define the delay variation and total delay.
- explain the QoS classes.
- describe the TCP/IP and ATM packetization effects.
- know about the compression of IP voice packet by ROHC.

6.1 INTRODUCTION

What is Quality of Service?

Quality of Service (QoS) is the collective measure of the level of service to a subscriber (ITU-T E.800). The service in question used to be voice, but now many types of services must be considered. Yet, voice is still one of the main services, especially when it comes to generating revenue. Also, voice is still a main focus of QoS discussions. A main reason is that voice is an isochronous service, which means that the decoded signal ideally should have the same audio frequency and frequency stability as the sent signal. With the present technology convergence the subject of voice and multimedia in packet networks comes into focus. Against this background a lot of the performance criteria in a packet network are included in this chapter:

- Packet delay (or delay in general)
- Jitter (delay variations)
- Packet loss or bit error rate
- Bandwidth or throughput
- Echo
- Silence encoding, if background noise if suppressed.

The above criteria are network oriented. Let us call it bearer level QoS. Nowadays the user may also perceive an application-related QoS performance. At least for mobile network terminals, various perceptions occur within the possible terminal capability range, depending on service enablers, application support enablers and service layer middleware.

See Figure 6.1 QoS is one of the critical success areas for a telecom actor, since the perceived end-to-end QoS has a major impact on user perception and satisfaction and consequently on churn. Compensation for a poor QoS might be to offer the service in question for free during a limited time period, or at a lower price. However, such solutions might need financial perseverance and are not considered is this chapter. The opposite solution, at least at bearer level, is to over-dimension the network, which would reduce ROCE. It was argued that the travel operator does not sell holidays by promoting the features of the plane. He sells the holiday. However, it would certainly be possible to have different travel classes for charter trips, similar to the differentiation in hotel standards.

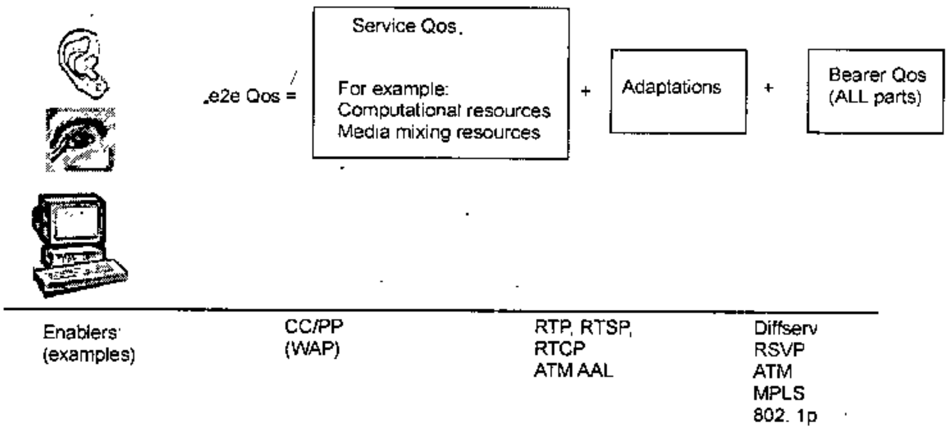

Fig. 6.1: Perceiving QoS at service terminating points by sets of QoS enablers

By paying a different overall price to the travel operator including flying standard class, the airline company gets paid for the provision of different classes of transport.

6.2 HISTORY

QoS has always been an important part of telecommunication. Various measures have been used. The probability of congestion for traditional voice trunk calls is still indicated in the number of congested calls per hundred call attempts. Analogue circuits were particularly expensive and investments were expressed in number of circuits. Other measured circuit characteristics related to service quality in telephony networks are echo, cross talk, signal to-noise ratio and lately bit error rate (BER). The characteristics were directly associated to the selected circuit, as well as the bandwidth, which was fixed and standard for all calls. A fairly common current perception of QoS is wider than, but not too far from, what has traditionally been called 'The transmission plan'. This plan caters for end-to-end perceived quality of voice in circuit-mode networks, originally in analogue networks and later in digital networks. The broad introduction and success of mobile systems brought echo aspects into focus, since efficient voice coding, as applied for example in GSM (global system for mobile communication), takes time (about 80 to 90 milliseconds).

Echoes with such time delays are very annoying.

6.3 COMBINATION OF VOICE AND IP

The current importance of QoS is very much associated with the transition from circuit switching to packet switching, with the success of the IP technology, with the development towards multimedia and finally with the success of mobile systems. One consequence is the appearance of voice, video and multimedia over IP, basically a best-effort technology.

Going one step further we get voice/multimedia over IP over wireless, 'VoIPoWL', the real challenge. IP was not designed for voice traffic, and wireless was not designed to carry IP traffic. Therefore the most critical QoS terms have become delay, delay variations/jitter and packet loss. This has indeed led to a semantic change of the meaning of the term QoS. Today, some people tend to use the expression in a narrow sense, such as: 'QoS is a necessity for (packetized) real-time services' or 'A specific QoS can be described as a set of parameters that describe quality requirements of a stream of data'.

The QoS of IP telephony (or VoIP, voice over IP) and associated charging, in relation to subscriber perception has been a hot question ever since the birth of the 'IP paradigm'. What is then so attractive about real time services over IP?

- IP technology enables unification of the private or public network by allowing voice to be treated as a data application.
- Once achieved, the unification enables us to decrease network operating cost, and opens up the door for innovation and fast service creation.
- For rational reasons VoIP is already a reality, especially in the local area network of many enterprises. For residents it could for example be combined with ADSL subscriptions (VoIPoADSL).
- The main advantage of running IP all the way over the air interface is service flexibility.

To date, cellular-access networks have been optimized in a two-dimensional space whose axes are voice quality and spectrum efficiency. IP introduces a third dimension in terms of service flexibility, but adds protocol overhead, contradicting the goal of spectrum efficiency. See Figure 6.2.

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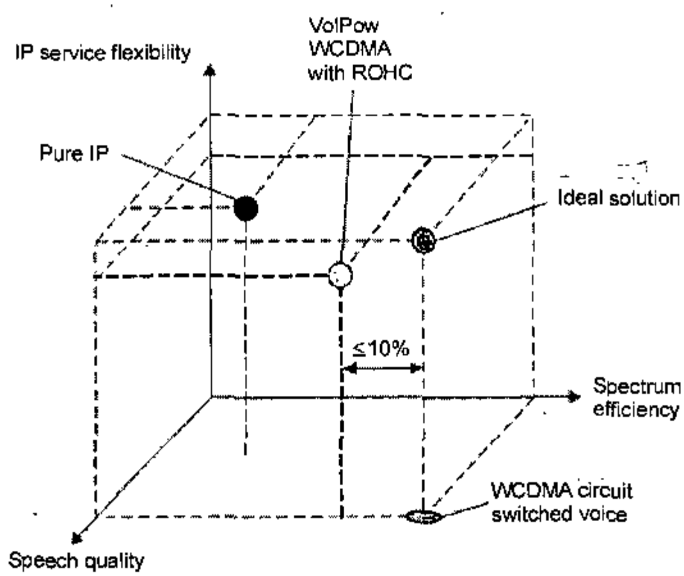

Fig. 6.2: A main target is QoS, also spectrum efficiency and service flexibility

The major challenges ahead for VoIP are QoS and interworking with legacy networks and systems. In fact, very few issues regarding telecommunications, if any, have raised such strong and passionate polemic as QoS. Few telecom areas have been targeted by such intense research and frenetic development since the mid-1990s.

6.4 PERCEPTION OF QOS: SERVICE REQUIREMENTS

The eye and ear are sensitive to delays in interactive conversation, but maybe even more sensitive to delay variations. They are less sensitive to bit errors, especially the ear, since one bit represents very little information, and the ear/eye/brain will fill in small missing information. For multimedia, lip synchronization (= limited skew) is important. The computer on the other hand isn't very sensitive to delay, but even one bit error can be devastating. See Figure 6.3. As already mentioned, an overall goal of this chapter is to support the implementation of a service plan as far as QoS is concerned. Considering the present power of the user, let us start with the user perception of service quality. See Figure 6.4.

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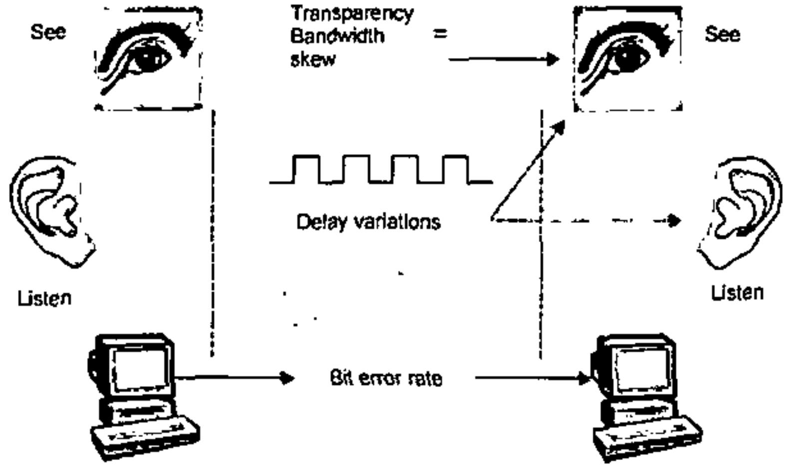

Fig. 6.3: Different demands from different terminating points

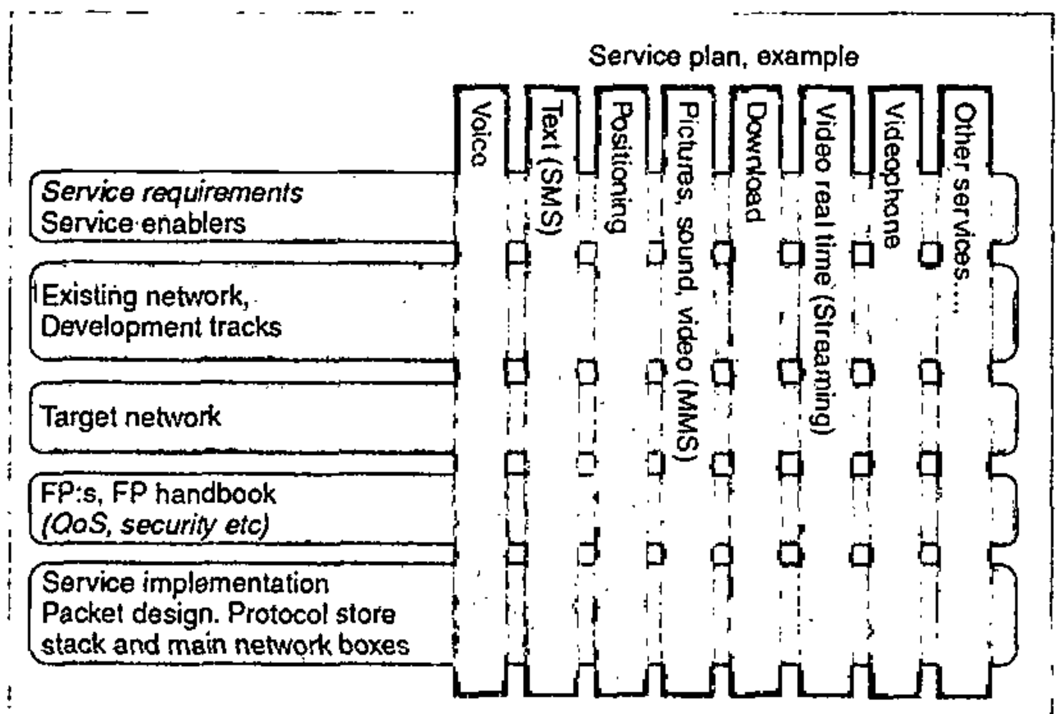

Fig. 6.4: The service plan and some (horizontal) implementation steps

6.5 TELEPHONY

Perceived Quality

Perceived quality end-to-end at application level is what matters for the user. What is it that determines whether we perceive the quality of a phone call as good or bad?

- You here what is said.
- You here who is talking.

This requires a sufficient signal level without too much noise or echo. The quality is often measured by letting a test panel compare the sound between telephony from different sources and rating the perceived quality. The average rating is called the MOS (mean objective score) value. ITU-T Recommendation P.800 provides the following scale: 5 = excellent; 4 = good; 3 = fair; 2 = poor; and 1 = bad. The current target for VoIP is class 4, which is the same as ordinary circuit-mode voice systems. Another current target for VoIP is called carrier grade. It means extremely high reliability with a down time of about 5 minutes per year, known as five-nines reliability (99.999 %).

NOTES

Delay and Jitter

Delay is an important area for conversational real-time services like telephony and video telephony. There are two aspects regarding delay:

- Total delay.
- Delay variation or jitter.

Voice is an isochronous service, which means that the decoded signal should have the same frequency and frequency stability as the sent signal. Deviations depend mainly on impact from active elements in the path, but also on rerouting. If the stream of information is uneven (also called 'jittery') or the values arrive in disorder, it becomes difficult to hear what is said and who is talking. What is called adaptation protocols in the enabler part are intended to cancel the deviations, and to restore the isochronous relation. Jitter is eliminated by means of delaying packets individually to restore the original intervals.

The price to pay is an increased overall delay. The process is called 'dejitterization'. The total delay gets worse at certain occasions:

- Connections over a long distance (especially when one or more satellite link(s) is used—a satellite hop adds a delay of about 240 ms).
- Voice is coded using advanced compression algorithms to save bandwidth (as in a GSM phone).
- Connection is made over networks using different voice coding, requiring a translation in a gateway between the networks (for example PSTN-GSM or Internet-PSTN).
- The voice information is packet or cell switched and thus stored in buffers in the switches during the transport.

Typically, a maximum total delay of 150 ms is acceptable in normal circumstances, and 400 ms in more exceptional cases. See Table 6.1.

NOTES

The corresponding figures for packet loss are typically 5 % and 10 % respectively. For IP telephony the TCP protocol cannot be used, since TCP asks for retransmission in case of erroneous packets. This would cause a varying delay when retransmission occurs.

Secondary Problems with Delay

Echo and talker overlap are problems that arise from high end-to-end delays in a voice network. Echo is noticeable by the ear/brain at about 25 ms distance between talk and echo. Talker overlap is the problem of one caller stepping on the other talker's speech.

Table 6.1: Acceptable delays

One-way delay (ms)	Description
0-150	Acceptable for most user applications
150-400	Acceptable provided that administrators are aware of the transmission time impact on the transmission quality of user applications
400+	Unacceptable for general network planning purposes, however, it is recognized that in some exceptional cases this limit will be exceeded

Noise

The signal-to-noise ratio should be as low as possible. The digitization of the trunk network, followed by the digital GSM and ISDN accesses, led to a significant improvement of the quality. One result was drastically reduced intelligible cross-talk.

Comfort Noise

In a normalHowever, if there is no background noise at all, you feel uncomfortable, because you do not know if the connection is broken or not. To take care of this, a so-called 'comfort noise' is added at the receiver's end in applications where everything is coded as silence below a certain threshold. This goes for both mobile telephony and IP telephony.

6.6 DATA COMMUNICATION

So far we have discussed the quality of telephony. Some of this is applicable for other services as well, some of it is not. The ability to successfully connect to other subscribers is important for voice services, since this is the basis for charging. For internet service providers (ISP) often a flat rate applies. Anything that makes the subscribers select you instead of your competitor as their ISP, will feel like 'good quality'. So what affects the perceived quality when we for example connect to the Internet from home?

- Short set-up time
- Bandwidth
- Fast data delivery without excessive queuing
- Low bit error rate (BER)
- Accessibility to many fellow subscribers
- Differentiated priority

Some services, or some users, need a higher priority and are prepared to pay for it. This is true for real-time services. Or you can imagine a business user at an airport who wants to download mail with attachments before entering the aircraft. Differentiated service classes, differentiated billing and resource reservation are methods used to improve this aspect of quality.

Security

Business information, money transactions and data of a private nature all demand some kind of protection against 'eavesdropping'. This can be solved with encryption, or by using tunnelling. There are also methods for putting an electronic signature on a data message, to ensure the receiver that the sender is who he claims to be (compare to the desire to hear who is talking in a telephone conversation). Public key ciphering is a method that solves both encryption and the signature.

Future-Proofness

If you use a certain data communication (for example an e-mail program), you do not want to lose information when you upgrade to a newer version (for example, have to rewrite your address book). This has more to do with the terminal software than the actual communication network. For the operator, the choice of technology for implementing a service should be future-proof, which means it must be scalable and possible to upgrade to new versions. Otherwise the operator might be in a situation where the original investments have to be totally replaced by new investments. Compare ROCE.

Reliability

In telecommunications we have been used very reliable networks that are up and running almost all the time. This is in contrast to the local enterprise networks, where stop-time during maintenance or upgrades have been common.

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6.7 MOVING IMAGE (VIDEO)

There are a few quality areas specific to video:

Delay Variation

Video is an isochronous service, just as telephony. The information is sent in a stream (streaming video) that has to be consistent and steady, not jumpy and jittery. Otherwise the picture will freeze and jump forward.

Total Delay

There is a difference between one-way broadcast services and two-way interactive services. When broadcasting rental films over a network, the delay will not affect the quality. In a video conference, or when using net-meeting on a PC, the delay is as important for the quality as it is for telephony.

Bit Error Rate

Depending on the compression technique that is used, bit errors might cause problems. The more the information is compressed (to save bandwidth), the more is lost if a packet is lost, or the more is misinterpreted if a bit error occurs in a packet that arrives. So normal TV broadcasting is not sensitive to bit errors, whereas net-meeting on the PC is.

6.8 MULTIMEDIA (VIDEO + AUDIO)

The same quality aspects as for moving image apply to multimedia communication, with one addition:

The synchronization between the sound and the picture (lip–voice synchronization) has to be good. The gap in time between them is called skew. The skew risks increase if voice and picture are sent over different channels, or if they are coded separately. For all these services, quality also depends on factors like short set-up times, being able to communicate with many others (having many film titles to select from), being able to find them (catalogue or enquiry services), mobility and clear billing information.

6.9 QOS CLASSES

Service Classification

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In this part of the chapter a brief summary of the connection between services and QoS classes is presented. The real behaviour depends a lot on the traffic situation in the network. In calculating a traffic model, the end-user behaviour with regard to particular applications needs to be determined. The mix of applications and the daily traffic distributions must also be characterized in order to carry out analyses and calculations.

All types of packet data traffic will not have the same requirements on delays, packet loss etc. As a result traffic may be divided into four different classes: streaming, conversational, background and interactive.

Table 6.2 : UMTS Traffic Classes and Some Related Requirements

QoS Class	Transfer delay requirement	Transfer delay variation	Low bit error rate	Guaranteed hit rate	Example
Concers-ational	Stringent	Stringent	No	Yes	VoIP, video con-ferencing audio conferencing
Streaming	Constrained	Constrai-ned	No	Yes	Broadcast services (audio, video), new, sport
Interactive	Looser	No	Yes	No	Web browsing interactive chat, games, m-com-merce
Backgro-und	No	No	Yes	No	E-mail, SMS, data-base downloads, transfer of meas-urements

Real-Time Applications

Streaming The fundamental characteristics for QoS are to preserve time variation between information entities of the stream, e.g., video streaming.

Conversational Here the fundamental QoS characteristics are to preserve time ariation between information entities of the stream and to have a low delay, e.g., voice.

Non Real-Time Applications

Background In the background class, the destination is not expecting the data within a certain time but is expecting a preserved payload content, e.g., e-mail. Interactive A request/response pattern is important in the interactive class and the payload content must be preserved.

6.10 UMTS QOS CLASSES

It is foreseen that UMTS should be designed for the case where the bottleneck is not the core network, but the UMTS bearer access speed. A summary of the UMTS QoS classification is shown in Table 6.2.

6.11 THREATS TO QOS

Multi-operator connections, extensive layering and interconnected technologies create many more interfaces than in the monopoly era. See Figure 6.5. Deficiencies in fundamental plans (other than QoS) create a number of threats. See Figure 6.6.

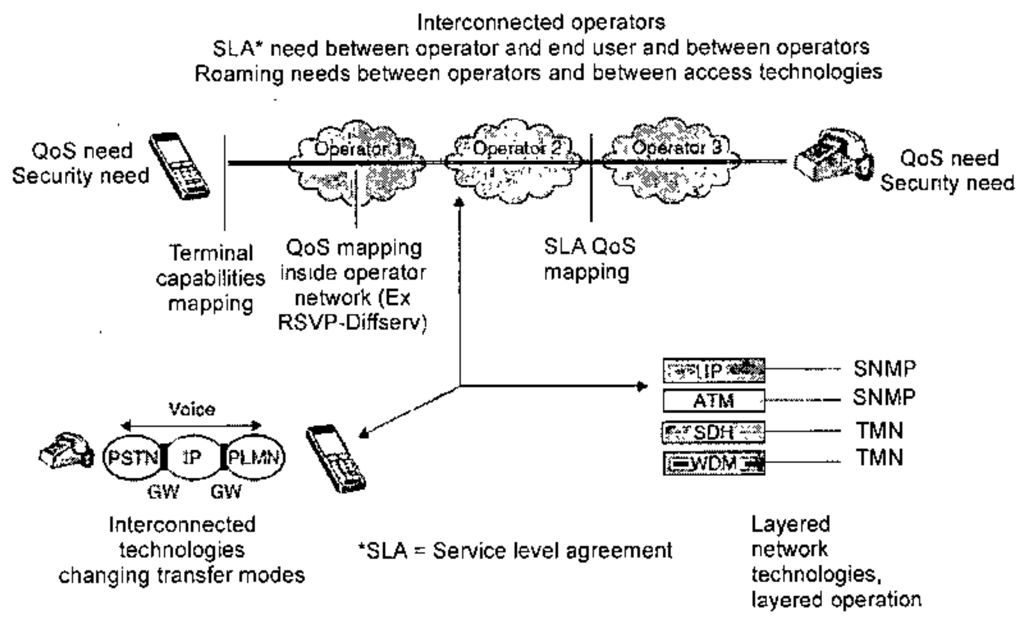

Fig. 6.5: The new environment is a threat to QoS

6.12 PASSING SEVERAL OPERATORS' NETWORKS

When nobody has the overall responsibility for the total delay, the question is how long it will become. There is also a need for mapping between different QoS technologies. Service level agreements (SLAs) are necessary in order to regulate the QoS between different operators.

6.13 CHANGE OF TRANSFER MODE

NOTES

A telephone connection from a PSTN network, via an IP backbone trunk to a mobile phone in a GSM network is an example of this type of connection. The voice is (probably) coded differently in the three different networks. This means that a translation has to be done at interconnecting gateway points between the networks. The translations take time (in this case it could add to more than 100 ms), which adds to the total delay. This means a reduced quality for the interactive real-time services, such as telephony and interactive multimedia (like video conferences). Delay is not a problem for data communication, where a gateway might translate from one mail format to another one or from one ASCII table to another. Instead the readability might be affected.

6.14 LAYERED NETWORKS

The horizontal network gives us increased freedom of choosing technology in the various layers. It is cheaper to manage one network than many. But there are two sides of the coin. The introduction of a new, widely layered approach gives initially an increased complexity and a poorer performance compared with tailored solutions.

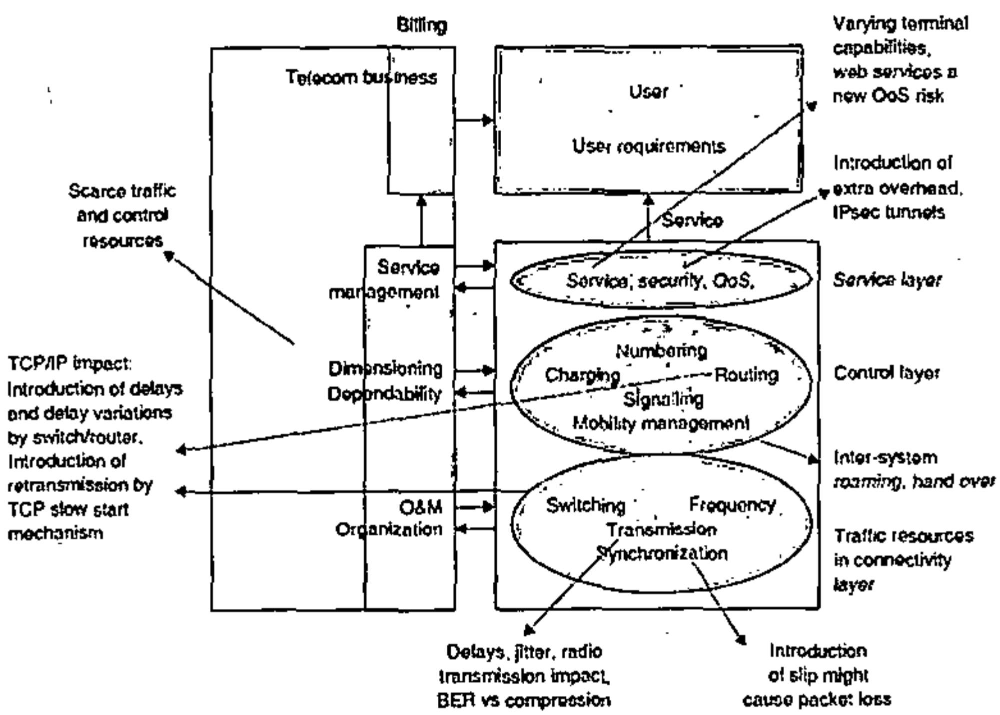

Fig. 6.6: Possible threats to QoS from other FPs

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When combining 'ordinary' layering with for example an IPsec tunnel, carried over IP, carried over frame relay, over ATM, on SDH, using WDM on optical fibres, what will the overall quality and efficiency become? What about QoS control? Is a kind of feedback possible from underlying layers to the application level? SLA between layers. The standard GMPLS is presented, with a kind of common overall approach to a number of layers. Another trend is to reduce the number of layers to a minimum.

6.15 TCP/IP AND ATM PACKETIZATION EFFECTS

Delays and Delay Variations in Packet Systems

Packetized systems are queuing systems. Traditionally all packets were treated equally: first in, first out. Having all packets share the same queue has much the same effect as having all highway traffic share a single lane: congestion and delays at the intersections, depending on the distribution of packet arrivals. The burstiness (peak rate to average rate) of many interactive applications should be borne in mind. It might be 200 times as much as voice, with a burstiness set to 1 for a reserved path.

Bandwidth sharing led to a situation where bandwidth started to be related for the first time to QoS, and delay handling became an important issue. IP networks have basically very little sensitivity to delay as data packets do not need synchronous reception and eventually can be retransmitted on error detection, some time after the original dispatch.

The packetized voice applications (VoIP, VoFR, VoATM) use short packet/cell sizes (typically below 100 bytes) to minimize delay and jitter. In a packet-handling device at least three processes can create queues: the arrival process; the serving (switching) process; and especially the output serialization process (see Figure 6.7). Serialization is a kind of multiplexing. When long data packets are occupying the output, excessive delay may arise for waiting packets used for real-time traffic. The packetization delay for an ATM cell is 6 ms, when used for a single voice channel and with a payload of 48 bytes. This is the time for a 64 k bit/s or 8 k bytes/s stream to fill the payload space. In IP data networks the best-effort data traffic has an average packet size of around 1.5 kbytes and a possible maximum of 64 kbytes. Now let us consider the case when this traffic competes for network resources with packetized voice traffic. Provided the overall traffic volume is within the design conditions, no significant queuing will exist in network buffers. Delay will then be kept within reasonable values, and voice quality will be good. See Figure 6.8.

Nevertheless when the total amount of traffic starts to rise, there will be queuing in the network buffers (router buffers in IP) and then the long packets of IP data (more than 15 times longer than voice packets) will be included in the queue causing long delays for the voice traffic. The amount of the overall delay in buffers might then become high enough to be annoying for the people involved in a voice conversation. The main advantage ATM has in terms of QoS compared with IP voice in data networks is derived from the fact that all the packets (cells) in ATM are short (53 bytes) and have the same size. Therefore there are no chances that long packets introduce unacceptable delays in the VoATM traffic.

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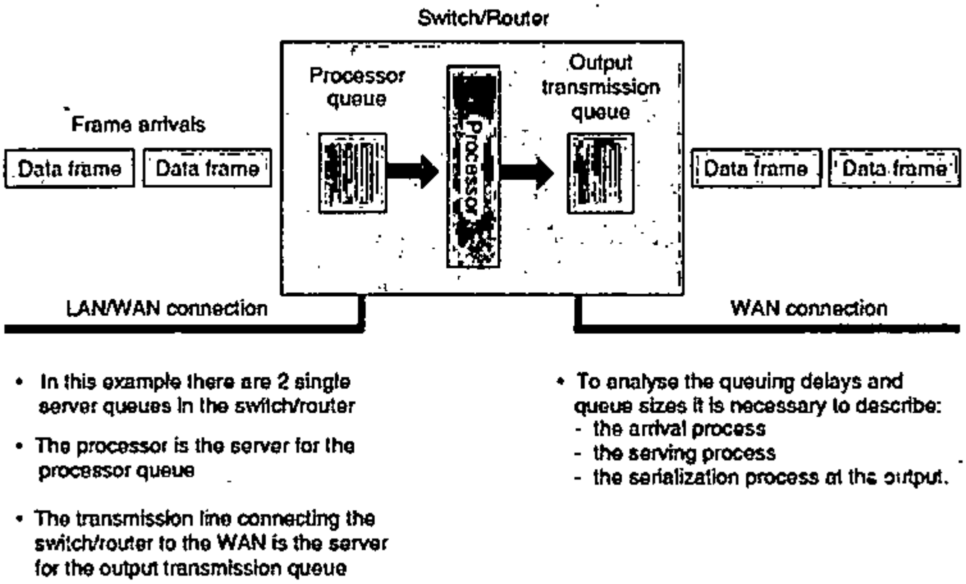

Fig. 6.7: Critical processes in a packet-handling device

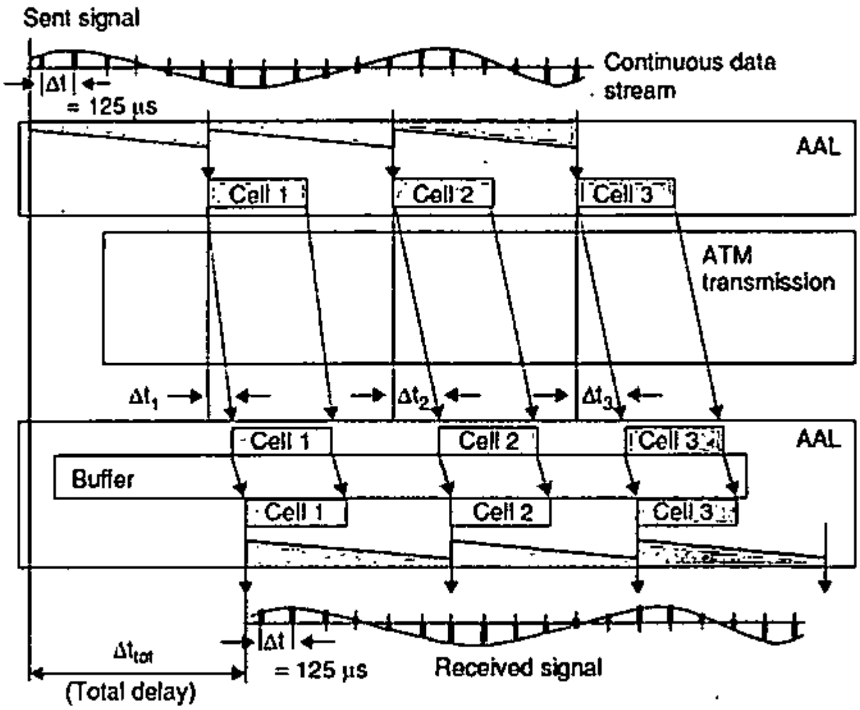

Fig. 6.8: Packetization delay when converting PCM to ATM

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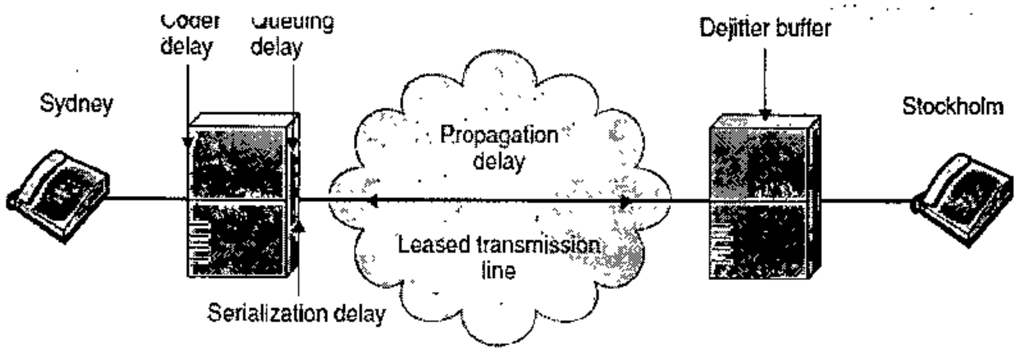

Coaxial cable about 0.005 ms/km
Fibre cable about 0.005 ms/km
Satellite hop about 240 ms
Dejitter buffer could be around 50 ms for a long distance call
Coder delay higher with less bandwidth need (GSM coding about 90 ms)
Serialization delay dependent of long competing data packets or not

Fig. 6.9: Example of delays over transmission and packetizing elements

In IP networks the delays occur mainly at routers throughout the network. Congestion has an additional effect in a packet switching network: When the queues fill up, excess packets are simply discarded. See Figure 6.9.

Mobile Environment

Among degradation sources for IP/wireless QoS are:

- Strongly varying transmission conditions – Fading, shadowing, interference, packet loss, etc. From bandwidth to power dependence.
- Limited unpredictable bandwidth.
- Handover – e.g., from GPRS to UMTS or between different capability cells in UMTS.
- Hierarchical cells – high bandwidth in small cells, low bandwidth in large cells.
- Varying terminal capabilities with respect to computational power and display size – PDA, mobile laptop, PC in wireless LAN.

6.16 CONNECTIONLESS TRANSFER

In connectionless transfer packets can arrive at the receiver in the wrong order, for example when the path has changed. This and other displacements in time are reasons for buffering, adaptation and 'dejitterization'. See Figure 6.11.

6.17 TCP EFFECTS

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Slow Start Mechanism

TCP has a major responsibility for the QoS received by the application on top of TCP/IP, with an error-free transfer as the main goal, at least for best-effort data traffic. To achieve this goal the transmitting end must adapt send speed and possible necessary retransmission to information at suitable speed limits from the receiver and congestion information from the network.

Congestion control is a distributed algorithm that is used to share network resources among competing users. It consists of two components: a network algorithm that updates and feeds back, implicitly or explicitly, congestion information to sources; and a source algorithm that dynamically adjusts rate (or window size) in response to congestion in its path.

In the current Internet, the source algorithm is carried out by TCP. In case of congestion TCP reduces the send speed. This speed reduction and the subsequent speed recovery has been a subject for much interest during the last few years. Why? Let us first look at Figure 6.11.

A reasonable QoS goal is that the inherent bit rate of a particular system should be possible to use for traffic, and thus generate corresponding income. The traffic types using TCP such as e-mail, file transfer or web browsing will be affected by a reduced transfer speed caused by TCP. Real-time applications such as IP telephony do not normally use TCP (but UDP). This traffic cannot slow down or retransmit, and tends to both cause congestion and suffer from loss.

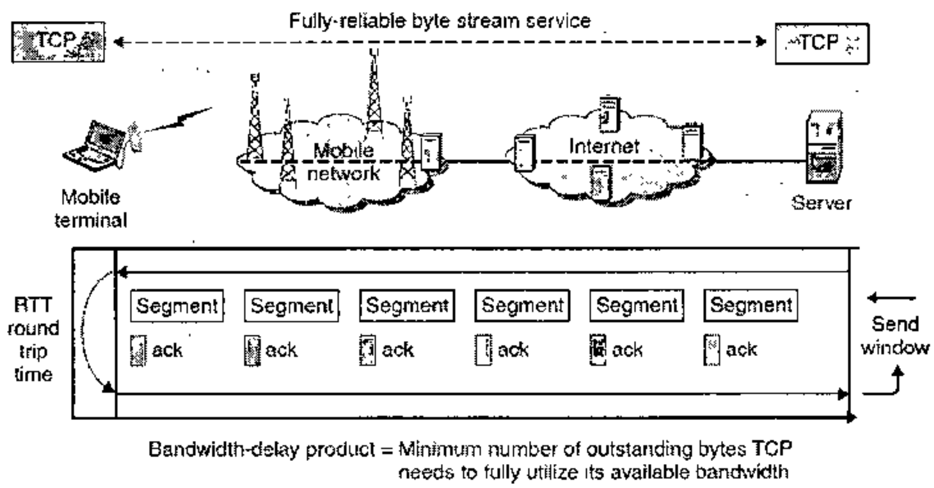

Fig. 6.10 : Important factors in TCP/IP over radio are round trip delay (RTD) and bandwidth-delay Product

TCP behaviour can force the carried traffic to become much lower than system speed would permit. The TCP algorithm uses window size, threshold and acknowledgement as the main parameters. A window is the maximum traffic volume that is not yet acknowledged by the receiver. It can be expressed as the maximum number of sent packets that are not acknowledged. In Figure 6.10 the traffic is segmented and the sender is waiting for six segment acknowledgements travelling between receiver and sender. Figure 6.10 also shows the round trip time, RTT (or round trip delay). RTT is equal to the time it takes for a packet to travel to the receiver plus the time it would take to travel in the opposite direction. A sending window is the window that is agreed with the receiver. A threshold is a speed limit set by congestion indications in an iterative way, in order to operate below congestion. It is therefore also called congestion avoidance.

The applied speed is determined by the lowest value of the sending window and congestion avoidance. It should be added that the threshold varies in time, and that the TCP algorithm forces the sender to reduce the speed (to a small window) and threshold (to 50 % of the previous one) significantly after congestion indications. This heavy speed reduction and the subsequent speed recovery, although quite fast, are called the slow start algorithm.

TCP and Radio

TCP is designed for high quality lines. As indicated before, however, the radio path might suffer from a low, unstable bandwidth, handovers, short periods of no connection, sometimes high BER and long, varying round trip delays (RTD). This does not fit TCP very well. BER causes packet loss. RTD is affected by buffering and serialization of data, propagation time and necessary retransmissions.

The possible ways to retain a higher speed include cutting the RTD by using different TCP connections for the radio path and the rest of the path, replacing the retransmission mechanisms with a faster one, or making retransmissions only over the radio path. Alternative retransmission methods require a mechanism at a lower level in the stack below TCP. Such a solution uses the radio link control (RLC) protocol at the link layer. However, in the last case, TCP will experience delays when RLC retransmits, which might cause a congestion indication to TCP, invoking the slow start mechanism. Using different TCP connections between the terminating points has other drawbacks such as time for protocol translation and an impact on security (TCP is above IP sec in the stack, for example). With a delay from sending to reception of acknowledgement of up to 450ms, which is not unrealistic with significant retransmissions at the radio path, the bandwidth-delay product for WCDMA operating at 384 k bit/s is 20 k bytes. At 64 k bit/s it is around 4 k bytes. This is the required number of outstanding bytes TCP needs to fully utilize the available bandwidth. A low bandwidth-delay product is the goal.

TCP and High Speed Links

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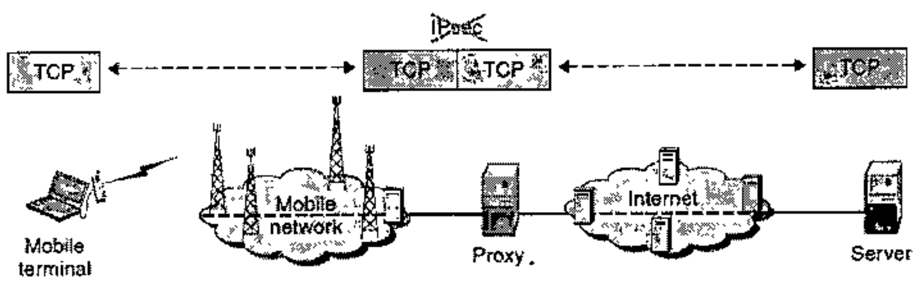
As a result of research at the California Institute of Technology and other research units an alternative or at least a complement to the TCP protocol has been developed. The aim is to reach robust and stable networking at 100 Gbps and higher speeds.

The protocol is a source algorithm which is called 'fast active queue management scalable TCP/IP' or FAST/IP. The protocol is especially interesting for research, enterprise and ISP needs. The largest difference compared with ordinary TCP is the smooth behaviour of the speed adaptation to the network capacity limitations, based on measurements of the delay between sent packet and acknowledgement. Preliminary results indicate a significant increase in transfer speed and utilization factor of existing Internet capacity.

To summarize the TCP aspects: TCP/IP is used much more widely than it was designed for. There are obvious risks that the user can perceive the problems that may arise. The network designer must therefore look for evolving improvements, in order to maintain or improve user satisfaction.

Security

Securing connections with IPsec should be done end to end if possible. As mentioned above a split of a TCP path into more path sections might give a shorter bandwidth-delay product. The split could be done by means of a proxy server, but such solution creates a non-wanted split in the IPsec path as well. See Figure 6.11.



- TCP proxy splits the end-to-end path into two parts
- Proxy separates the part with long delays (radio network from the part with packet losses (Internet))
- Proxy cannot be used with end-to-end IPsec

Fig. 6.11: QoS and security in conflict

6.18 COMPRESSION OF IP VOICE PACKETS BY ROHC

It could be expected that a strong header compression should lead to a decreased QoS, at least in environments with degradations. For ROHC, however, there are also positive effects, according to Figure 6.12.

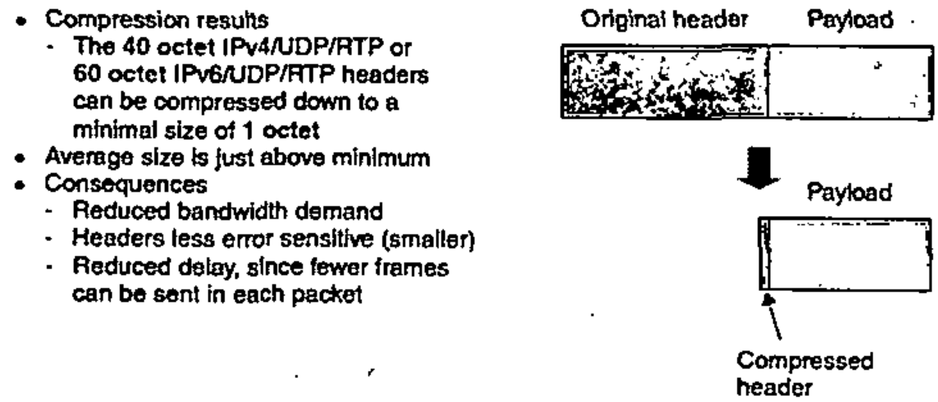


Fig.6.12: Compression of voice packet headers can have positive effects as well

6.19 QOS ENABLERS

In order to enable real-time services over IP three protocols will be briefly presented: RTP, RTCP and RTSP. For QoS adaptation of ATM to various traffic types the three adaptation layers AAL 1, AAL 2 and AAL 5 are provided. Differentiated services and integrated services are used for resource allocation, as well as MPLS, which is also a traffic-engineering tool. All these enablers will be briefly treated. See also Figure 6.13.

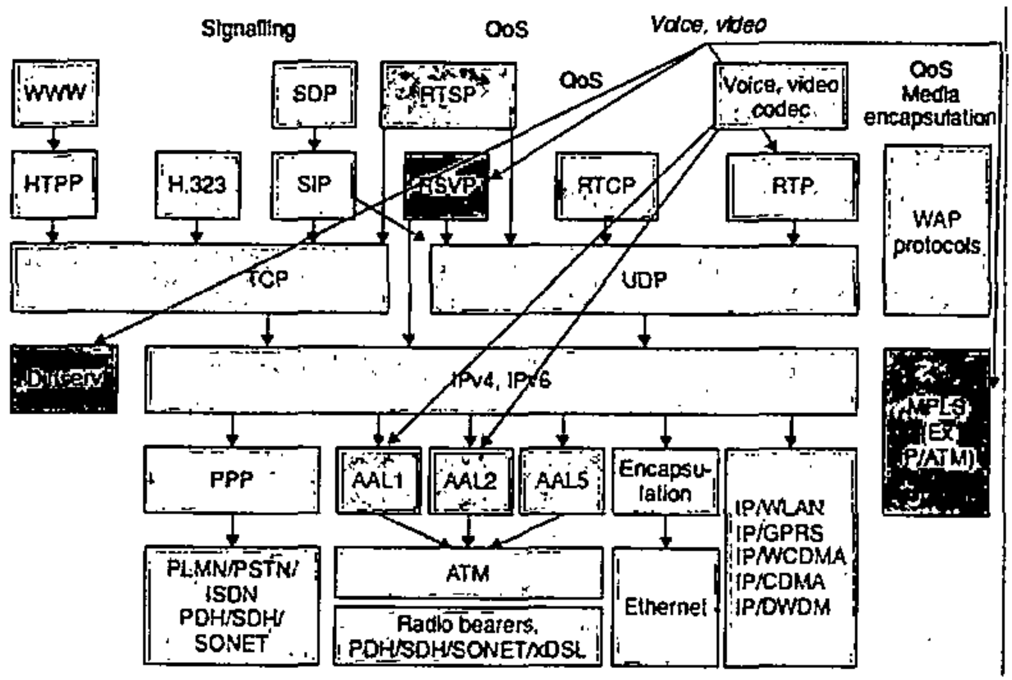


Fig. 6.13: QoS adaptation protocols, resource allocation and traffic engineering protocols

6.20 ADAPTATION-TYPE ENABLERS

RTP (RFC 1889)

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RTP provides end-to-end delivery services for data with real-time characteristics, such as interactive and streaming audio and video, including IP telephony. RTCP (real-time control protocol) is a part of RTP and helps with lip synchronization and QoS management. RTP is used by RTSP, SIP and H.323 for the user data portion of these protocols. The RTP services include payload type identification, sequence numbering, time stamping and delivery monitoring. The time stamp is related to the sampling or the presentation or composition time of the media carried in the payload of the RTP packet. It is used for playing back media at the correct speed, and together with RTCP, it is used for synchronizing the presentation of other streaming media. Applications typically run RTP on top of UDP to make use of its multiplexing and *checksum services. Both protocols contribute* parts of the transport protocol functionality. RTP supports data transfer to multiple destinations using multicast distribution if provided by the underlying network.

RTP does not provide any mechanism to ensure timely delivery or provide other QoS guarantees, but relies on lower layer services to do so. It does not guarantee delivery or prevent out-of-order delivery, nor does it assume that the underlying network is reliable and delivers packets in sequence. The sequence numbers included in RTP allow the receiver to reconstruct the sender's packet sequence, but sequence numbers might also be used to determine the proper location of a packet, for example in video decoding, without necessarily decoding packets in sequence.

RTCP

RTCP is the control protocol that works in conjunction with RTP. RTCP control packets are periodically transmitted by each participant in an RTP session to all other participants. The primary function is to provide feedback on the quality of the data distribution. The feedback may be directly useful for control of adaptive encodings but experiments with IP multicasting have shown that it is also critical to get feedback from the receivers to diagnose faults in the distribution. Sending reception feedback reports to all participants allows determining whether possible problems are local or global.

RTSP (RFC 2326)

The real-time streaming protocol (RTSP) is used as a session control protocol for media streaming applications. Several features and semantics in RTSP have been inherited from HTTP. Using RTSP, a client streaming

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application can establish a session with a media streaming server. Using this session, the client can ask the server:

- to start streaming media;
- to pause, back-up and replay, and fast forward streaming media; or
- to stop streaming and disconnect the session.

RTSP is usually used on top of TCP but can also be used on top of UDP. RTP and RTSP are used together in many systems, but either protocol can be used without the other. RTSP establishes and controls either a single or several time-synchronized streams of continuous media such as audio and video.

ATM Adaptation

In order to take care of all kinds of services ATM has its own protocol stack. It consists of three layers:

1. The ATM adaptation layer (AAL). It is here that 48-byte data units with AAL and payload are created.
2. In the ATM layer the five-byte header is added.
3. The physical layer takes care of the mapping of the bits onto the physical medium.

ATM is designed for all types of media. Different services demand different kinds of adaptation support and therefore different kinds of AAL protocols. AAL1 takes care of constant bit rates, especially voice coded with 64 k bit/s. AAL2 takes care of variable bit rates like compressed voice and video. AAL 2 is a 'small cell' transfer mode of its own with dedicated AAL 2 switching. AAL5 takes care of data. See Figure 6.14.

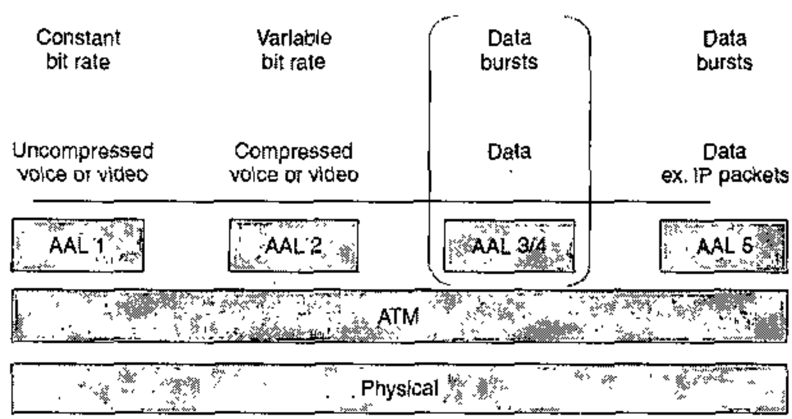

Fig. 6.14: Adaptation protocols in ATM

6.21 NETWORK-DRIVEN QOS COMPONENTS

802.1p, Ethernet QoS

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The idea with 802.1p is the use of flags in the media access control (MAC) header to establish packet priority (not reservation!) in shared-media 802 networks. 802.1p awareness is requested for devices, hubs and switches. The issue of differentiating between network packets, and perhaps treating them differently according to the applicable QoS differentiation, is done by means of the MAC header. The MAC header (the lower half of Layer 2 in the ISO OSI Model) is the only part of a packet that hubs or switches investigate in their scope of work. 802.1p provides prioritization of packets traversing a subnet by the setting of a threebit value in the MAC header. Thus, when the local segment becomes congested and the hub/switch workload results in the delay (dropping) of packets, those packets with flags that correspond to higher priorities will receive preferential treatment, and will be serviced before packets with lower priorities.

6.22 QOS IN IP NETWORKS

In IP networks the routing is normally based on hop count and delay. This often leads to an uneven traffic load in the network. Some links become heavily congested while others remain almost idle. Resource allocation should therefore be complemented by traffic engineering and performance optimization. The initiatives on QoS in IP networks are conceptually similar to those in ATM networks and consist of:

- Admission policy (possible shaping).
- Assignation of specific paths for synchronous (real-time) traffic preventing the competition from long IP data packets.
- Prioritization (certain packets can be dropped in case of congestion).
- All QoS methods have the same goal which is to open a differentiated lane for realtime communications out of the sometimes congested heavy traffic highway assigned to best-effort traffic.

The main enablers are RSVP through resource reservation, MPLS through label switching and differentiated services with a defined per hop behaviour in each router based on the traffic identification. See Figure 6.15. RSVP is normally used for reserving bandwidth in the access. RSVP offers guaranteed quality. It is heavy work to maintain RSVP in large backbones. At the edge nodes, when entering the Internet from the access network, a policy decision is made. Depending on who the

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user is, what type of traffic he/she generates, and other factors, for example time of the day, or month, the data is assigned a certain traffic class. Traffic shaping and policing might also occur at this point. The purpose of shaping is to even out peaks in the traffic. This means that shaping introduces a delay and should preferably strike the non real-time traffic.

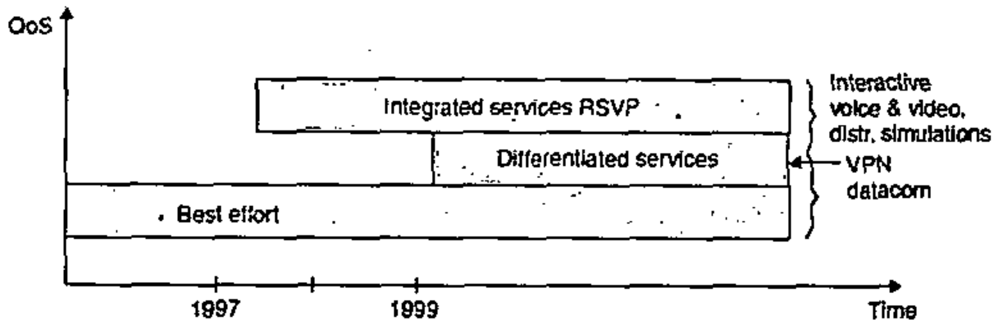

Fig. 6.15: QoS methods and their main applications

Policing looks at the agreed service level and prevents traffic above the agreed levels in cases of high load. This means that a packet loss is introduced, so this should not strike loss-sensitive data. See Figure 6.16.

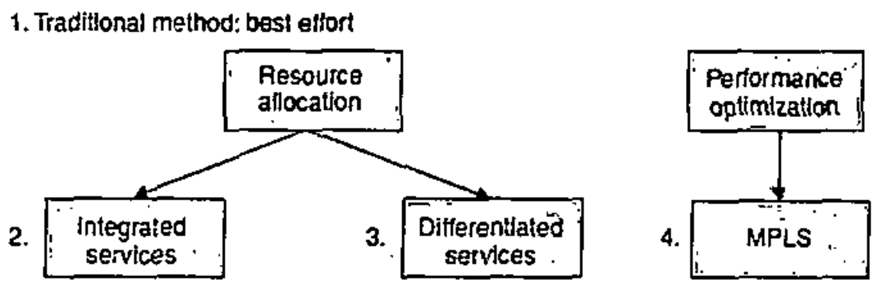

Fig. 6.16: Best QoS is achieved with resource allocation, traffic engineering and performance optimization

6.23 INTEGRATED SERVICES

Resource Reservation Protocol

RSVP carries and disseminates QoS information to QoS-aware network devices along the path between a sender and one or more receivers for a given flow. See Figure 6.17. Integrated services supports real-time transfer and guaranteed bandwidth for specific 'flows'. A flow is a distinguishable stream of related datagrams from a unique sender to a unique receiver that results from a single user activity and requires the same QoS. The flow/connection must then be identified and treated in the same manner through all intermediate nodes. The flow is unidirectional and it is identified by the destination IP address and the port number.

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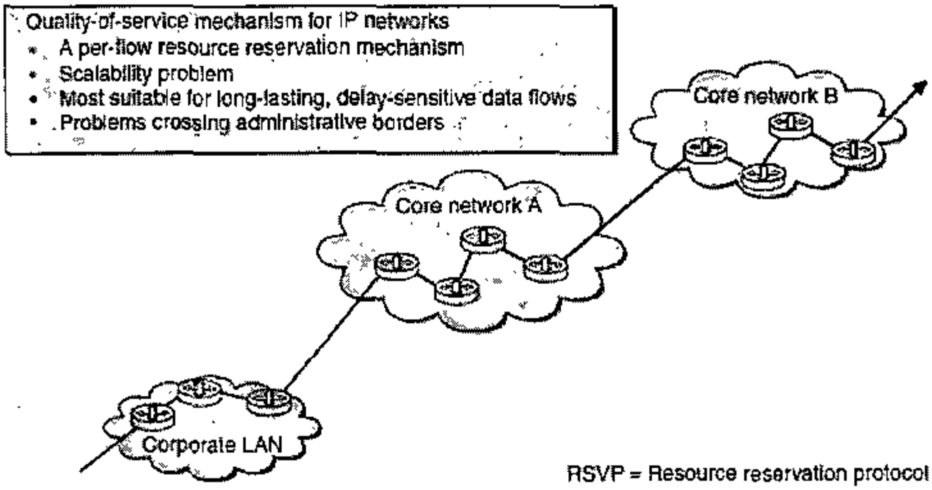

Fig. 6.17: *A reserved RSVP path for a specific flow*

6.24 DIFFERENTIATED SERVICES

Essentially, differentiated services specify the transfer priority of a packet as it passes through each network device on its journey through the network. In order to allocate this priority, differentiated services marks the packets with a code point value, called the DiffServ code *point, which is used by network devices such as routers to determine* the per-hop behaviour (PHB) treatment.

Diffserv does not give any guarantees. It is like travelling by train without knowing when you will arrive. The standard is a compromise between reservation and prioritization. (you travel faster than packets with a lower priority). Diffserv is considered a scalable technology that can offer differentiated services for various needs in large networks.

6.25 MPLS (MULTI-PROTOCOL LABEL SWITCHING)

See Figure 6.18 MPLS (multi-protocol label switching) introduces connection-*oriented label switching mechanisms inside the otherwise connectionless* IP technology. MPLS offers dynamic bandwidth allocation, traffic engineering, scalable IP over ATM support and support for VPNs. MPLS introduces the concept of label-switched paths (LSP) for both individual and aggregated traffic streams. Separate LSPs are used to serve flows with different QoS requirements. LSPs are set up between media gateways based on topology information provided by routing protocols, such as OSPF (open shortest path first). Each LSP carries traffic from only one specific service class. The LSPs are created with

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a specific set of characteristic parameters (carried in MPLS signalling) according to the type of traffic (voice, signalling, etc.) it is intended to carry. LSPs may be set up either statically or dynamically according to the actual bandwidth needed between the media gateways.

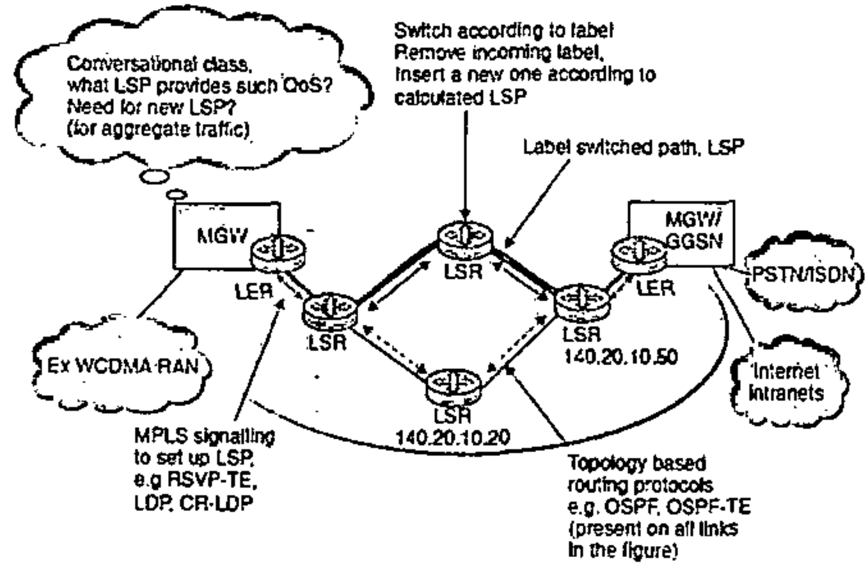

Fig. 6.18: MPLS terminology and way of working

The end-points of an LSP on the border of the MPLS enabled core network are defined as label edge routers (LER). At these points traffic from surrounding networks will be labelled and switching will be carried out based upon the label which is exchanged on a link-by-link basis. The LER function is implemented as part of the media gateway function. Each LSP carries traffic for a number of users. The number of LSPs as well as the number of calls a LSP is intended to carry is a trade-off between available resources and additional load produced by the MPLS signalling, which is required to maintain the LSPs.

Not all types of traffic carried through the network require the use of LSP paths. MPLS trunks are used to apply adequate traffic engineering, security and resource management on the core network. Traffic engineering facilitates performance optimization while utilizing network resources economically, efficiently and reliably. MPLS encompasses techniques for reliability so that network service outages arising from errors, faults and failures can be minimized.

6.26 QOS AT THE APPLICATION LEVEL COMPOSITE CAPABILITIES/PREFERENCE PROFILES

The present transfer of web information is normally based on recognizing a particular browser type. An alternative is to use composite capabilities/preferences profiles (CC/PP). In order to use CC/PP the terminal is provided with a user agent with a CC/PP profile.

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CC/PP is a language for describing what the user agent can (currently) do by means of content negotiation. This information would then be conveyed to the originating server as part of an HTTP (or other protocol) request, and it is up to the server to decide how to use the user agent profile to best meet the needs of the user agent client. The two primary ways in which a profile might be used are selection and transformation. Selection is the process by which the originating server chooses an appropriate representation of requested web content from a finite set of existing representations.

Transformation, on the other hand, assumes that there is no finite set of representations, but that content is flexibly created based on the properties expressed by the user agent profile. The content would be stored in an XML-compatible format and then transformed into an appropriate language (or modules thereof) that could be understood and optimized for the user agent, such as XHTML or WML.

Negotiation can include information on the user agent's capabilities (physical and programmatic); the user's specified preferences within the user agent's set of options; and suitable bearers are negotiated, especially the RAB bearer across the radio access specific qualities about the user agent that can affect content processing and display, such as physical location. See Figure 6.19.

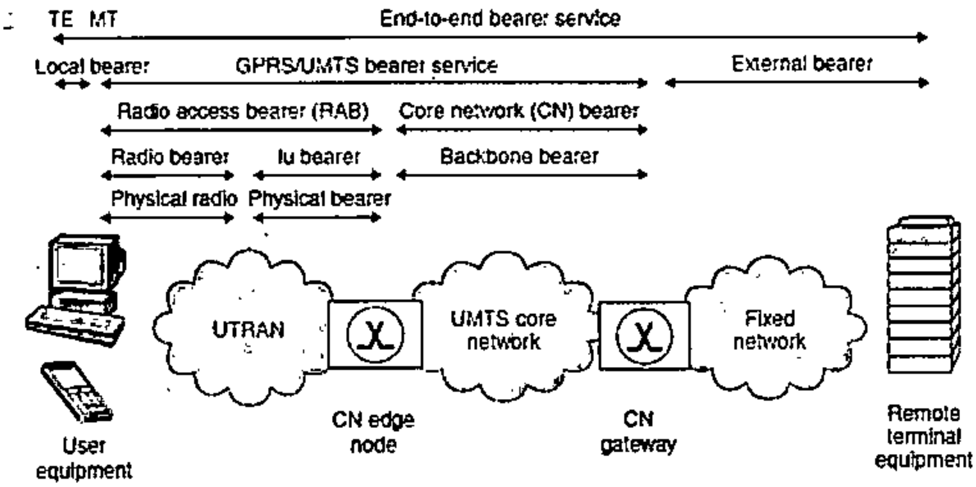

Fig. 6.19: Many bearer services are part of the UMTS system, provided there are choices.

CC/PP is designed to work with a wide variety of web-enabled devices, such as PDAs, desktop machines, laptops, WAP phones, phone browsers, web television units and specialized browsers for users with disabilities.

Proxies may also be used to provide markup transformation, transmission or caching services for CC/PP-enabled clients and servers.

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6.27 IMPLEMENTATION OF QOS IN UMTS

UMTS is targeted for multimedia traffic with different QoS requirements. Attributes that define the characteristics of the transfer may include throughput, transfer delay and data error rate. This section covers two main ways to manage QoS in UMTS: RAB (radio access bearer) mapping for the access network and QoS handling.

6.28 RAB MAPPING

The composite system contains many layers of bearers. Many layers are stratified on top of each other. From a QoS point of view the RAB plays an important role, since UMTS allows negotiation of the choice and attributes of the radio bearer. An RAB offers circuit (initially) or packet mode and a number of bandwidths. The bearer class, bearer parameters and parameter values are directly related to an application as well as to the networks that lie between the sender and the receiver.

Bearer negotiation is normally initiated by an application, while renegotiation may be initiated either by the network (for example in a handover situation) or by an application. An application-initiated negotiation is basically similar to a negotiation that occurs in the bearer establishment phase:

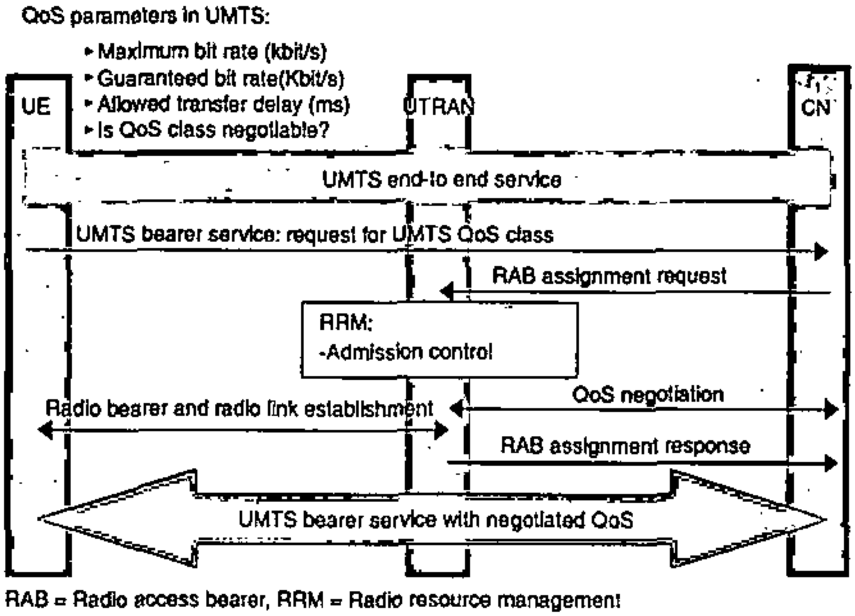

Fig. 6.20: RAB negotiation for the UMTS access network

the application requests a bearer depending on its needs and the network checks the available resources and the user type of subscription and then responds. The user either accepts or rejects the offer. The properties of a bearer service affect the price of a service. See Figure 6.20.

At the start of UMTS service not all of the QoS functions will be implemented, and therefore delay-critical applications such as speech and video telephony will be carried on (more expensive) circuit-switched bearers, Later, it will be possible to support delay critical services transported as IP packet data with QoS functions.

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6.29 QOS HANDLING

Another UMTS QoS issue is the choice of QoS enabler for IP traffic (RSVP, MPLS etc.), ATM service classes or frame relay. The applications and services are divided into four different QoS classes. The subscriber QoS profile, if any, is stored in the HLR. It is possible to store a differentiated QoS. The SGSN server, the MGW and the GGSN are responsible for QoS negotiation and handling.

For a specific call the QoS that is requested from the application or the user is mapped to the QoS profile that is negotiated at PDP context activation. The PDP QoS is mapped to the QoS mechanisms of the concerned networks, such as: DSCP values in Diffserv networks, MPLS labels in MPLS networks, ATM service classes, frame relay traffic parameters, etc. See Figure 6.21.

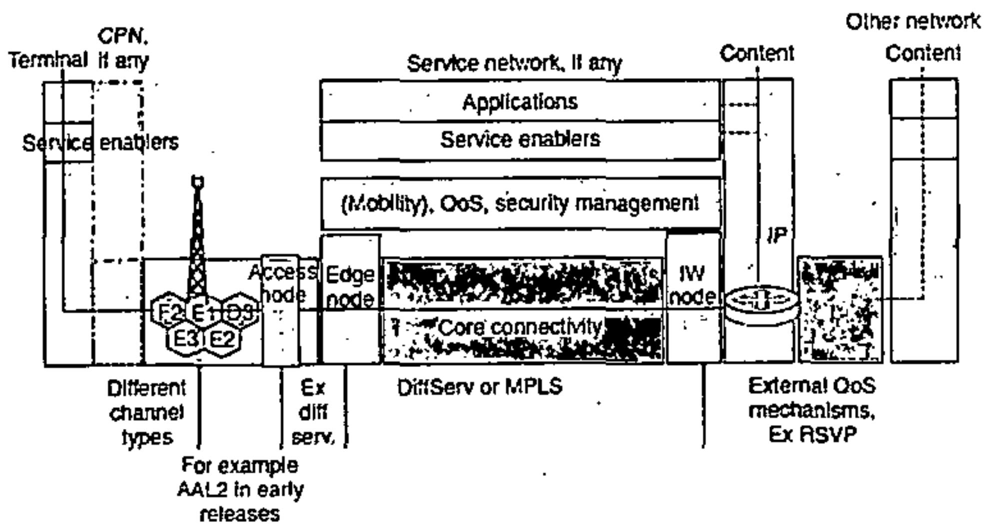

Fig. 6.21: Example of chosen QoS enablers in 3GPP R99

It is important that the fixed path has sufficient capacity for the wireless traffic. Otherwise the scarce resources of the wireless path might not be used to its potential and the QoS might be affected. The SGSN MGW implements QoS handling and RAB mapping. Fallback of QoS

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level is possible when roaming between UMTS and other mobile networks. See Figure 6.22.

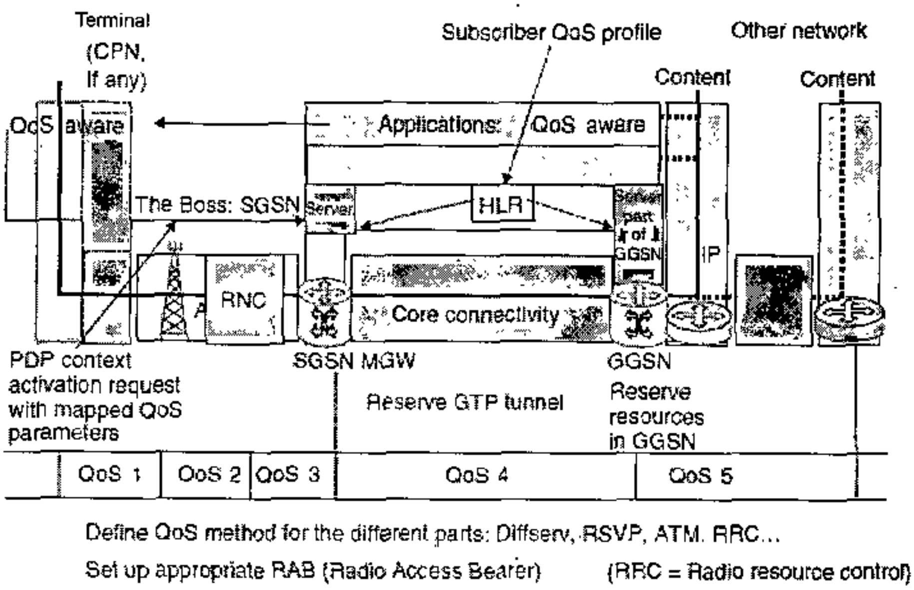

Fig. 6.22: QoS communication example – the SGSN server is still collocated with the SGSN MGW

SUMMARY

- QoS has always been an important part of telecommunication. Various measures have been used. The probability of congestion for traditional voice trunk calls is still indicated in the number of congested calls per hundred call attempts.
- The current importance of QoS is very much associated with the transition from circuit switching to packet switching, with the success of the IP technology, with the development towards multimedia and finally with the success of mobile systems.
- 'QoS is a necessity for (packetized) real-time services' or 'A specific QoS can be described as a set of parameters that describe quality requirements of a stream of data'.
- TCP is designed for high quality lines. As indicated before, however, the radio path might suffer from a low, unstable bandwidth, handovers, short periods of no connection, sometimes high BER and long, varying round trip delays (RTD).
- The real-time streaming protocol (RTSP) is used as a session control protocol for media streaming applications. Several features and semantics in RTSP have been inherited from HTTP.

REVIEW QUESTIONS

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1. What is quality of service?
2. Discuss the perception of QoS.
3. What are different QoS classes?
4. What are different threats to QoS?
5. Explain the TCP and high speed links.
6. Describe the QoS enablers.
7. Discuss about the delays and delay variations in packet system.
8. Define the layered networks and change of transfer mode.
9. Differentiate between the real-time applications and non-time applications.

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CHAPTER 7 ADAPTING TO A GLOBAL ECONOMY: IMPLICATIONS OF TELECOM REFORM FOR SMALL DEVELOPING COUNTRIES

★ STRUCTURE ★

7.0 Learning Objectives
7.1 Introduction
7.2 Fundamental Policy Issues for Developing Countries
7.3 *CTU—Countries Telecom Structure*
7.4 Defining Development in the Caribbean
7.5 Some Lessons From the Caribbean
7.6 International Issues, Advocacy and Negotiation
- *Summary*
- *Review Questions*

7.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- differentiate between the PTTs and TNCs.
- describe the caribbean telecommunications union (CTU).
- discuss about the information technologies and services.
- explain the fundamental policy issues for developing countries.
- define the development in the caribbean.
- know about the network development.

7.1 INTRODUCTION

The drive for telecom reform began in the US, which already had one of the leading telecom sectors in the world, and spread initially to other developed countries. The objective of the US reforms was not to achieve universal service. That already had been achieved. The US reform responded to concerns about AT&T's efficiency and monopoly power, increasing demands from other US companies to enter the telecom service market, and increasing demands from large businesses for improved and advanced telecom services. The US reform was a restructuring of its domestic telecom industry as a foundation for continued economic growth in its transition to an information economy.

The US reforms were entirely a domestic matter. Other countries have approached telecom reform more cautiously. Canada, Australia and the Nordic countries already had achieved a universal service, but have seen the benefits of liberalisation in terms of improved efficiency, industry development and building a foundation for an information economy. In most other developed countries, before the reforms the PTTs had not come anywhere close to achieving a universal service and had operated at high levels of inefficiency in reference to world's best practice. As a result the potential economic and social gains from reform are seen as substantial.

Yet, with the exception of the UK and a few smaller countries, such as New Zealand, the reforms are proceeding much more slowly. There is recognition that foreign telecom operators – and particularly the large US operators and BT – are poised to enter their markets, and the newly reformed PTOs may not be ready for the competition. Moreover this foreign competition will create platforms of efficient, advanced telecom services that may give foreign transnational corporations (TNCs) in many industries an additional competitive advantage over domestic firms in the same industries. The principles of the Bangemann Report, which announced a European policy of rapid telecom liberalisation are being implemented slowly, and countries with the most inefficient PTTs have been given an extra five years, until 2003, to fully liberalise their telecom sector. Telecom reform in these countries will provide a mixture of benefits and costs, and national policies are attempting to ensure that most of the benefits are realized within the country.

Developing countries have even more complex issues to consider in fashioning their policies. In most, but not all countries, the PTO provides an uncompleted telecom network. Its primary social policy has been to provide employment and financial contributions to the treasury, rather than to develop a universal telephone service. It has never had sufficient capital to construct a full national network and suffers from a shortage of technical and managerial skills. Reform in these countries must attract foreign capital and skills, but the countries often are not in a strong position to control and manage the foreign resources in the best interest of the domestic economy and society.

These countries are vulnerable to the possibility that the telecom system may be developed and operated entirely in the interest of foreign the economy; or the new dependencies created. In telecom these additional dimensions of the problem are even more important, as the Caribbean experience illustrates.

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7.3 CTU—COUNTRIES TELECOM STRUCTURE

This perspective on telecom reform draws on the experiences of the Caribbean countries which comprise the Caribbean Telecommunications Union. The CTU's role is to advise and harmonise telecom policy and development among its members, most of which are island countries in the Caribbean. The overall population of the CTU countries is about five million, with a telephone penetration rate that has risen to just under 20 percent.

While the unit household in many areas seems well served when compared with 'business' lines connected, there is a vast number of rural households, with less than adequate telephone access. On average, the economies are moving rapidly toward services and information, with about 60 percent of the regional economy in the services sector, which requires increased telecom availability for both old and new services. The telecom sector exhibits a dominance of foreign direct investment (by Cable and Wireless [C&W] of the UK), some state investment, and an uneven correlation of revenue to investment. There is a diverse set of structural arrangements that exist among the countries in the pre-competitive environment of the Caribbean. For example, Belize has a model of foreign private shareholding, ordinary public shareholding and State investments through National Insurance funds. Barbados shows some inefficiencies compared with the Bahamas, but both are state owned. Trinidad and Tobago, with a mixed company, has high revenue but unmatching infrastructure investment. Jamaica's high revenue stream does not match the vast gap in infrastructure development.

Virtually all countries have telecom legislation, but relevant modern legislation obtains only in Trinidad and Tobago, Jamaica, Barbados, Belize, Dominica, and Grenada. The regulatory structure shows that there is a varied administrative machinery to supplement the legal structure. The administrative instrument tends to be a public utilities commission, with interesting variants in Jamaica, a fair trading commission; and in Antigua & Barbuda and Trinidad & Tobago, telecom authorities. Institutionally, in terms of capacity to exercise control over the telecom portfolio, the relevant ministry in each country tends to have responsibility for licensing and spectrum management.

7.4 DEFINING DEVELOPMENT IN THE CARIBBEAN

Telecom has played an important role in development in the Caribbean, which has been significantly different than in developed countries. In these developing countries the telecom sector is more directly linked to overall development of the countries; it assists with the balance of payments, and contributes to job creation and an improved quality of life. There is a strong interface between telecom reform and the wider political package of policy concerns and responses. The upshot is that there is no simple, normative description of what telecom development specifically entails in developing countries. The sequence of the discussion on areas and issues for telecom reform is necessarily tendentious, in that it commences from the premise of what would be most conducive to overall development.

Network Development

Statistics indicate great development of the Caribbean networks, evidenced by strong urban and business growth; and reasonable household reach However, the statistics mask an important rural problem. For most national networks there is an unfinished infrastructure being developed more rapidly in urban areas, which is not keeping pace with rural development. Concomitantly, business decision-makers are espousing a model of regulation based on the North-Atlantic model of price-caps. As the question of pricing is very much tied to investment, it is unclear how rural telephony will develop, even with cellular technology. Are there incentives for the necessary investment? How can service be provided at a price that is affordable to the rural consumer?

Evidence from other parts of the world indicates that rural business tends to follow, not precede, rural telecom structure development. Also, there is a multiplier effect of new residential rural users conferring externality benefits to the overall system. Therefore, a very high priority must be to provide for some incentive to stimulate investment in the 'unfinished' networks. It is not clear that price cap regulation would help at all, and it could provide a stronger incentive to invest elsewhere. The challenge for policy and regulation is to strike the right balance in stimulating network development. Part of the new balance may require re-conceptualising universal service in innovative ways, which includes shifting the emphasis from 'service' to 'access'. Today there are major external pressures to review the conceptual approaches to universal service and universal access. The US has championed a particular view of universal service. Europe's public service tradition of the State still has an impact on its concept of universal service. Neither of these

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approaches is grounded in Caribbean reality. Further, in countries which already have achieved near-universal service, there is a shift from definitions of household penetration to communities of interest, e.g., sharing costs for connecting schools, libraries, etc., as the focal point of universal access. The Caribbean still needs increased household penetration and it needs access to networks for its telecom development. While the new concepts include some focus on geographic coverage – e.g., rural areas – and distributional equity – e.g., the disabled, there are socio-political needs of the Caribbean to be considered. For example, the information society requires electronic access to public information. Thus, applications of the new technologies of telecom development consequently carry new obligations – access to jobs, health, education, etc., Further, there is the neglected societal demand for safety and social cohesion, which require access to universal service even more now than in the past.

Caribbean Information Infrastructure

Within the discussion of the global information infrastructure (GII), each country is now seeking its own relevance through recognition of, and consensus building on what constitutes its national information infrastructure (NII). This places a focus on how regulatory reform can enhance the NII. As countries struggle to move toward information societies, electronic access to the economic, social and cultural environment may determine whether or not the individual is able to participate in citizenship. In addition, social concepts can have a taxonomy of responses which, in the particular circumstances of a country, must have specific and not general usage. Social rights may be basic but in reality they tend to be what is affordable, so responding to changes and pressures effectively becomes fundamentally important. Developing countries are reluctant to sell the concept of the basic right to telecom in their overall negotiations of telecom investment and infrastructure development with foreign investors.

The basic telecom issue for Caribbean countries has a fundamental tension: how to negotiate between establishing conditions for international trade and simultaneously developing the local telecom infrastructure. The WTO rules of open markets simply require market access for foreign operators. For developing countries, the terms of the trade-off are important. Will there be expansion into rural telephony which can subsequently create business demand, or will foreign investment in the capital cities and resort areas make it more difficult to extend basic telephony to rural areas?

7.5 SOME LESSONS FROM THE CARIBBEAN

At the present time there are at least seven areas that Caribbean countries are examining in this sector. The first is national legislation. How can the countries best modernize legislation at two levels: one in terms of ensuring universal service development, and two, in determining what kinds of institutions shall be established in relation to trade and regulation in the telecom sector.

The second area is cable television. It has become a major issue in several countries, most notably Jamaica, to the extent that the government has issued a broad decree on how it ought to be treated. Jamaica has placed cable television under the Broadcast Commission, and that may be the model for other countries. The important issue that is emerging now is the limited market availability and market potential that exists in some places. Should existing PTOs get involved in cable television if that will develop a larger cable market, or would that take limited capital resources away from investment in network expansion toward universal service?

The third area is how the PTO ownership model should change in the Caribbean. Currently there are different combinations of the state, private sector and foreign private sector ownership in many parts of the Caribbean. Countries are considering privatisation, but a model of privatisation designed to fulfil development objectives, not just a transfer of ownership and control in order to get foreign investment.

The fourth area is the type of competition that will best serve development objectives. In principle, competition that will extend the market geographically and help achieve universal service objectives, or add new value-added services, is compatible with these objectives. It is much less clear that duplication of infrastructure investment will help serve development needs, given the limited investment capital available and the higher priority needs for investment in other areas.

The fifth area is network infrastructure. The Internet is beginning to place observable demands on infrastructure development. The push to establish a NII of the capability being discussed in the US would imply an enormous demand for network expansion that would compete for the limited capital resources with other investment priorities. For the near-term future at least, perhaps innovative investment in wireless technologies and cooperative use could extend services to rural and low income areas while at the same time earning higher returns than would investment in broadband information superhighways.

The sixth area is that of user groups, and the Caribbean has some very sophisticated users. The Caribbean survey on the NII identified three major user groups: finance, government and education. The finance sector is doing extremely well, in fact far better than any of the other business sectors. This raises an important issue of what the CTU telematics policy should be in relation to improving the work of the finance sector. Government itself, is becoming a very large user, both in its daily business and in its international activities. For example, tourism links abroad are an essential part of the development of a key industry. The

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third emerging sector is education. There are now many experiments in the region in the school system, familiarising people with approaches to telematics and using telecom services in education. But the supply of education and other government services using new telecom services can only serve that portion of the population that the telecom system reaches. The people most in need of these services are not on the network.

The seventh area is the important task of establishing programs for human resource development in the changing telecom environment. Caribbean countries do not yet have in place, although there are special initiatives underway, a coherent policy that shows how the countries intend to support this new electronic culture, either in the school system or in the area of entrepreneurship. Trials in Saint Lucia, Jamaica, Trinidad and Tobago, and a few other countries, provide a foundation for development of an overall policy in the near future.

7.6 INTERNATIONAL ISSUES, ADVOCACY AND NEGOTIATION

The Caribbean telecom infrastructure has global connectivity, including fibre links to the US, the UK and Europe. The Caribbean is a key transit point providing gateway traffic in the C&W regional configuration. The gateway logic also shows that the economies of scope in C&W allow them to become vertical players in global telecom markets. The region continues its ongoing negotiations with C&W on its role in contributing to development in the region.

In the new environment it is apparent that advocacy and negotiations – mostly beyond the national frontier – are going to be crucial elements in telecom regulatory reform in the Caribbean and most other developing countries. Yet, multilateral processes are costly and complex. They demand a continued presence of expert personnel who can be regularly engaged in consensus-building in a shifting global telecom market. Consumer interest groups, important at the national level, are overshadowed by the array of transnational provider interests. An international synergy (comparable to INTUG, for example) is necessary to carry forward the views for small states. It may be the case that there is emerging a model of a relatively weak (in international terms) independent regulator at the national level which needs a wider international grouping that can mediate a new type of governance over international telecom decisions.

The human resource skills for international negotiations, and therefore participation, are the weakest element for developing countries. It is here that action at regional and multilateral international levels is requisite for the viability of these States. There is a need to develop multi-disciplinary skills for the sector, and also to establish the necessary alliances for creating negotiating 'space'. There seems to be a prima facie case for considering an international group for independent telecom regulators to advocate the public interest of individual States, especially given the pressures of international level advocacy by the global private telecom players. For example, the US spawns many global telecom players. Simultaneously, the FCC's position on the US public interest is the expansion of the US market abroad. Placed in the context of developing countries, the US policy is not realistic, since these societies need breathing space within which the policymakers and regulators can define the priorities for overall determination of the nation's public interest. Simply adopting the US regulatory structure and policies is not likely to achieve it.

Telecom development, therefore, in the emerging information society can benefit from the synergies of an international group of independent regulators who can mediate in the multilateral processes of the WTO, ITU, etc. These independent regulators must have a strong base for strategic negotiation, a multidisciplinary team of experts for support, a capacity to intervene through knowledge and alliance building, and *a continuing plan for appropriate human resource capability-building.* This may be crucial to the governance side of the development of the Caribbean Information Infrastructure and the maintenance of effective engagement with foreign investors and international agencies.

SUMMARY

- Moreover this foreign competition will create platforms of efficient, advanced telecom services that may give foreign transnational corporations (TNCs) in many industries an additional competitive advantage over domestic firms in the same industries.
- The Caribbean Telecommunications Union (CTU) is one of the regional organisations that help to integrate telecom activities in the region.
- Telecom reforms expanding opportunities for the introduction of new communication and information technologies and services (CITS) open up two new dimensions of the issue that have not been explored to any significant degree.
- Part of the new balance may require re-conceptualising universal service in innovative ways, which includes shifting the emphasis from 'service' to 'access'.

- As countries struggle to move toward information societies, electronic access to the economic, social and cultural environment may determine whether or not the individual is able to participate in citizenship.

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REVIEW QUESTIONS

1. Discuss the fundamental policy issues for developing countries and its aspects regarding India.
2. Distinguish the WTO and ITU.
3. Describe the international issues, advocacy and negotiation.
4. Discuss about the caribbean information infrastructure.
5. Explain the some lessons from the caribbean.
6. Discuss about the countries telecom structure (CTU).

CHAPTER 8 REGULATING COMMUNICATION SERVICES IN DEVELOPING COUNTRIES

★ STRUCTURE ★

8.0 Learning Objectives
8.1 Introduction
8.2 Paradoxes of the Regulatory Mandate
8.3 Using Market Structure to Achieve Regulatory Goals
8.4 Regulatory Challenges Incompetitive Markets
8.5 Institutional Requirements
- *Summary*
- *Review Questions*

8.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- describe the transformation in the telecom service market.
- discuss about the paradoxes of the regulatory mandate.
- explain the universal service obligations.
- differentiate between the USO and PTO.
- define the organization for economic cooperation and development.
- know about the using of legal instrument to ease resource deficiency.

8.1 INTRODUCTION

Telecom services have experienced the heavy hand of regulation for quite sometime. But, regulation in past decades was quite different from that which has begun to unfold in recent years due to sweeping reforms in the sector. This chapter looks at recent transformations in the sector and its impact on telecom regulation. In doing so the piece concentrates on the particular challenges that developing countries face in the transition from traditional state-owned monopolies to more open, competitive, and privatized markets.

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The transformation in the telecom service market has been so profound that in some developed nations a debate has emerged as to whether there is any need at all for an industry-specific regulator. In developing countries, this chapter argues, the situation is quite different and the need for a telecom regulator during this transition period is essential. Yet, the mandates of today's telecom regulators in developing countries are somewhat different from those of the recent past. Although some of the core goals of regulatory activity – such as the pursuit of universal services – are still vital to their functions, new ones, mainly related to the rise of competition in domestic markets, have come into play.

For decades, the pursuit of universal service seemed in direct conflict with competition. Haunted by the fear of social inequality, due to a skewed distribution of services, and rejoiced by the political and economic benefits it provided, governments in developing countries eagerly embraced state-owned telecom monopolies to fulfil universal service obligations. Growing evidence from both developed and developing countries, however, shows that, contrary to what was expected, competitive markets can go further than monopoly arrangements in the achievement of higher network penetration. A brief summary of the impact of liberalisation in various aspects of the market – network penetration, prices, quality of services, employment, etc.,—is presented in the second section of the chapter.

Although competition and increased private participation are policy choices that regulators can use to effectively fulfil most social and economic goals, an open/privatized market can also dramatically increase the demand for regulatory intervention and stretch regulatory resources in developing countries to their limits. Examines the challenges that regulators face in competitive markets, such as interconnection, structural and accounting separations, number portability, and the like. The final section highlights some of the institutional requirements that most regulators in developing nations would have to tackle to effectively intervene in the market. Issues related to the institutional design of the agency, transparency, autonomy, and the more concrete matters of finances and human resources are included in this analysis.

8.2 PARADOXES OF THE REGULATORY MANDATE

Industry-specific telecom regulation should not be taken for granted. Some countries have decided that there is no need for such an institution (e.g., New Zealand). Others are following the same path and will soon do away with their telecom regulatory authority (Australia). And, finally, others have been involved in a heated debate as to whether their telecom regulatory agency should be abolished or not (USA). In all of these cases, the functions of telecom regulators are to be absorbed by competition commissions or the like. Regulatory actions are based on industry and/or consumer complaints guided and supported by the rights and obligations set in competition laws and exercised through the judicial system of the country.

Although the fashion of questioning telecom regulators seems to be taking hold among some groups in the advanced and mature telecom markets of industrialized nations, the opposite trend is on the rise among developing countries. That is, there is a growing belief that telecom markets require a strong, independent, well-staffed, and sufficiently funded industry-specific telecom regulator. The reasons for this are simple. First, in most developing countries, there are no competition laws or similar legal instruments, nor is there a tradition to exercise such legislation. Second, there are no competition commissions. And, although there are some consumer defence institutions, they are ill-suited to deal with issues that go beyond consumer complaints. Third, the judicial system in almost every country is not prepared – due to knowledge and resource constraints—to deal with the complexity and dynamism of telecom-related controversies. Fourth, due to the very same deficiencies of the judicial system, a telecom regulator is necessary to set proper market conditions for the rise of competition.

Finally, the aim of attracting private capital (local and foreign) to long-term ventures in the telecom sector will be hampered in the absence of an autonomous, professional regulator enforcing a clear and well-defined regulatory framework that offers companies a buffer against market volatility.

Assuming that telecom-specific regulators are necessary in developing countries, then, what are the main goals and mandates that will guide the actions of regulators? In general, there are three dominant mandates that guide the operations of telecom regulatory agencies in their daily operations. The first and more traditional one, is to serve social goals – such as the fulfilment of universal services obligations. The second is aimed at controlling telecom service provision due to its strategic role in the defence and economy of the nation. The third, and most recent one, calls for the regulator to play a key role in stimulating and assuring fair and balanced competition in the domestic communications market.

Although most regulatory agencies around the world engage all three roles, the relative weight of each differs according to the degree of economic development and the particular political system of each nation. In industrialised countries, liberalised markets have press regulators to concentrate on stimulating and fine tuning competition and achieving significant improvement in the quality and sophistication of services.

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In developing nations, however, regulatory agencies are still heavily involved in the pursuit of more general socio-economic goals, such as expansion of basic services, the building of a national telecom infrastructure, and the control of the industry "in the national interest."

This latter mandate of control and monitoring is based on the fact that most governments in developing countries see telecom as vital to national interest and national security. These concerns seem largely anachronistic to developed nations where telecom and information services have become a commodity. In developing nations, however, most communication services and networks—including value-added telecom facilities such as the Internet – are still treated as special cases of national interest. Social mandates, on the other hand, have been largely concentrated in the fulfilment of universal service obligations (USO). It has been assumed until recently that meeting USO requires the subsidy of network deployment and tariffs among rural and residential urban users. This is basically a redistributive regulatory function that many argue is increasingly in contradiction with promoting competition in the market. As a promoter of competition, the regulator's main function is to ensure that incumbent carriers do not abuse their market power by setting discriminatory and predatory pricing, unreasonable terms of interconnection, unfair revenue-sharing arrangements, and so forth.

Therefore, modern regulatory agencies generally find themselves needing to achieve often contradictory welfare, national interest, and market goals. On the one hand, they are supposed to protect the interests of consumers from whom they derive the legitimacy of their existence. On the other hand, they must respond to the interests of the government to which they directly owe functioning and often financing. Furthermore, they must develop a good working relationship with the industry which they are supposed to regulate and from which they derive the information required to adequately perform regulatory tasks. Finally, they must be receptive to the needs and interests of large business users upon whom much of the economic health of the country depends, but whose requirements often clash either with industry, government, or residential consumers.

The management of this complex web of often contradictory interests was a more workable task in the past when the regulator's main function was to shield state-owned monopolies from the entry of other operators. The rise of closed markets and protectionist, passive regulation was cemented by the notion that universal service was achievable only under monopoly conditions.

But, are monopoly markets the most appropriate means of achieving important social telecom goals, such as universal service? There is a growing amount of evidence that calls into question this well grounded assumption and suggests that open competitive markets might provide a better environment to achieve the main socio-economic mandate that the regulator carries. The following section looks at recent evidence of the impact of market liberalisation in developing nations on some of the main regulatory goals: the fulfilment of USO, reduction of prices, improvement in the quality of services, and the protection of employment and revenue stream of the public telephone operator (PTO).

8.3 USING MARKET STRUCTURE TO ACHIEVE REGULATORY GOALS

Although the world of telecom seems to be inexorably moving towards open markets, the premise that competition provides adequate incentives to achieve rapid development of telecom services and infrastructure is far from being widely accepted among governments around the world. A recent survey carried out by the Organization for Economic Cooperation and Development (OECD) among member countries, for example, found that the objective of meeting universal service obligations was the most common reason cited for justifying the maintenance of monopoly provisions (see OECD 1995b). From these survey results, one can easily deduce that the resistance in most developing countries to telecom liberalisation is quite similar if not stronger.

Evidence in recent years has shown that telecom competition in both developed and developing countries has not only brought down prices of services, but has also achieved higher network penetration rates than closed markets. Competition in basic wireline services has been recently launched in a small number of developing countries; evidence of its effects are sparse. Cellular services, instead, have experienced higher degrees of competition for a more extended period of time. Statistical analysis of the performance of competitive and non-competitive markets in twenty-six developing economies shows that open markets have experienced a much higher level of service penetration than closed ones (for more details, see Petrazzini and Clark 1996).

Increased participation of private capital, in various forms of privatisation, seems also to provide better conditions for a rapid increase of network penetration. A comparison of privatised and non-privatised systems among least developed nations in the Pacific basin and Africa shows that those under private ownership have achieved a much faster tele-density growth than their state-owned counterparts. In Latin America, privatised companies have also performed better than state-owned ones, installing two times more main lines than their publicly owned counterparts (ITU 1995a, and Petrazzini and Clark 1996). In these cases, however, it is not clear whether the drive for increased network

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penetration is due to privatisation or due to the threat of competition that most of these privatised companies face in the near future. The nature of ownership (i.e., private or public) does not seem to indicate a clear relation with improved performance in the same manner as does competition.

The fact that telecom competition boosts network penetration rather than hindering universal service comes as a surprise to many industry observers who for years had argued that the opposite was true. What does not surprise anybody is the fact that competition drives prices down; in some cases, dramatically. In Chile, for example, after competition was introduced in domestic long distance and international services, tariffs dropped as much 70 percent. The impact of competitive markets on prices is even more evident when one compares a competitive market like Chile with a monopoly one like neighbouring Argentina. The price per minute for a call to the US is seven times lower in Chile than in Argentina.

If price cuts are clearly associated with competition, the impact of open markets on the quality of services is less obvious. Initial evidence in developing nations does not provide a solid basis to argue that liberalisation brings improvement or deterioration in the quality of services. Outcomes have been mixed, with service quality improving and deteriorating evenly in both competitive and monopoly markets. The same is true for markets that have privatised compared with those that remain under state ownership.

Regulators in many developing countries have been reluctant to introduce competition in basic services, assuming that an open market would lead to high unemployment in the sector and the likely bankruptcy of PTOs. The available evidence in this regard shows that jobs are not lost as expected, and, in fact, the opposite seems to be true. Competition reduces the number of employees in the incumbent carrier, but expands the size of the market, and, with it, the number of jobs available in the sector. In Asia and Latin America, while competitive markets have seen the number of employees in the sector go up, monopoly markets (be they private or public) have experienced, on average, a reduction of their work-force. Competitive markets show also that former monopoly carriers face limited revenue loses in the early stages of liberalisation, and benefit from increasing profits after the second or third year of post-liberalisation operation. Furthermore, all retained a significant share of the market despite the rise of competition (Petrazzini and Clark 1996). If developing country regulators decide to use competition as an integral tool to achieve socio-economic regulatory goals, they would need to face a number of rather complex and challenging matters that are uniquely engendered by the opening of telecom markets.

8.4 REGULATORY CHALLENGES INCOMPETITIVE MARKETS

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Telecom services is a rather peculiar industry. It is a commercial service, but one which is somewhat different from other services in the sense that service supply is governed not only by commercial, but also by social welfare, concerns. It is also a networked service, and therefore network externalities and economies of scale come into play. Finally, service provision has been under monopoly control everywhere for almost a century, providing substantial market power to the incumbent operator.

Due to these and other related factors, the entry of competitors raises issues that are generally not encountered in other sectors of the economy. Interconnection and number portability, for example, are unique to the telecom sector. Providing adequate regulatory solutions to these matters present regulators with unprecedented and challenging tasks.

Although regulating a competitive telecom market encompasses a wide variety of issues and tasks, regulatory activities in the early stages of competition would be heavily involved in preventing the incumbent from using its market position to crowd competitors out of the market. Probably one of the most significant challenges in this regard is the achievement of adequate interconnection terms and conditions for new entrants. In early stages of competition new entrants lack backbone networks of their own and face serious network bottlenecks to access customer premises with their own lines. For these, and a variety of other related reasons, second operators have to interconnect to the public switched telephone network (PSTN) if they are to provide services and survive in the market. The incumbent operator, would naturally try to block and make entry of competitors difficult, if not impossible. Interconnection, and the conditions under which it is granted—in terms of prices, points of interconnection, routing of competitors calls, network information, and so on – therefore, becomes essential to the growth of competition. Pricing of interconnection, in particular, is a crucial factor. For that reason, regulators in some markets have asked incumbent operators to implement accounting separation. The requirement is important because it provides information on the cost from which interconnection charges are derived, showing if charges have resulted in discriminatory pricing or not.

Sound interconnection conditions and pricing are a prerequisite for competition to flourish, although not sufficient in and of themselves. Structural and accounting separations are also crucial to the rise of a healthy competitive marketplace. Incumbents generally provide services in most segments of the market, i.e., basic local, national and international

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long distance, cellular, value-added, etc. For some of these services, incumbent operators still enjoy monopoly prices (or weak competition and high profits), allowing the company to cross-subsidise and set predatory prices in the more competitive services. This anti-competitive threat has led to regulation which is oriented towards achieving structural separations among the various operations of the company. Carriers (mostly incumbent ones) are required to set separate branches with separate accounting and revenue collection systems for each of their market operations. Although this approach is not without its weaknesses – demanding that regulators periodically monitor the possible cross-subsidies – the strategy provides a first step in easing the problem.

Number portability is another innovation that liberalised markets require if competition is to survive. There are two types of number portability: geographical and operator portability. The former has been implemented by carriers for sometime already: when changing locations, customers retain their telephone numbers – generally by paying a fee. This type of portability does not have any manifest impact on the competitiveness of the market. It is operator number portability that is crucial for the introduction and sustainability of competition in the long run. Given the possibility of signing with one of the new carriers, consumers should be able to change operators without having to give up their telephone numbers. Studies have shown that between 60 and 70 percent of consumers would not change operators if they had to give up their telephone numbers (Ovum Ltd. 1994). The reason is quite simple, in that there are high economic and social costs associated with the change of telephone numbers.14 Therefore, enforcing operator number portability is an essential issue in the pursuit of a level playing field in competitive markets.

Finally, there are issues that, although not directly related to the everyday practice of competition, affect the competitiveness of new entrants. One is the cost of new licenses. Cash-starved governments in developing countries have found the granting of new licenses and the auctioning of radio-spectrum to be tempting sources of much needed funds. The problem with high license fees or radio-spectrum auctions is that the high cost of market entry is subsequently transferred to consumers in the form of high tariffs.

It also puts new carriers at a cost disadvantage vis-à-vis the former monopoly operator – who has had several decades to amortise the cost of its investment – making it difficult for new entrants to compete with lower prices. In other words, high license fees provide the government with a significant amount of cash, but the cost of licenses are later bared by the productive system of the country in the form of high tariffs and connection fees. Ultimately, the cost of production goes up and the competitiveness of the country goes down, leaving the government with restricted economic activity and slim general tax revenues.

8.5 INSTITUTIONAL REQUIREMENTS

To effectively tackle the challenges of liberalisation, governments in developing countries need to address a number of prerequisites such as the institutional design of the agency, the degree of transparency and independence required by the body, and the financial and human resources needed for its operation.

Institutional Design and Transparency

The institutional design of the agency embodies issues such as the composition of the directorship, jurisdiction of the agency, mechanisms for appeal (if any), and other related matters. Choosing the way in which the agency will be headed raises questions as to whether the body should be headed by a director general or by a collegiate body.

Jurisdiction refers to choices of whether the agency should be under the control of the head of state, a ministry, congress, or none of these; and whether the reach of the agency should cover only telecom related matters, or should also include broadcasting and related (electronic) content industries. The institutional design also should address whether the decisions of the agency are subject to appeal, and if so, to whom and in what terms. Since these and other related institutional aspects of the agency are closely bound to the political, cultural, and economic conditions of each country, choices to be made will vary considerably from one country to the next and should be examined on a case by-case basis. For this reason this aspect will not be further considered in this chapter.

There are, however, some issues such as the degree of transparency and autonomy of the agency and the resources available for its operation that, although institutional in nature, have been shown to have fairly homogeneous implications for the development of the industry regardless of political and cultural boundaries.

Investor and consumer confidence in domestic regulatory agencies is not only based on clear and detailed regulation, but also on the transparency of the regulatory process. This is true in every country around the world, but is particularly true in the case of developing nations where transparency of official decision-making has always been a principle more often praised than practised.

In the era of regulated state-owned monopolies, a transparent regulatory process was of no major public or commercial concern. Today, with rising competition in every segment of the market, the issue of transparency in the regulatory process has become crucial. A transparent regulatory

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process is both an issue of public accountability and a pragmatic business strategy to boost local telecom market investments.

In the late 1980s and early 1990s, during the drive for telecom privatisation in emerging markets, global capital seemed abundant and the business profits offered by the telecom sector in developing nations was an irresistible opportunity. In the mid-1990s, available capital seems to be increasingly scarce.18 Yet, the demand for telecom infrastructure and for the required capital has increased rather than diminished. As the competition for capital grows, and the attractiveness of emerging economies cools, investors have become more careful in their evaluation of potential investment opportunities. In an increasingly restricted global capital market, the transparency of the regulatory process in developing nations is becoming one of the key factors to gain longterm investment commitments from private capital without having to give away high rates of return to guarantee high profits in the short-term.

A non-transparent regulatory process has negative effects on the promotion of competition, as well. The success or failure of new competitors in telecom markets is closely tied to conditions and terms of interconnection. Interconnection agreements generally require the intervention of the regulatory agency. Regulatory solutions often do not satisfy either the incumbent or the new carrier. Therefore, if the decision-making process is carried out in an unclear and non-transparent way, suspicion of favouritism and biased preferences can easily discourage potential investors from entering the market and existing ones from making any new long-term investments.

Struggle for Autonomy

A closed and obscure regulatory process is also a fruitful ground for the influence and lobbying of powerful interest groups. In an open, competitive, and increasingly global marketplace, much of the trust of both the public and industry in the regulator relies heavily on the autonomy and independence the agency gains from the various interest groups and constituents that have considerable leverage to influence and distort the decision-making process.

Efforts to "de-politicise" operations, decision-making, and resource allocations in the telecom sector of developing countries have taken two main paths. On the one hand, governments have privatised state-owned carriers and opened the market to third party entry. On the other, they have started to restructure the regulatory process by creating relatively autonomous agencies operating at arms' length from government. However, while much has been achieved in the former case, much less has been attained in the latter.

One problem is that the appointment, surveillance, reporting structure, and budgetary allocation of regulators is still closely tied to the various branches of the central administration. In several countries, the head of the executive branch (president or prime minister for example), still plays an important role in the life of regulatory bodies – through the appointment of regulators or intervention in politically sensitive regulatory decisions. Presidential or prime ministerial mandates grant the regulator legitimacy from the highest stratum in government, shielding the regulator from the often intense, and many times contradictory, pressures of Congress and other political forces in society. But the *marginalisation of Congress and other representatives of political forces* in society also diminishes the legitimacy of the body's decision-making. In other words, the decisions of the agency under one administration might be interpreted as unilateral and nonconsensual, and risk being scrapped by a subsequent administration.

In an effort to create more democratic regulation, some governments have opened the process to input from various sectors of society. Confronted with considerable pressure from various interest groups, and hampered by their weak position in the political arena, regulators have often delayed the resolution of sensitive issues to avoid conflict. Delays in regulatory decision-making *in a rapidly changing industry can only* create insecurity, delaying or stalling investment decisions, new ventures, and the rise of competition – all of which have a direct negative impact in the expansion of services and infrastructure. For this reason, it is extremely important for any regulatory agency that intends to become *open to input from various sectors of society to have strong statutory* powers and a high level of autonomy.

Yet, the irony of greater autonomy is that an agency with increased powers becomes a more attractive target for "capture" than a passive, non-autonomous one. An active role and concentration of power in the regulator sends a clear signal to industry about the source of decision-making and whom they should target for lobbying if decisions are to be influenced in any way. Furthermore, a proactive regulator, receptive to regulatory innovations and change, increases even further its capture value for those who intend to transform the rules of the game in their favour.

Although increased autonomy and higher statutory powers might augment the visibility of the regulator as well as its allure as a target for capture, that same visibility shields it from players in the market in ways that are not possible under closed and obscure regulatory processes. Regulation carried forward in an open fashion – through hearings, public notices, and consultative documents – increases the public visibility of the regulator, and reduces the likelihood of capture. This does not

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mean that regulatory decisions are not often prone to the influence of powerful interests, but it highlights that under open, participatory conditions, capture is less likely.

Finally, one should keep in mind that transparency and autonomy are "fuzzy" notions that can have two manifestations: a formal one based on the law that imposed it, and a substantive one affected by concrete daily regulatory practices. Often these do not easily converge. While much transparency and autonomy may have been required and granted through legislation, the actual implementation will depend on a variety of institutional, cultural, political, and economic conditions in each society.

The institutional design of the agency, for example, can affect the actual degree of transparency and autonomy enjoyed by the regulator. It would be easier for a single director general to operate in a non-transparent fashion, than for a collegiate body to reach a broad consensus to do so. In the same way, it is easier to capture an agency headed by one individual than it is to capture one headed by a large collegiate body.

The formal autonomy of the regulator granted by the law can also be easily undermined if the institution does not have financial autonomy. The sources and management of the agency's finances are key elements in the regulator's independent decision-making.

In summary, implementation of transparency and autonomy is not only a matter formal legal ruling, but also of finding the right institutional, financial, and political conditions for the agency to achieve in practice what is prescribed in the law.

Monetary Resources

Regulators operating under traditional regulatory schemes tend to be constrained by the fact that the scope and allocations of budgetary resources are controlled by the executive or some of its branches. It is generally the minister of economy or the secretary of finance who determines the amounts allocated to the various items in the budget, and regulators cannot necessarily manage nor reallocate resources according to the changing needs of the agency and demands of the industry.

To overcome some of the problems generated by these budgetary straight-jackets, some regulators have won government approval to create a telecom trading fund. The fund allows regulatory agencies to operate on a quasi-commercial basis, while remaining part of the government. This new financial and accounting framework allows regulators to independently collect and manage revenues from licensing fees or other sources without the constraint and bureaucracy traditionally imposed by centralised budget control. These schemes provide enough flexibility for an efficient use of resources to respond to the new demands of an ever-changing telecom market.

In most developing countries, however, the problem of financial resources goes beyond the issue of who controls the budget into the very basic question of how to raise sufficient funds to run the agency, where financial constraints not only undermine the autonomy of the agency, but can also hinder its ability to perform the most basic functions. Without adequate financing, the regulator can turn into a policeman without a stick.

One of the main problems is that the regulator's budget is generally part of the larger national budget and telecom requirements generally give way to more politically sensitive matters such as social welfare programs and the like. Therefore, an independent source of financing becomes crucial for the operation of the regulatory agency. Some governments have begun to rely on licensing fees to finance regulatory operations. Others have ruled that financing should derive directly from the revenues of the carriers operating in the local market. These approaches are attractive for developing nations because they remove the budgetary burden from the state and provide regulators with a reliable and stable source of financing. Theoretically, these strategies should solve the financial problem of regulatory agencies in the developing world. In practice, however, the approach is not without its problems. Although the funds are legally allocated to the regulator, often more powerful agencies within the government – such as the ministries of economy or finance – gain control over the resources and redistribute a lesser amount to the regulator for its operation. Another potential problem is related to the fact that dependency on revenues generated by service providers can lead to collusion between regulator and those who are regulated, to the detriment of consumer interests. This trend is more likely in the largely closed and still highly politicised markets of most developing nations than in open competitive environments.

Financial dependency on service providers or government makes regulators vulnerable to subtle yet consistent pressures in favour of those groups. For these and other related reasons, the creation of an independent fund supported by a tax on telecom services can provide a buffer to the pressures that agencies face in their daily operations.

Human Factor

Deficient finances lead not only to weak and vulnerable regulatory agencies, but can also create an insurmountable obstacle to attract what an agency needs the most in an era of market competition: highly qualified human resources. Staff salaries generally constitute as much as 90 percent of regulatory agencies' expenditures, and therefore becomes the single most important element affected by a deficient financing scheme. Although most developing nations suffer from human resource deficits, it is important to point out that it is not always a problem of quantity of personnel as much as it is one of quality and diversity of skills. Governments in the developing world have used state enterprises and agencies to buffer unemployment problems. Hence, regulatory agencies – like most other state controlled bodies – may have an abundance of labour but in the majority of cases the staff will not have adequate training or the expertise required to handle the growing complexity and diversification of the telecom market. Most agencies are still dominated by personnel with a professional profile more attuned to an era of single basic service monopoly (i.e., engineers) than to the current competitive and diversified service market (which requires accountants, policy and financial analysts, economists, lawyers, and so forth).

The process of building regulatory capabilities in developing countries is proving to be one of the most difficult and elusive tasks of the reform process. Acquiring the necessary funds, hiring a diversified and highly professional staff, buffering political influences and pressures from interest groups, and opening the regulatory process to public participation can be a slow and painstaking process. Meanwhile, developing nations need to offer reliable and sound regulatory frameworks upon which the industry can make mid- and long-term decisions. To ease some of these short-term burdens, legal instruments can become a transitory substitute for actual daily regulation of the sector.

Using Legal Instruments to Ease Resource Deficiency

Analysts have suggested that developing countries can diminish the problems created by weak financial and human resources by incorporating legal instruments into their regulatory goals and targets. Policymakers and regulators can build into contracts, licenses, specific regulations, and general laws, those social ends that the government is interested in achieving.

This approach to reducing the cost of regulation has, however, significant spillover effects. On the positive side, it provides a solid and stable regulatory framework which increases the likelihood of long-term investment in the sector. Due to the often unstable economic and political environment reigning in most developing countries, investors tend to require clear and detailed licensing or contract conditions that are also embodied in long-term legal instruments that cannot be easily turned around if political conditions change (see, for example, Sinha 1995, Hill and Abdala 1993). The lack of a stable regulatory framework has been one of the main factors scaring away investors away from emerging markets, or leading them to consider only short-term investment with a high rate of return. Therefore, consolidating regulatory targets in domestic legislation will not only ease the resources burden, but it will also provide a boost to increased long-term investment.

On the negative side, regulation built into legislation might become an obstacle to adapting the rules of the game for rapidly changing conditions in the industry. Frequent technological innovation and rapid changes in market profile have raised the need for a regulatory framework that is flexible enough to provide regulators with the necessary leeway to adjust the rules to the changing market environment. Furthermore, several developing nations are involved in broad economic and state reforms as well as telecom reforms and require considerable regulatory flexibility to test various forms of market arrangements and the role of the state in this emerging developmental model. The growing presence of private investments in the sector and the increasing influence of multilateral agreements such as those developed in the context of the World Trade Organization (WTO) will put a limit on the legal and operational flexibility of regulators in the developing world. The WTO, for example, has specific mechanisms that bind countries to the regulatory offers they make. Countries that do not comply are subject to the WTO's Dispute Settlement Understanding (DSU) process (see ITU 1996, and Petrazzini 1996).

In summary, a fixed and detailed legal instrument might operate to the detriment of an up-to-date regulation and to market choice experiments, but it grants investors safe ground for their ventures and regulators a partial solution to the problem of limited resources.

SUMMARY

- In developing nations, however, regulatory agencies are still heavily involved in the pursuit of more general socio-economic goals, such as expansion of basic services, the building of a national telecom infrastructure, and the control of the industry "in the national interest.
- The fact that telecom competition boosts network penetration rather than hindering universal service comes as a surprise to many industry observers who for years had argued that the opposite was true.
- For these, and a variety of other related reasons, second operators have to interconnect to the public switched telephone network (PSTN) if they are to provide services and survive in the market.
- Efforts to "de-politicise" operations, decision-making, and resource allocations in the telecom sector of developing countries have taken two main paths.

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REVIEW QUESTIONS

1. Discuss the use of market structure to achieve regulatory goals.
2. What are different regulatory challenges in competitive markets?
3. Discuss about the using market structure to achieve regulatory goals.
4. Explain the regulatory challenges in competition markets.
5. Describe the institutional requirements.
6. Define the institutional design and transparency.
7. Know about the struggle for autonomy.
8. Distinguish between monetary resources and human factor.

CHAPTER 9 TELECOM POLICY REFORM IN INDIA

★ STRUCTURE ★

9.0 Learning Objectives
9.1 Introduction
9.2 Existing Structure of Telecom Sector
9.3 The Two Policy Documents of 1994 and 1999
9.4 Key Issues of Policy
9.5 Regulatory Issues
9.6 Assessment of Regulatory Reform
9.7 Recommendatory Role
9.8 Licensing Powers Remain with Government
9.9 Some Concluding Observations
- *Summary*
- *Review Questions*

9.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- explain the existing structure of telecom sector.
- know about the key issues of policy.
- define the district head quarters.
- discuss about the two policy documents of 1994 and 1999.
- distinguish the VSNL and MTNL.
- describe the assessment of regulatory reform.
- differentiate between the tariff issues and convergence issues.

9.1 INTRODUCTION

The Indian economy is currently undergoing a structural shift. The production of merchandise such as agriculture and manufactured products are contributing a smaller share of economic output, while contribution of the service sector is growing. The service sector in India today accounts for more than 48% of economic activity and is likely to grow at the rate of 8% per annum. A majority of service workers are engaged in the creation, processing and distribution of information. The telecom sector therefore assumes major importance as an enabling infrastructure. Accordingly, it is vital for the country that there be a comprehensive and forward looking telecommunications policy which creates a suitable framework for development of this service industry. The availability of infrastructure for electronically transferring and accessing information is perceived as critical for hastening the realization of economic, social and cultural benefits as well as for conferring competitive advantage.

The telecom sector in India has witnessed rapid changes in the last five years. There have been far reaching developments in Information Technology (IT), consumer electronics and media industries across the globe. Convergence of both markets and technologies is a reality that is forcing realignment of the industry. At one level, telephone and broadcasting industries are entering each other's markets, while at another level, technology is blurring the difference between different conduit systems such as wireline and wireless. As in the case of most countries, separate licenses have been issued in India for Basic, Cellular, Internet Service Providers, satellite and cable TV operators, each with a distinct industry structure, terms of entry, and varying requirement to create infrastructure. However, this convergence that now allows operators to use their facilities to deliver some services reserved for other operators, necessitated a re-look into the existing policy framework.

The Government of India (Government) has recognized that provision of world class telecommunications infrastructure and information is the key to rapid economic and social development of the country. This will not only help in the development of the IT industry, but also provide for widespread spillover benefits to other sectors of the economy.

The first step in this direction was announcement of the National Telecom Policy in 1994 (NTP 94). This provided for opening up the telecom sector to competition in Basic Services as well as Value Added Services like Cellular Mobile Services, Radio Paging, VSAT Services etc. It also set target for provision of telephone on demand and opening up of long distance telephony. This was followed by a New Telecom Policy declaration in March 1999 (NTP 99), to remove some of the bottlenecks and move the liberalization process forward.

9.2 EXISTING STRUCTURE OF TELECOM SECTOR

Telecommunications was not perceived as one of the key infrastructures for rapid economic development during the formative years of the Indian

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economy. The low levels of investment in this sector have affected the quality, quantity and range of services provided. In 1998, Indian Telephone density per 100 persons was 2.2 while the world average was 14.26 (World Telecommunication Development Report, ITU, 1999).

For the provision of basic services, the entire country is divided into 21 telecom circles, excluding Delhi and Mumbai. Department of Telecom Service (DTS) provides basic services in the 21 telecom circles, while Mahanagar Telephone Nigam Limited (MTNL) serves Delhi and Mumbai. Six private licenses have been issued for 4 the provision of basic services, out of which only three have commenced services at present. Private participation in the cellular mobile market, on the other hand, has been comparatively more successful. Eight cellular licenses, two in each of the metros were awarded in October 1994. Subsequently bidding resulted in the award of licenses in 18 Circles. For two circles, Jammu and Kashmir, and Andaman and Nicobar Islands, no bids were received, while for West Bengal and Assam, only one bid each was made.

In the last year, cellular services have grown at an annual rate of 35.49 %. The subscriber base crossed 1 million by the last quarter of 1998 and at present (Dec '99) exceeds 1.5 million (see Table IV). As a percentage of basic subscribers, cellular subscribers aggregate approximately 5%. This percentage is anticipated to increase substantially following significant changes in the cellular industry that are likely to occur shortly viz. entry of a third operator in certain service areas, introduction of the calling party pays (CPP) regime for cellular mobile and move to a license fee regime based on revenues generated from a fixed license fee regime.

As many as 137 licenses (of which 93 licenses were actually operational by December 98) have been issued for providing radio paging services for which bids were invited in two stages, first for 27 large cities (which had a population of over one million) and in the second round for 19 Telecom Circles. The number of licensees selected for each area range from two to four.

Among other 'Value Added Services', licenses have been issued to 14 operators for providing V-SAT based data services to closed user groups. Nine of these licenses are operational so far. 'On line services' (electronic mail, fax on demand, web page hosting, electronic data interchange) have been operational in the country for past four years. While there is free entry into this segment, growth has been slow, chiefly on account of exclusive dependence on DoT / MTNL for lines and access.

Growth of Internet services has also been retarded in India (current number of subscribers - 250,000) owing to the restrictive policy of retaining the monopoly of public sector entities, viz., VSNL and MTNL.

This policy was relaxed only as late as 1998 and there has been a surge of interest since, boosted especially by significant reduction in leased circuit charges through TRAI's Telecommunications Tariff Order (TTO) of March 1999 . Till date 110 licenses have been issued to private Internet Service Providers (ISP) – 18 for category 'A' (All India), 37 for category 'B' (Territorial Circle & four Metro Telephone Districts of Delhi, Mumbai, Calcutta and Chennai) and 55 for Category 'C' (City). The liberal ISP policy is expected to promote fast proliferation of Internet within the country and give boost to applications like Electronic Commerce, Web Hosting, Virtual Private Network, etc. On current estimations of demand, Internet subscriber numbers are expected to grow to about 2 million in the next two years. One provisional license has been issued for providing Global Mobile Personal Communications by Satellite (GMPCS). Issue of licenses to other prospective GMPCS operators is reportedly under consideration.

9.3 THE TWO POLICY DOCUMENTS OF 1994 AND 1999

NTP 94 spelt out five basic objectives of which two objectives of availability of telephone on demand and universal service (connecting all villages) were targeted to be realized by 1997. Both of these objectives have remained unrealized. In regard to quality of service, matching "world standard" and providing "widest possible range of services" "at reasonable prices" were stated aims. Two other objectives were to make the country a major manufacturing base and exporter of telecom equipment and to ensure the country's defense and security needs. (The powers of licensing and spectrum management were retained by the Government on the ground that both need to be strictly monitored in order to protect the strategic interests and security of the country).

There were serious gaps in the policy document as regards provision of a suitable environment for entry of private service provider and on the issue of regulation. The 1994 policy was designed with the approach that services should continue to be provided largely by a strong incumbent that faced little competition. The same view seems to be reflected in the 'guidelines' for selection of private basic service operators.

Efforts to involve the private sector under that regime encountered certain obstacles. In addition, while major targets were specified in NTP 94, an accurate assessment of the underlying resource requirements was not done. For example, to realize the enunciated objectives, an estimated ₹ 230 billion of additional resources were required. A need for private sector contribution to the effort was clearly recognized, but various implementation problems including incomplete reforms, mitigated the efforts to achieve the targets. Meanwhile, convergence arising due to changes in technology and the overall market structure for service provision had changed and there was a need to provide fresh directions through another policy. The opening up of the Internet sector set the background to NTP 99, which is a major attempt to plug the loopholes in the 1994 policy. Its enunciation of policy objectives is itself a marked improvement. Provision of 'Universal Service' (including unconnected and rural areas, re-targeted for year 2002) is sought to be balanced by provision of sophisticated telecom services capable of meeting needs of the country's economy. The latter objective is further amplified to include 'Internet' access to all district head quarters (DHQs) by 2000 and providing high speed data and multimedia capabilities to all towns of population of 200,000 and above by 2002. Apart from a target average penetration of 7 per hundred by year 2005 (and 15 per cent by 2010), targets for rural 'tele-density' have been set to increase from the current level of 0.4 per cent to 4 per cent during the same period.

To meet these teledensity targets, an estimated capital expenditure of ₹ 4,000 billion for installing about 130 million lines will be required. Recognizing the role of private investment, NTP 99 envisages multiple operators in the market for various services. Another major change has been a shift from the existing license fee system to one based on one time entry fee combined with revenue share payments. Whereas NTP 94 only acknowledged the need to induct private participation in a big way into value added as well as basic services, and to "ensure fair competition", NTP 99 goes further in targeting a greater competitive environment and level playing field. Other restrictions include, for instance, a limitation on sub-licensing, on transferability of shares for a specified period (i.e. five years), and the licensee being treated as a defaulter when there is a non-compliance of any license condition. It must be borne in mind that over time, the Government has made attempts to remove restrictions that adversely affect performance of the licensee. For instance, there was earlier a condition that the last mile linkage should be only with copper wire, but this condition has been relaxed.

NTP 99 allows DOT/MTNL to enter as third cellular mobile operators in any service area if they wish to provide these services. To ensure a level playing field, DoT and MTNL will have to pay license fee but DoT's license fee will be refunded because it has to meet the Universal Service Obligations. It is worth noting that to the extent that the fee will be specifically refunded to bear the cost of Universal Service Obligation (USO), this aspect should be accounted for when calculating the USO levy and apportioning the revenues from that levy. Some of the other notable advances marked by the NTP 99 are as follows:

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- Speeding up competition in long distance, including usage of existing backbone network of public and private entities in Rail transport, Power and Energy sectors for data (immediately) and for domestic long distance voice communication when latter is opened to competition from January 2000. This opens up the scope for entry of a new category of ' infrastructure providers' or 'carrier's carrier'.
- The Fixed Service Providers (FSP) shall be freely permitted to establish 'last mile' linkages to provide fixed services and carry long distance traffic within their service area without seeking an additional licence. Direct interconnectivity between FSP's and any other type of service provider (including another FSP) in their area of operation and sharing of infrastructure with any other type of service provider shall be permitted.
- Policy to convert PCO's, wherever justified, into Public Teleinfo centres having multimedia capability like ISDN services, remote database access, government and community information systems etc.
- Transforming in a time bound manner, the telecommunications sector to a greater competitive environment in both urban and rural areas providing equal opportunities and level playing field for all players;
- Strengthening research and development efforts in the country and provide an impetus to build world-class manufacturing capabilities.
- Achieving efficiency and transparency in spectrum management.
- Commitment to restructure DoT.
- Interconnect between private service providers in same Circle and between service provider and VSNL along with introduction of competition in Domestic Long Distance.
- Undertaking to review interconnectivity between private service providers of different service areas, in consultation with TRAI.
- Permission for 'resale' of domestic telephony.
- Clarity regarding number of licenses that each operator may be granted. (This could lead to consolidation of industry operators over the long term).
- Emphasis on certain other issues including Standardisation, Human Resource Development and Training, Disaster Management and Change in Legislation

According to the new policy, the number of players in each circle for Basic Services and their mode of selection shall be decided on the basis

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of recommendations from TRAI. As opposed to the fixed license fee regime based on which licenses were awarded earlier, fresh licenses shall be issued on the basis of one time entry fee and a percentage of revenue share to be determined by DoT on the basis of recommendations made by TRAI. Cable operators will be permitted to provide lastmile linkages and switched services within their service areas of operation. Subject to obtaining a basic service license, they shall also be permitted to provide two-way communication including voice, data and information services.

NTP '99 proposes that the long-term policy will be to have uniform 20-year licenses for both Basic and Cellular Mobile services. Extensions of license periods initially by five years and subsequent ten-year extensions are also envisaged. These provisions need to be used in a transparent manner, which again brings up the issue of government divesting itself of the licensing powers in favour of the regulatory authority. Internet Telephony has not been permitted under NTP 99. However, recent announcements by the Government indicate that Internet Telephony will be allowed in India in the near future.

NTP 99 represents a welcome effort to address key issues relating to telecom reforms and to lay down policies that could transform the sector into a competitive and efficient infrastructure within a reasonable time frame. The policy aims at providing a modern and efficient telecom infrastructure, and takes account of the convergence of IT, media, telecom and consumer electronics. The emphasis is on making India an "IT super-power". However, as mentioned above, the regulatory scenario for telecom is changing rapidly and there are a number of issues which would require further analysis and perhaps a change in policy framework in the next few years.

9.4 KEY ISSUES OF POLICY

As stated above, the new policy provides the framework within which the telecom sector in the country shall function and focuses on creating an environment, which enables continued attraction of investment in the sector and allows creation of a world class telecommunication infrastructure. This section attempts to analyze and provide details of the issues that are likely to arise in the implementation of the new policy.

For example, we discuss the nature of the interconnection regime that will most likely result in attaining the objectives of the new policy, the achievement of USO, the possibility of changing license conditions to encourage more investment in the sector and regulatory principles

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that are important to achieve the ambitious objectives of NTP 99. The significant issues are detailed below:

Interconnection

In a multi-operator environment, interconnection is a crucial regulatory issue for telecommunications policy. No new entrant into the market will be able to compete effectively unless it is able to interconnect its network with the facilities of the incumbent operator either directly or indirectly via the network of another competitive entrant. In the course of transition to competition, a pivotal issue is how best to meet the requirements of interconnection of each of the service providers. For most telephone users, the services offered by the new entrant will be almost useless unless the entrant could enable its subscribers to communicate with the large number of subscribers of the incumbent operator. Consequently, competition in the market can flourish only if entrants are able to interconnect their facilities with those of the incumbent and to do so at terms that allows the entrant to provide the service at competitive levels of price and quality. A 'fair and reasonable' interconnection policy is a critical input to foster competition in telecommunication markets.

Prior to NTP 99, direct interconnection among service providers was not a policy; instead, two networks had to be connected via the incumbent operator i.e. DoT (now DTS). This was combined with certain charges for interconnection that are in several instances above cost based interconnection charges. For interconnection, the principles that have been emphasised by TRAI include:

- interconnection principles regarding pricing, timeliness, point of interconnection, and quality of interconnection should be based on a "no less favourable standard" in comparison to another operator (including the conditions implicitly or explicitly provided to one's own operations);
- interconnection charges should be cost based;
- these costs should be those "caused" by constructing the link with, and through the use of, the network of the interconnecting service provider these are "incremental", or "additional" costs arising due to interconnection);
- the interconnecting service provider must be allowed access to unbundled elements of the network that it requires, and not be charged for facilities that it does not require;
- for any particular interconnection service, the same interconnection charge should apply to any service provider irrespective of the service provided;

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- all interconnection service providers should be allowed to charge an interconnection price.

NTP 99 states that direct interconnection between service providers in the same service area shall be permitted. This implies, for instance a cellular service provider can directly link it's network to that of the other service provider in the same service area without having to interconnect via DoT. Not only is this likely to reduce price to the end-user, but perhaps also result in more efficient utilization of the networks. Although direct interconnection between private networks has been slow to take off following removal of the policy restrictions on it, increased traffic and penetration is likely to provide private operators the necessary impetus to take advantage of direct interconnection.

The necessity of providing a 'level playing field' for public and private operators is another key policy issue. In this context, for instance, an incumbent operator that deters entry to a new operator can keep efficiency from being maximised. To achieve the possible economies of scale and scope and network externalities, the role of regulation should be to reduce or eliminate market power (level the playing field) and mimic the outcomes of the competitive process (ITU, 1999). In a press statement made recently, the Government has reiterated it's commitment that in terms of NTP 99, "there is going to be the same licensing regime for all operators i..e. interconnect revenue sharing arrangements for cellular services for payment of access charges between DOT and MTNL for STD and ISD traffic will be the same as applicable to the other private operators". Two basic requirements emerge from this discussion: (a) a restructured DoT that can take on new entrants on competitive instead of monopolistic terms, and (b) autonomous regulation vested with requisite authority. As is well known, the autonomous regulator has been in position for last two years; the need for restructuring DoT is endorsed in NTP 99 and a time frame set for corporatisation of the DoT.

Tariff Issues

Linked to interconnection and competitive efficiency is the issue of tariff and tariff policy. It is now widely recognized that enhancing efficiency and investment in telecom requires the introduction of competition, which in turn needs a regulatory mechanism to facilitate competition. An essential ingredient of transition from a protected market to competition is alignment of prices to costs (i.e. cost oriented or cost based prices), so that prices better reflect their likely levels in a competitive environment. In basic telecom, for example, a major departure from cost based pricing such as under the prevailing price structure in India, involves a high degree of cross-subsidization (see Table VI). This introduces inefficient decision-making by both consumers and service providers. Cost based prices also

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provide a basis for making subsidies more transparent and better targeted on specific social objectives, e.g., for achieving the USO. For consumers, cost based prices reflect economic costs and provide efficiency oriented incentives for consumption, in contrast to the present telecom tariffs in India that are not linked with either costs or incentives that enhance economic efficiency. For service providers, cost based prices better prepare the ground for competition among different operators.

Cost based prices restrict the possibility of cream skimming by operators, facilitate smooth inter-flow of traffic, and reduce the dependency of operators on narrow market segments for maintaining their financial viability. This in turn also promotes a greater concern among operators for a wider set of its subscriber base, and to focus on quality of service, improving technology and service options. If tariffs for services which incorporate high level of cross-subsidies (for e.g. basic service)), are not made cost oriented, then major adjustments would be required in the pricing structure when competition takes place in the telecom market.

Traditionally, DoT tariffs have cross-subsidized the cost of access (as reflected by rentals) by domestic and international long distance usage charges. In order to promote desired efficiencies, 're-balancing' of tariffs is a necessity and therefore an important policy issue. Re-balancing of tariffs involves reducing tariffs that are above costs while increasing those below costs. Thus, re-balancing implies a reduction in the extent of cross-subsidisation in the fixed services sector. Such a rationalization is required as a condition precedent to the conversion of a single operator system to a multi-operator one. Regarding tariff determination, as in other policy considerations, TRAI has the obligation to ensure transparency in exercising its powers (for which a systematic procedure of consultation with all interest groups has been adopted by TRAI). After going through a comprehensive consultation procedure covering service providers, consumers, policy makers and parliamentarians, TRAI issued its Telecommunication Tariff Order (TTO) on March 9, 1999. The Order represents a landmark for infrastructure regulatory agencies in India in terms of attempting to rebalance tariffs to reflect costs more closely, and to usher in an era of competitive service provision. The chief features of the tariff order were substantial reductions in long distance and international call charges, increase in rentals and local charges and steep reductions (an average of about 70 per cent) in the charge for leased circuits.

For basic services, TRAI demonstrated that tariff re-balancing was necessary to prepare the market for competition. A small proportion of the subscribers account for a major share of call revenue, and these subscribers would be the subject of competitive churn when private sector operators enter the market.

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Loss of such customers will have a significant effect on the revenue situation of the incumbent, making it difficult to meet the objectives of USO and network expansion. Thus, while tariffs have to be reduced for the services which are priced much above cost (e.g. long distance and international calls), tariffs for below cost items need to be increased. Such a re-balancing exercise is common when preparing the situation for competition.

The methodology of specifying tariffs included the following feature to impart flexibility. For certain services, TRAI specified particular tariff levels while for several others it showed forbearance. Even for those services for which tariff levels are specified, the framework includes the possibility of providing alternative tariffs. The tariffs specified by TRAI form a package which is termed the "standard tariff package". This package must always be provided to the customer. In addition, the service provider is left free to provide any "alternative tariff package". Since the standard tariff package is always available to the customer, any alternative tariff package has to be better in order to attract any customer. Therefore, the standard tariff package provides a minimum guarantee to the customer. In one sense, it specifies the peak expenditure level for the customer; with the alternative tariff packages being attractive only if the expenditure involved in them is lower than that for the standard tariff package. This method of flexibility was adopted because of the growing tendency in telecom markets to provide different tariff combinations for various baskets of services.

Traditionally, rental charges in India have been linked to the size of the exchange providing the connection. TRAI has specified that rental charge for larger exchanges, in the case of high callers, will increase by over 60 per cent in nominal terms by April 2001. There is an increase in the price of local calls for low calling subscribers and a decline in such call charges for high calling subscribers. Domestic long distance calls will see an initial reduction of up to 23 per cent with further reductions of 28 per cent over the period to 2002. Charges for international calls to areas outside of SAARC and neighbouring countries will decrease by over 50 per cent from present levels over the same period.

In the case of basic telecom tariffs, changes in certain tariffs (e.g. rental, domestic long distance and international call) are to be phased in over a period of three years. The TRAI has also stated that it will conduct a review of the situation to assess the validity of the underlying assumptions on which it based its determinations, and to make any changes, if necessary. For cellular mobile, tariffs were restructured because the prevailing rentals were low and call charges were high. This resulted in a tariff structure that dissuaded usage and loaded the subscriber base. Thus, call charges were reduced and rentals were increased. The methodology clearly included license fee as costs and showed that a high license fee translates into higher tariffs.

Standard monthly rental for mobile cellular has been increased from ₹ 156 to ₹ 600, but the maximum call charges has been reduced from ₹ 16.80 per minute to ₹ 6 per minute. The alternative tariff packages provided by service providers have resulted in even lower tariffs. Leased circuit tariffs were decreased in order to encourage the use of telecom by business and bulk users, and to provide a competitive stimulus to such users through the use of leased circuits. TTO 1999 evoked considerable protest from a number of quarters. The tariff package was an attempt to balance a number of objectives. The Explanatory Memorandum to the Order provided a detailed reasoning on this matter, including with respect to affordability of tariffs. Since there was a major systemic change encompassed in the tariff changes, it was not possible to be definite about any eventuality. Thus, the annual review of the situation will shed more light on the underlying situation.

Convergence Issues

Private Sector participation in the Indian telecom sector will provide a fillip to technology upgradation and help bridge the gap in adoption of new technology. There have been far reaching developments in the recent past in telecom, information technology, consumer electronics and media industries. According to NTP 99 convergence of both markets and technology is a reality that is forcing realignment of the telecom industry. On the one hand, telephone and broadcasting industries are entering each others markets, while technology is blurring the difference between conduit systems such as wireless and wireline. These rapid changes in technology have largely diluted the monopoly characteristic of telecom service provision, thereby opening up avenues for improved efficiency. Competition is now viable in a range of services, including long distance transmission of voice and data. Facilitating effective competition among the various players is therefore a key policy issue. This has also been acknowledged in NTP 99. Convergence of technologies implies a need not only to consider the appropriate method of charging license fee, but also forces the policy maker to review a number of other aspects, including whether to regulate and the nature and extent of regulation.

The attempt of all the policy initiatives is to promote the flexibility of technology choice and service provision. Thus, neutrality of policies towards the technology platform is seen as a desirable attribute, not only because this enhances opportunities but also because the policy maker is not in a position to anticipate the likely developments and fine-tune policy.

The basic driving force of growing competition in what was once thought to be a natural monopoly is the increasing versatility with which services can be provided, based on the digitisation of all signal transfer technology. As the manner in which signals are transferred from one location to another becomes common, it is possible for a service provider in one segment of telecommunication, say network television services, to perform the functions of another, say, the local phone company. Efforts to maintain barriers across such segments will eventually be overwhelmed by technology. Regulation will follow convergence rather than the other way around. Additionally, traditional methods of distinguishing between telecommunications and broadcasting are becoming less clear as a result of technology developments in both industries. The nature of telecommunications and broadcasting transactions, the technology used, and the methods of funding the infrastructure are becoming more and more similar. Some of these diversification activities are on account of technical convergence of the medium (the fibre optic cable) used to distribute services. The high and versatile data carrying capacity of fibre-optic networks means that they will also be ideal network resources to be re-sold to multiple service providers. These could be cable operators, broadcasters, telephone operators, internet service providers, or any other company that needs to send digital signals into the connected units. In several developed systems, broadcasting is increasingly exploiting the traditional telecommunication medium of cables rather than radio waves, and vice versa. Conversely, entertainment and advertising are among the areas turning to the ordinary telephone network. The use of telecommunications infrastructure for entertainment provision will make it possible to deliver a potentially unlimited number of TV channels, and the need to limit the number of channels to preserve radio frequencies will disappear.

Convergence of IT, telecommunications and broadcasting is marked in the developed economies by growing number of alliances, partnerships and mergers in the three industries. The barriers between information products and other industries are disappearing and new competition and new alliances are appearing in developed systems. At the user level, Internet telephony and e-mail are challenging traditional telecom business models. The impact is felt both in offices and at home. While in offices, desktop and portable PCs pack the power of yesterday's mainframe computers, web television, smart phones and low price computing devices denote the future digital networked home.

Technology Issues

Two more issues that should be of high policy concern deserve note here. In order to become globally competitive, India has to keep pace with developments world-wide in telecommunication services and technology. Accessing of the related technologies and promoting needed investments in a competitive environment raise important policy concerns.

1. *Radio Spectrum Allocation:* NTP 99 mentions the need to have a transparent process of allocation of frequency spectrum and for the interim, proposes the setting up of a suitably empowered 'Wireless Planning Co-ordination Committee'. The modalities remain to be worked out. In this context, it is possible and indeed appropriate to raise revenue by auctioning rights to the use of this spectrum, as has been done successfully in the United States and Australia. Given the fact that as the Indian economy develops the valuation of these spectrum rights is likely to undergo substantial change over time, it is advisable to award such usage rights for relatively short periods, e.g. 15 years, without restricting the service that they can be used for. For this, it is necessary to develop an efficient spectrum allocation plan with due regard to ITU's recommendations on standardisation.
2. *Research and Development:* With the huge reserve of highly qualified manpower, the R&D area is one that should be high priority. NTP 99 holds out the objective of India's emergence as an IT superpower and of Indian telecom companies becoming truly global players. It envisages government measures to ensure that industry invests adequately in R&D for service provision as well as manufacturing. Increased integration with global markets will provide the thrust (as evidenced by the software industry); this needs to be supplemented by targeted investment to realize the aims spelt out in NTP 99.

Quality of Service

A major objective and one around which important policies are designed is, world class quality of service. In India, as in many other developing countries the low teledensity has put a lot of emphasis on rapid expansion. With the effort focussed on expansion, quality of service issues have sometimes not received full attention even though QOS has steadily improved over the years. One of the benefits expected from private sector entry is an improvement of QOS to international standards. QOS is therefore, an important issue. Quality of service standards have been built into license conditions QOS has been also identified as one of the major areas of concern in the regulatory agenda. In fact the Regulator is devising QOS norms to be applicable across the board on all operators. Not only is it proposed to declare QOS norms, it is also proposed to monitor the quality of performance. This is also a major consumer welfare strategy.

Consumer Welfare

This is the prime objective of the telecom revolution in India. Telecom as an infrastructure is a necessity not only for businesses but all consumers.

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The policy objective in this regard is to reach the service to more and more new consumers by making access easier and to improve the service available to existing consumer. Provision of greater choice through competition is also expected to benefit the consumer in terms of better services and lower tariffs. Therefore, while liberalization policy is itself geared to improve consumer welfare, a need has also been felt for specific policies to achieve this objective. The Regulatory framework is an important means to ensuring consumer welfare. Customer satisfaction and monitoring of performance of operators is high on the Regulatory Agenda. Interconnection policy is also focussed on achieving a nearly seamless architecture so that consumer's access is unrestricted. Another policy initiative to improve consumer welfare is to adopt tariff structure suitable to social requirements to ensure that tariff is affordable for all users.

Competition Issues

1. *Competition in Long Distance:* At present, DoT is the only provider of domestic long distance (DLD) services in the country. The liberalisation of fixed and llular services has resulted in private operators providing telecom services in a few states in the country. These operators are allowed to offer long distance services within their service area, but inter-circle long distance traffic is the monopoly of DoT. According to NTP'99, DLD beyond the service area will be opened up for private operators from January 1, 2000.4. All access service providers will have to provide interconnection to the domestic long distance Operator (DLDO) so that the subscriber can exercise choice with respect to the DLDO. NTP '99 also allows resale for domestic telephony. At present, most of the long distance infrastructure in the country is with DoT, which has 76,000 Rkm of optic fibre cable (OFC) in comparison to 3,000 Rkm with other agencies including organizations that use captive telecommunication networks, mainly for their internal operational purposes. Railways, State Electricity Boards, Power Grid Corporation of India Ltd. (PGCIL) and Gas Authority of India Ltd. (GAIL) are principal among these. However, these agencies possess Right of Way (RoW) required to deploy OFC along a route which is a critical asset. NTP 99 envisages utilisation of utilities' facilities for voice services in addition to data, which is already permitted. Hence, a telephone service provider should have an option to either build its facilities or lease them from owners of any such facilities. OFC offers advantages over other transmission media for long distance carriage. Technological developments are making it possible to create higher capacities over a single pair of fibres,

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resulting in connectivity acquiring greater significance than system capacities. International experience has been that the non-facilities-based operators provide additional benefits (in terms of product innovations and prices customised to end-users' needs) without entailing any additional costs to the economy. The DLD Policy will need to address an array of issues relevant to the introduction of competition. The key determinants of DLD policy are as follows:

- Type of Competition, that is whether these entities compete on facilities or service or both
- Areas of operation, which means geographical boundaries within which these entities will be allowed to operate.
- Degree of Competition, which is determined by the number of entities to be licensed in the segment
- Time Frame for policy implementation and transition through different stages of competition

Competition can be introduced either through facilities-based or non-facilities-based modality. Non-facilities-based competition would entail competition by entities not operating their own facilities. Competition in facilities can be introduced either by allowing utilisation of infrastructure of entities such as utilities for provision of telecom services or by licensing facilities-based operators. International trends show that resellers are a feature of mature markets representing unrestricted competition in services. Most developing countries do not allow third party resale in the initial phases of liberalisation. If the region of operation of the DLDO is nationwide, it may be possible for the new entrant(s) to compete with DoT, since the latter has presence throughout the country. Moreover, tariffs for long distance are reducing rapidly and also becoming distance insensitive; hence it may be appropriate to foster the emergence of entities that can compete over a larger geographical area.

The degree of competition could be limited or market determined, with or without restrictions to entry. Countries with a public sector incumbent have opted for limited competition during the transition period, while incumbent restructuring was under way. Over the long term, the entry of more players in the long distance segment (on national as well as regional basis) may be examined for potential reduction in costs to user and for rapid growth of services like the 'Internet'. Clearly, India's long distance infrastructure would be supplemented and upgraded with the entry of new player(s) in the long distance market. The final the terms and conditions and other modalities of DLD liberalization will be announced by DoT, following the recommendations of TRAI on the subject.

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2. *International Long Distance:* In accordance with a commitment to WTO, the question of opening up International Long Distance to competition will be reviewed by year 2004. This position is restated in NTP 99. Commitments given to foreign investors to who shares of VSNL have been divested is perhaps one reason why Government is not in a hurry to induct competition in this segment. Opening this service to competition will give a boost to the domestic services, particularly the Internet, and will facilitate the flow of private investment. Vast scope also exists for expansion of India's services sector in the area of long distance computing and office support to leading overseas business undertakings. Pushing down international telecommunication costs through competition will expand these opportunities and bring long terms benefits to the economy. The logic in retaining this island of monopoly when the rest of the sector is being opened up needs to be considered. International tariffs have been reduced approximately 20% in the first phase of rebalancing engineered by TRAI. The phenomena of call back and the likely decrease in accounting rates will create further pressure to re-balance tariffs in the medium term. If the only tariff reduction is a decline in international tariffs, it will imply a decline in revenues, mitigated to some extent by the volume response. Making up for the revenue loss requires certain other tariffs to increase i.e. those tariffs that are below costs or not high enough to attract competition.
3. *Competition in Local Services:* With the emergence of competition in certain circles for the provision of basic services and the continued growth of cellular subscribers, signs of competition are emerging in the provision of local services. The circles where private basic services have been launched (AP, Maharashtra including Mumbai, and MP) account for about 32% of the total DEL's provided by DoT. At the same time cellular services have shown considerable growth in the last one year. According to NTP 99, entry into basic and cellular markets will be open for more players. It is therefore, likely that more (in terms of numbers) and effective competition will exist in the future. In addition, as the manner in which signals are transferred from one location to another becomes common, it is possible for a service provider in one segment of telecommunication, say network television services, to perform the functions of another, say, the local phone company. Efforts to maintain barriers across such segments will eventually be overwhelmed by technology. Moreover, traditional methods of distinguishing between telecommunications and broadcasting are becoming less clear as a result of technology developments

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in both industries. Some of these diversification activities are on account of technical convergence of the medium (the fibre optic cable) used to distribute services. The high and versatile data carrying capacity of fibre-optic networks means that they will also be ideal network resources to be re-sold to multiple service providers. These could be cable operators, broadcasters, telephone operators, internet service providers, or any other company that needs to send digital signals into the connected units. According to NTP 99 'resale' of facilities will be permitted. It is the experience in advanced systems that 'resellers' use a variety of methods and marketing tools to win customers, including lower rates, access code calling, multi-level marketing, telemarketing, agent sales, direct mail, incentive programmes etc. They purchase discounted capacity from established carriers and sell it at competitive retail prices. This will give carriers a route to niche markets, which they otherwise may not be able to penetrate. International trends, however, show that resellers are a feature of developed markets and most developing countries do not allow resale in the initial phase of liberalisation.

9.5 REGULATORY ISSUES

One characteristic of India's telecom reforms - and cause of much of the problems attending it—is that major reform measures like private entry into services were attempted without having a well thought out overall strategy or even a bare road map as a guide. The absence of clarity that marked the reference in NTP 94 to regulatory requirements of the reformed sector is an eloquent illustration. The following mention appeared at the very end of that policy statement: In order to implement the above policy, suitable arrangements will have to be made to (a) protect and promote the interests of the consumers, and (b) ensure fair competition. The logical consequence of a decision to permit India-registered companies to operate both basic and 'value added' services and to promote private (including foreign) investment in the sector, is an end to DoT's monopoly on access, setting up of an independent regulator, and separation of DoT the service provider from DoT the policy maker. However, though private entry was allowed, these other regulatory steps were not taken at that time.

The Telecom Regulatory Authority of India (TRAI) was constituted in March 1997. Responsibilities entrusted to the TRAI include tariff fixation, access charge, revenue sharing between DOT and the private sector, dispute-settlement and consumer protection. (More details in **Annex II**). The establishment of TRAI divests the DoT of several regulatory functions which the latter has exercised on behalf of Government of India. However, the process has been far from smooth, with a call now being made to strengthen the Telecom Regulatory Authority of India Act 1997.

9.6 ASSESSMENT OF REGULATORY REFORM

Regulatory reform in Indian telecom can be seen as a two-step process. One, the establishment of an independent regulator and, two, the regulatory Authority implementing reform on the basis of its policy initiatives. A crucial concomitant of this process is the separation of the incumbent service provider from the policy maker. Since its establishment, the telecom regulator in India has taken a number of initiatives pertaining to tariffs, interconnection charge and revenue sharing, and has provided its recommendations on license conditions/license fee for certain service segments. The regulator has also addressed a number of disputes under Section 14 of the Act.

An important feature of the TRAI Act 1999 is that the Authority has to ensure transparency while exercising its powers and discharging its functions. Hence, the TRAI has adopted a procedure of consultations, under which it prepares consultation papers on the issues under consideration, seeks comments from the general public and experts in the area, and provides an Explanatory Memorandum along with its Tariff Orders, interconnection charge or revenue sharing Regulation, and its recommendations. Such an exercise is being performed for the first time by policy makers in India.

TRAI has also been vested with powers to frame regulations necessary for its functioning; including for the levy of fees and charges for services. The TRAI Act provides for a separate fund ('Telecom Regulatory Authority of India General Fund') which will be credited with all grants, fees and charges received by TRAI and funds from other approved sources. Provision has also been made for Central Government grants towards meeting the expenses of the regulatory Authority.

As mentioned above, there is now a perception among the Government that the powers of the regulator need to be increased. An overall perspective that would be important in this regard is to emphasise a system which makes it possible to quickly implement reform. Certain other features derived from the experience of regulatory reform across countries would be of use.

In several countries that have implemented significant telecom liberalization, the focus now is on convergence of policies as well as on regulation that addresses "unfair competition". Further, the rapid developments in the area of internet are posing particular problems for the regulator. It is now evident that internet service providers will be increasingly able to use their technologies to provide competitive services in comparison to those provided by the main telecom service providers. The changes are also throwing up new regulatory issues, which may even lead to a recasting of the established principles in certain cases. There is now also a tendency for service providers to bundle different services, thus creating difficulties in regulating them as separate entities. In a number of instances, convergence of services and technologies is also resulting in a convergence of regulatory authorities, or greater co-operation among the separate regulatory authorities handling the policy issues.

In this regard, it is also useful to consider the view expressed recently by International Telecommunication Union: "Licensing frameworks around the world are facing pressures for dramatic change, however. The future is uncertain by the voice telephony paradigm that defines the telecommunication industry is being overtaken and will inevitably disappear. It will be replaced with an IT paradigm that accommodates the multimedia characteristics, global seamlessness and virtuality that will characterize a pervasively IT-based global economy operating over converged technologies and services in cyberspace. Regulatory regimes of the future will have to reflect different public interest concerns,. Countries that embrace rather than resist the IT paradigm will shift their focus away from a concern for the assured availability of reasonably priced basic voice services provided over traditional public networks. Instead, they will focus more on promoting multiple outlets for voice telephony and ensuring that a reliable and universal virtual public network is maintained across a crazy quilt of interconnected technologies and applications. Overall, this will likely mean decreased reliance on individual licensing of particular services and facilities and increased reliance on general rules. It will also involve greater coordination among authorities in different industry sectors. Telecommunications regulation will be less concerned with licensing and pricing and more concerned and continuous efforts to adapt standards of reliability and interoperability to unrelenting technology changes, as well as with frequency allocation and assignment, dispute resolution and consumer protection. A lot more of the telecommunication industry will probably end up being regulated by the market." (ITU, 1999, "Trends in Telecommunication Reform 1999", page 129)

9.7 RECOMMENDATORY ROLE

In line with standard practice with regard to such legislation, Government of India has reserved the right to give policy directions to TRAI and also to seek its recommendations on matters connected with technology, service provision etc. Both these provisions have figured in recent past in reported disagreements between TRAI and Government. NTP 99 has recognized the role of TRAI recommendations in a number of areas (see Annex II for more detail). To help implement NTP 99, the Government has sought TRAI's recommendations on several important issues, including:

- Policy regarding introduction of competition in domestic long distance services including recommendations on the scope of service, service area, number of long distance operators, license fee structure, selection criteria for service providers, and interconnection between service providers in different service areas;
- Issue of fresh licenses for radio paging service providers, including entry of more operators in the service area on the basis of review after two years, level of entry fee, percentage of revenue share as license fee, definition of revenue, basis for selection, and migration of existing licensees to revenue sharing arrangement regime;
- Issue of fresh licenses for VSAT service providers, including level of entry fee, percentage of revenue share as license fee, and other facets of license conditions;
- Issue of fresh licenses for the fixed service providers, including the number of private service providers for a circle besides DOT, selection criteria, migration from fixed license fee to revenue sharing arrangement regime for existing licensees, and other facets of license conditions;
- Issue of fresh licenses to cellular mobile service providers in the six vacant circles/slots (one slot each in West Bengal and Assam circles; two slots each in Jammu and Kashmir, and Andaman and Nicobar), including level of entry fee and percentage of revenue share from the licensor, definition of revenue for the purpose of revenue sharing, migration of existing cellular mobile service providers to revenue sharing arrangement, and any other issue considered relevant;
- Issue of fresh license for public mobile radio trunk services, including issue of fresh licenses throughout the country, level of entry fee and percentage of revenue share as license fee, and definition of the revenue for the purpose of revenue sharing;
- Recommendations on terms and conditions of license agreement for GMPCS, including an examination of the provisional license, terms and conditions of the license, and quantum and structure of license fee;

- Terms and Conditions of usage of backbone network of utility service providers, including the class of operators to fund UAL, various cost models or approaches to determine the percentage contribution from the revenue for the operators and the mechanisms for computing it, per unit subsidy for VPTs and rural DELs separately to cover capital and recurring expenditure, and whether per unit subsidy will be the same or different in different geographical area/tribal and non-tribal areas of the country.

9.8 LICENSING POWERS REMAIN WITH GOVERNMENT

Apart from the policy making function, Government has retained the licensing function with itself. There is no set pattern with respect to whether licensing powers should be available with the regulator or with the Government. According to ITU sources, countries where the regulator has the licensing power include:

- In Africa: Botswana, Ghana, Mauritiuis, Namibia, Nigeria, South Africa, Tanzania, Zambia;
- In Americas: Paraguay, United States, Venezuela;
- In Asia Pacific: Pakistan; Australia, Hong Kong, Philippines and Sri Lanka (licensing spectrum).

In India, the main issue with respect to licensing has been not that it should be with the regulator but that under the TRAI Act 1997, the terms and conditions of the license should involve a consideration of recommendations from TRAI.

9.9 SOME CONCLUDING OBSERVATIONS

Telecommunications reforms policies everywhere have recognised the need to have many more participants than the incumbent operator in the process of telecommunications network expansion and service development. It is generally accepted that these new participants will stimulate development of the sector and provide a degree of competition to the incumbent public telephone operator thus positively influencing the efficiency of service provision. Thus the question is no longer to have competition- the traditional arguments for exclusivity no longer hold.

Instead, it is how fast competition should be ushered in. Even after five years since the announcement of NTP 94, which sought private sector participation in the Indian Telecom market, there is little to show by way of competition in the sector. The liberalisation of the Indian telecom

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sector has been riddled with uncertainty and has raised questions regarding India's commitment to the reform process. The bidding process for basic services resulted in only 6 out of 22 licenses being awarded out of which only 3 licensees have commenced operations. Over the last three years there have been numerous disputes between the incumbent DoT and TRAI over the jurisdiction of the latter. This has been one of the troubling issues. In a market dominated by few players and lack of effective regulation, competition is unlikely to emerge, thus increasing the likelihood of anti- competitive behaviour on the part of the dominant players. A regulatory framework and institutional arrangement must be developed to prevent abuse of market power and to promote competition. The Government has stated that it is committed to a strong regulator and there are indications that the TRAI Act will be modified to clarify certain provisions of the Act. There are quite a few Circles that private service providers have not found attractive to enter. However, an effective communication infrastructure could contribute to the economic growth of these areas. There are also some 290,000 villages that remain to be connected by phone. Setting up of a funding mechanism through the proposed Universal Service Access levy is therefore a matter of priority. The issue can also be tackled through a policy to establish clear open access and interconnection guidelines.

Along with opening up access of one telecom segment to operators in other segments and vice versa, this would lead to development of a data communications market that would optimise utilisation of both installed wireline and wireless transmission capacity. The presence of many operators and a technological and regulatory environment that permits the interconnection of one network to another would also lead to a quantum expansion in reach. For example, it is conceivable that a satellite phone operator in GMPCS would resell its spare satellite capacity, which is a sunk cost, to operators who will use it to provide trunk connectivity to local rural networks, at a fraction of the cost needed for dedicated wireline trunk connectivity. It is not necessary to trade-off reach in order to raise revenue. While the need for a Universal Access Levy will remain, the duration and level of such a levy can be limited by exploring the commercial possibilities opened by competition. Experience around the world is also showing that due to the networked nature of telecommunications markets, introduction of effective competition requires the active presence of regulators, especially in the early stages of market reform. Digital convergence however is imposing new challenges to the regulatory frameworks that had developed in recent years for the promotion of competition in the telecommunication market. In December 1996, International Telecommunications Union held a colloquium on regulatory implications

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on telecommunications convergence. It was emphatically noted that in the future, impact of convergence upon regulation would be greater than the impact of regulation on convergence.

Convergence of technologies implies a need not only to consider the appropriate method of licensing and charging license fee, but also forces the policy maker to review a number of other aspects, including whether to regulate and the nature and extent of regulation. The attempt of all the policy initiatives should be to promote the flexibility of technology choice and service provision. Thus, neutrality of policies towards technology/platform is seen as a desirable attribute, not only because this enhances opportunities but also because the policy maker is not in a position to anticipate the likely developments and fine-tune policy. The Government of India has recently announced a change in its licensing policy, for example, for cellular mobile, which now allows technology neutrality (with the condition that technology must be digital). Similarly, NTP 99 provides flexibility for different service providers to provide another type of service, subject to having obtained the relevant license for providing that service. Likewise, NTP 99 has increased the flexibility with respect to interconnection among service providers within a service area.

In India's case, license fees have been identified as source for government revenue. Given India's fiscal situation and the revenue raising possibilities of telecom licenses, it is difficult to abjure the revenue maximising option. However, focusing only on revenue maximization does not lead to satisfactory results even from the view point of this limited objective. Further, if revenues have to be earned from any sector, it is more efficient to earn it out of the actual earnings rather than to seek them from projected earnings in an uncertain environment. There is considerable evidence to suggest that high license fees are responsible to a large extent for rendering telecom projects 'non-bankable' and for the slow take-off of sector liberalization.

In India, there is a major emphasis on expanding the teledensity in the next seven years, and the Government has explicitly recognized the role of the private sector in meeting such targets. Delay in implementing the operations will create problems in meeting the stated objectives. The need of the hour is to begin operations in as many places as possible, and to infuse competition so that another objective of the Government policy can be met with success through the market itself, namely to provide the services at affordable prices. To that extent, any license fees charged should be low, covering for instance contributions to the proposed Universal Service Access levy, the cost of regulation, and some additional amount to meet other objectives such as the creation of a Telecom Fund.

The delays in the reform process have been very costly to the economy. The gap between the FDI commitments (Rs 280 billion) and the actual investment (Rs. 40 billion up to 1997-98) provides one index of the growth

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that could have been registered by the sector if correct policies were in place. In terms of physical delays, by conservative estimates, some two million additional telephone lines (and an equal number of Internet connections) would have been facilitated by now.

One final comment. It is in the fitness of things that policy statements for the telecom sector have been periodically reviewed with the changing telecom scenario. Although the reform process has been underway for more than four years with little to show by way of introduction of competition in the sector, it will not be amiss to claim that there is awareness of the crucial issues that need to be addressed. Given the acknowledged importance of telecommunications to overall national interests, governments tend to get involved in the management of the sectors progress. Unfortunately in terms of development, the interests of the government and the private sector do not always reconcile easily - which has resulted in telecom stagnation in many countries, including India. Evidence shows that governments which most 'competently' foster private sector advancement of their telecommunications industries are best placed to gain world class telecommunications services and the attendant benefits. Arguably, early liberalisation could give any country a first mover advantage in attaining high telecommunications performance. However, hasty adoption of developing economies of liberal frameworks adopted by developed economies could easily fail and in the process discredit the idea of liberalisation. Enthusiasm for liberalisation and it's possibilities needs to be juxtaposed with a realistic transformation programme that takes into account the country's economic and political dynamics.

SUMMARY

- The telecom sector in India has witnessed rapid changes in the last five years. There have been far reaching developments in Information Technology (IT), consumer electronics and media industries across the globe.
- Department of Telecom Service (DTS) provides basic services in the 21 telecom circles, while Mahanagar Telephone Nigam Limited (MTNL) serves Delhi and Mumbai.
- In regard to quality of service, matching "world standard" and providing "widest possible range of services" "at reasonable prices" were stated aims.
- The emphasis is on making India an "IT super-power". However, as mentioned above, the regulatory scenario for telecom is changing rapidly and there are a number of issues which would require

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further analysis and perhaps a change in policy framework in the next few years.

- The logical consequence of a decision to permit India-registered companies to operate both basic and 'value added' services and to promote private (including foreign) investment in the sector, is an end to DoT's monopoly on access, setting up of an independent regulator, and separation of DoT the service provider from DoT the policy maker.
- In several countries that have implemented significant telecom liberalization, the focus now is on convergence of policies as well as on regulation that addresses "unfair competition".
- Apart from the policy making function, Government has retained the licensing function with itself. There is no set pattern with respect to whether licensing powers should be available with the regulator or with the Government.

REVIEW QUESTIONS

1. Discuss the Existing structure of telecom sector in India.
2. What are key issues of telecom policies of India?
3. Distinguish between the technology issues and competition issues.
4. What are different key determinants? Explain in details.
5. Explain the licensing power remain with government.
6. Note on recommendatory role.
7. Differentiate between competition in long distance and international long distance.
8. Discuss about the regulatory issues.

CHAPTER 10 CHARACTERISTICS OF TELEPHONE MARKET AND SUBSCRIBERS

★ STRUCTURE ★

10.0 Learning Objectives
10.1 Introduction
10.2 Structural Evolution of the Indian Telecom Industry
10.3 Current Structure of the Indian Telecom Industry
10.4 Telecom Subscribers in India
10.5 Wireless Subscriber Market Share: Service Wise (GSM & CDMA)
- *Summary*
- *Review Questions*

10.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- know about the structural evolution of the Indian telecom industries.
- define the telecom sector in the pre-liberalization era.
- distinguish the VSAT and VAS.
- describe the current structure of the Indian telecom.
- discuss about the telecom subscribers in India.
- differentiate between the public sector and private sector.
- explain the public mobile radio trunked services.

10.1 INTRODUCTION

The Indian telecom industry has undergone significant structural transformation since its liberalisation in the 1990's. During the last decade, the Indian telecom industry has evolved into a multi-segment, competitive market from a small supplier-dominated market having public sector monopoly. Coherent Government policies have played a crucial role in shaping the structure of the Indian tëlecom sector.

10.2 STRUCTURAL EVOLUTION OF THE INDIAN TELECOM INDUSTRY

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Telecom Sector in the Pre-Liberalisation Era (1980–1990)

Before liberalisation, the public sector held a monopoly in provision of telecom services. The entire telecom services operation in the country was carried out by the Department of Telecommunication (DoT), a public sector entity established in 1985. It managed the planning, engineering, installation, maintenance, management, and operations of telecom services for the whole of India. In order to ease out its operations, two new public sector corporations viz. MTNL and VSNL were set up under the DoT in 1986. Thus, before the entry of the private players, the telecom services were provided by three public entities viz. DoT, MTNL and VSNL. While MTNL primarily looked after the operation of basic telephony services in Delhi and Mumbai, VSNL provided international telecom services in India. DoT looked after basic telephony operations in regions other than Delhi and Mumbai. Prior to liberalisation the telecom services were broadly classified as domestic basic (which included basic telephony, telex and fax); domestic value-added services (VAS) which covered all other services such as paging, cellular, data services, VSAT and international basic and VAS.

Telecom Sector in the Post-Liberalisation Era

Private sector participation in the Indian telecom sector has been a gradual process, wherein the government initially permitted players from the private sector to provide value added services (VAS) such as Paging Services and Cellular Mobile Telephone Services (CMTS), followed by the fixed telephony services (FTS) or Basic services. Eventually the private sector has been allowed to provide almost all telecom services. Liberalisation process in the telecom services market began in 1992, with the unbundling of the domestic basic services and the domestic VAS and entry of private players for providing the VAS such as cellular and paging services. During this period, the government provided licenses to private players according to the services that were to be provided in the specified areas of service provision. The country was divided into circles (or categories) on the basis of economic potential. Thus, primarily these divisions were mostly adjoining the states of India. Such demarcations were primarily responsible for existence of various regional players in provision of telecom services. During 1994, through a competitive bidding process, licenses were granted to 8 CMTS operators in four metros, 14 CMTS operators in 18 state circles, paging operators in 27 cities and 18 state circles.

After the domestic VAS, the basic services were opened up to private players. The National Telecom Policy (NTP) 1994, which endeavoured to build world-class telephone services in India and aimed at providing telephones on demand, enabled the entry of private players in the provision of basic services. Given the need for resources in addition to government sources for achieving the targets of NTP-94, private investments and involvement of the private sector was considered inevitable to bridge the resource gap. Thus, the private operators were allowed to render basic services in the local loop. Initially, the provision of basic services had been deliberated as a duopoly between a selected service provider and the DoT. In line with this, policy licences were awarded to 6 BTS operators in 6 state circles.

The need for independent regulation had risen with the entry of private players. Also, to fulfil the commitments made when India joined the World Trade Organisation (WTO) in 1995, the Telecom Regulatory Authority of India (TRAI) was established in 1997 to regulate telecom services including fixation/revision of tariffs. The establishment of TRAI was a positive step in terms of separation of regulations from policy making and operations, which continued to be under the purview of the DoT.

Further, in 1998, the Government also declared the policy for Internet Service Provision (ISP) by private operators and had even begun licensing of the same around that time. Subsequently the Global Mobile Personal Communications by Satellite (GMPCS) was also opened up for the private players.

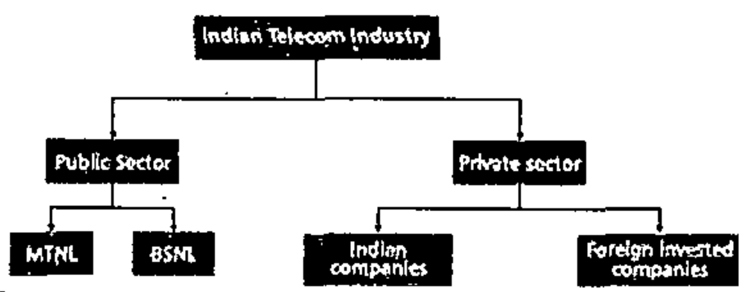
Although the private players had been allowed to participate in many telecom services segments, the results of privatisation had not been satisfactory entirely. Thus, a New Telecom Policy (NTP-99) was announced on March 26, 1999, which came into effect from April 1, 1999. The NTP 1999 not only provided a major fillip to private sector participation in this industry but also laid down the path for significant development of the Indian telecom industry. The NTP 1999 allowed private operators providing cellular and basic service to migrate from a fixed licence fee regime to a revenuesharing regime to make the operations of the private players financially viable. This policy change provided the muchneeded relief to private players who were earlier burdened with huge debts that they had to service owing to their licence fee commitments. Another notable provision of the Act had been the entry of multiple private sector operators in the sector in contrast to the policy of duopoly practiced earlier. This not only increased competition in the industry but also assisted the private players to attract new investment and augment their subscriber base. The entry of private operators in the cellular sector helped to reduce the operational cost of the industry. It also reduced the mobile tariffs and provided a much needed boost to the industry. The Act also made the following provisions: it permitted interconnectivity and sharing of infrastructure among various service providers within same areas of operations; it allowed both voice and data traffic by service providers; it opened up national long distance (NLD) and international long distance (ILD) services to competition et al. Thus, the NTP 1999 can be viewed as the genesis of the cellular revolution being witnessed in India.

The NTP 99 had also enunciated to separate the policy and licensing functions of the DoT from the service providing functions to ensure a level-playing-field among private operators and incumbents. Accordingly, as a predecessor to corporatisation, two new departments viz. Department of Telecom Services (DTS) and the Department of Telecom Operations, were carved out of DoT, to separate the service provision and operational functions of DoT. Later in 2000, DTS was corporatised and renamed as Bharat Sanchar Nigam Ltd (BSNL), and thus the functions of the incumbent service provider were separated from that of the policy maker. DoT is now responsible for policy-making, licensing and promoting private investments in both telecom equipment manufacturing and in telecom services. Subsequently in 2002, even VSNL was privatised and its monopoly in ILD services was terminated (from March 31, 2002).

10.3 CURRENT STRUCTURE OF THE INDIAN TELECOM INDUSTRY

Currently, both public sector players as well as the private sector players are actively catering to the rapidly growing telecommunication needs in India. Private participation is permitted in all segments of the telecom industry, including ILD, DLD, basic cellular, internet, radio paging, et al. The broad structure of the telecom industry (in terms of service providers) is depicted in the diagram below:

Exhibit 2.1: Structure of Telecom Industry



Source: D&B Research

Fig. 10.1: Structure of telecom industry

Public Sector

After the privatisation of VSNL in 2002, only two premier PSUs, MTNL and BSNL operate in India and provide various telecom services. As noted earlier, MTNL operates in Delhi and Mumbai and BSNL provides services to the remaining country. In the post-liberalisation era, these PSUs not only have made significant progress but also have provided stiff competition to their private counterparts.

Private Sector

Private operators have played a very crucial role in the growth of the telecommunication industry, primarily in the mobile services. With the liberalisation of the telecom industry, the private sector has been increasing its foothold in the telecom services space. After the introduction of NTP-99, the contribution of private players towards telecom services has witnessed rapid strides. While the private sector is instrumental in providing both fixed line as well as wireless services, it is mainly active in the wireless segment. The fixed lines account for only about 2% of private sector's total subscriber base. While some private players have a pan-India presence, there are many regional players that cater to only certain service areas.

10.4 TELECOM SUBSCRIBERS IN INDIA

The subscriber base of the public as well as private players has grown rapidly post-liberalisation. The subscriber base of telecom industry grew from around 18.68 mn during FY98 to 429.72 mn during FY09 and a significant proportion of this growth has emanated from the private sector. The private players registered an absolute growth of around 339.30 mn in subscriber base during FY98-FY09. This could be largely attributed to rapid growth in mobile subscriber base of the private players. With the gradual opening up of the telecom industry, the private players have been able to garner strength and improve their hold on the telecom service provision. Further, the introduction of the New Telecom Policy (NTP-99), which enabled migration in the license fee payment mechanism from a fixed regime to a revenue-sharing regime, provided a major boost to private sector players. Moreover, initiatives such as allotting third and fourth cellular licenses, shifting to a unified access licensing regime, execution of calling party pays (CPP) regime, making incoming calls free, also drew significant growth in the cellular subscriber base.

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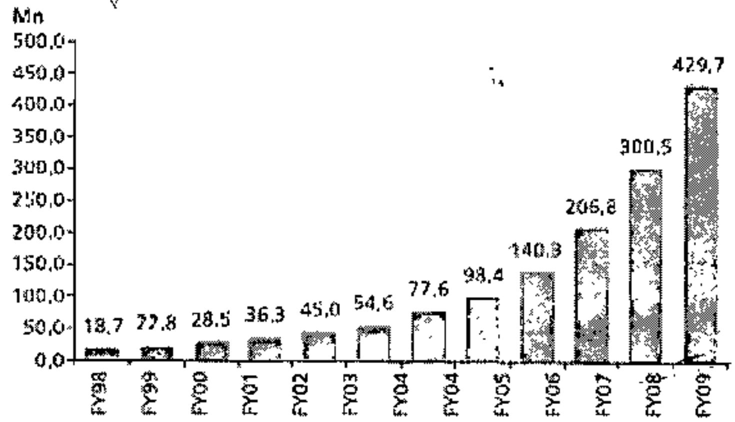
Chart 2.1: Subscriber Base

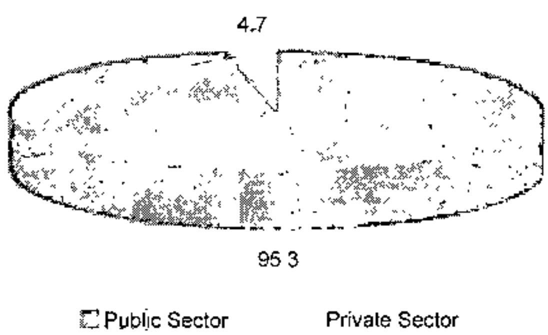


Source: TRAI

Fig. 10.2: Subscriber Base

Although the subscriber base of public entities has also expanded, it has grown at a much lower rate as compared with private players. During 1998-2008, the subscriber base of PSU operators grew by merely 71.72 mn. The public sector has witnessed sustained depletion in its share in the total subscriber base over the years, as it has been on a comparatively lower growth trajectory.

The share of private sector in the total subscriber base has increased substantially from 4.7% in FY98 to 79.2% in FY09. Even though these figures signify the dominance of the private sector in terms of subscriber base, it is important to note that the prominence of private and public sector service providers varies in different segments of the telecommunication industry.



Market shares in terms of Subscriber base
Source: TRAI

Fig. 10.3: Market Share in Financial year 1998(%).

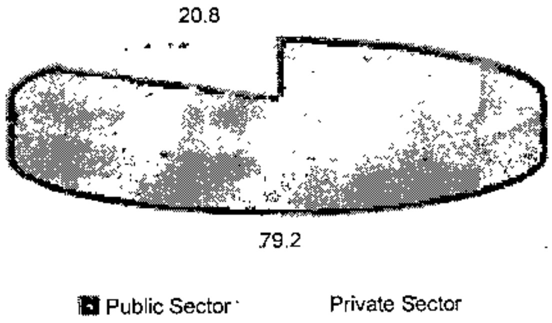


Fig. 10.4: Market Share in Financial year 2009(%)

Segments in the Telecommunication Industry

Telecommunication services in India can be divided into two broad segments, wireline services and wireless services. While the wireline services include the fixed line telephony, wireless services comprise mobile, WLL (F) and WLL (M). On the whole, the Indian telecom industry has made significant progress; however, the source of emergence of this growth in terms of wireless and wireline segments has undergone substantial change in the past few years. The wireline segment, which accounted for a major share of the telecom industry during beginning of the current decade, has witnessed a decline in its subscriber base in the last 2 years. The subscribe base of the wireline segment, which reached a peak of 41.54 mn during FY06, has witnessed a declining trend since then. The subscriber base of the wireline segment has declined to 37.96 mn in FY09 from its peak in FY06. On the other hand, the growth in subscriber base of the wireless segment has increased substantially over these years. The subscriber base of the wireless segment has increased from around 6.70 mn in FY02 to as much as 391.76 mn in FY09. Over these years, not only the number of wireless subscribers but also the pace of its growth has increased substantially.

Other telecommunication services such as internet services, broadband services, VSAT, also have evolved gradually and have become an integral part of the Indian telecom industry. Thus, broadly the Indian telecommunication industry can be classified into the following segments:

- Wireline services
- Wireless service: GSM and CDMA

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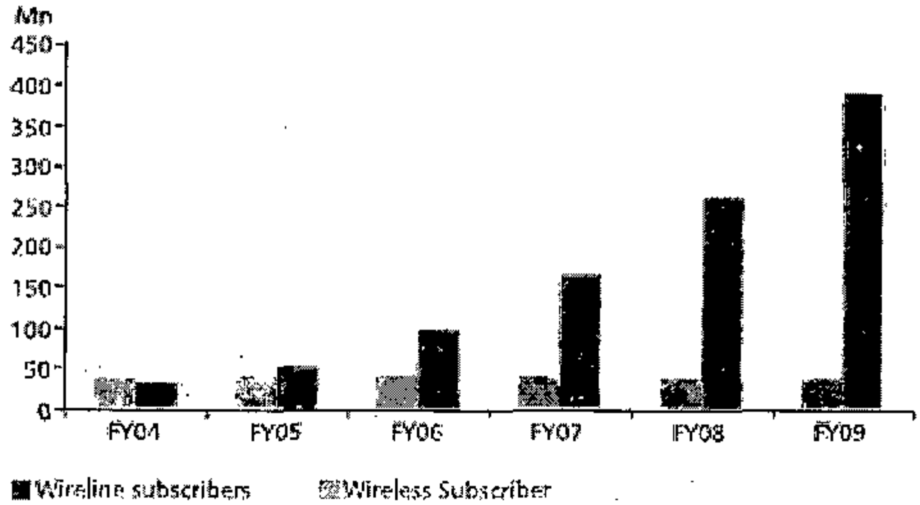


Source: TRAI

Fig. 10.5: Wireline and Wirless subscriber base

- Internet services
- Public Mobile Radio Trunked Services
- Global Mobile Personal Communication by Satellite (GMPCS)
- Very Small Aperture Terminals (VSAT)
- Mobile Value Added Services

Wireline Services

The wireline segment includes basic wireline services rendered to households, commercial units and to service providers such as public call offices. While the incumbent PSUs have been the dominant players in wireline service, some private players have been gradually making their presence felt in this segment. As on March 31, 2008, 5 licensed private operator groups were providing wireline connections in addition to the incumbent BSNL and MTNL.

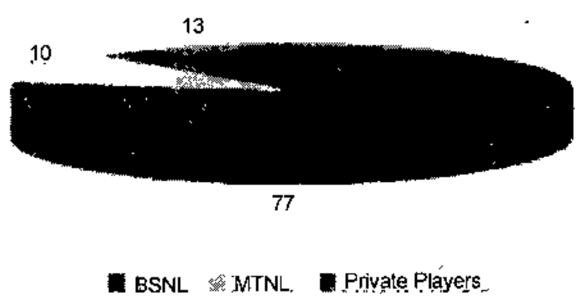
Table.10.1 : List of Wireline Service Providers

List of Service providers providing wireline services alog with their area of operation*	
Services Providers	**Area of Operation**
BSNL	21 Cirles (Except Delhi & Mumbai)
MTNL	2 Circles (Delhi & Mumbai circles only)
Bharti Airtel Ltd	17 Circles–Except Assam, Orissa, Jammu & Kashmir, Bihar, North East and Himachal Pradesh

Tata Teleservices (Maharashtra) Ltd	20 Cirles—and Except Assam, Jammu & Kashmir North East
HFCL Infotel Ltd.	1 Circles (Punjab circle only)
Shyam Telelink Ltd	1 Circle (Rajasthan Circle only)
Reliance	21 Circles—(Except Assam and North East)

Market Share in Terms of Subscriber Base

BSNL and MTNL have been key players in the wireline service. Even though private players have been allowed to participate in fixed services since 1994, they only have around 13% contribution in the fixed line subscriber base (as on March 31, 2009). Though private players like Bharti and Reliance have registered notable growth, the Government-owned BSNL dominates the segment in terms of subscriber base. The public sector companies enjoy a first-mover advantage in this segment and this is likely to have helped them seize a substantial share in the wireline market and maintain their dominance in this segment. The public sector accounts for almost 87% of the subscriber base of the fixed line services (as on March 31, 2009); however, over the years, the share of private sector has witnessed some improvement.



Source: TRAI

Fig. 10.6: Market share in terms of subscriber base FY 09 (%)

Wireless Services

Wireless services can be further divided into Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA). The WLL (F) is operated under the CDMA technology. The GSM services, which account for 73% of the total subscriber base of the wireless service, dominate the wireless segment.

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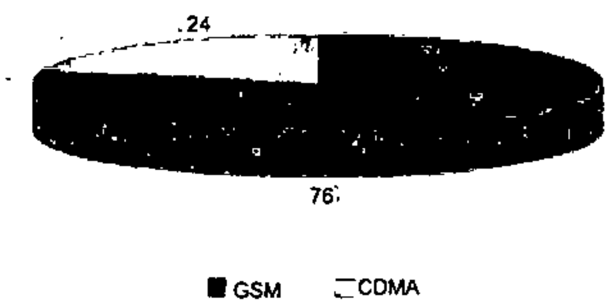
10.5 WIRELESS SUBSCRIBER MARKET SHARE: SERVICE WISE (GSM & CDMA)

The wireless services have witnessed significant growth in the past few years. India primarily follows the GSM mobile system, in the 900 MHz and 1800 MHz band. The 900 MHz band has greater transmission characteristics, thereby enabling lower capital expenditure for expansion of coverage area as the number of towers and base stations required are lesser as compared to the 1800 MHz band.

The wireless services segment of the telecom industry clocked an annual average growth of around 63.79% during FY05- FY09. India has overtaken the USA to become the second-largest wireless network in the world, and is second only to China, with the addition of about 8 million subscribers every month in the recent times. By end of FY09, the wireless industry had touched the 391.76-mn-subscriber-mark. This total subscriber base of FY09 comprise of 297.26 mn GSM subscribers and 94.50 mn CDMA subscribers. During FY09, around 130.69 mn subscribers were added in the wireless segment of the telecommunication industry.

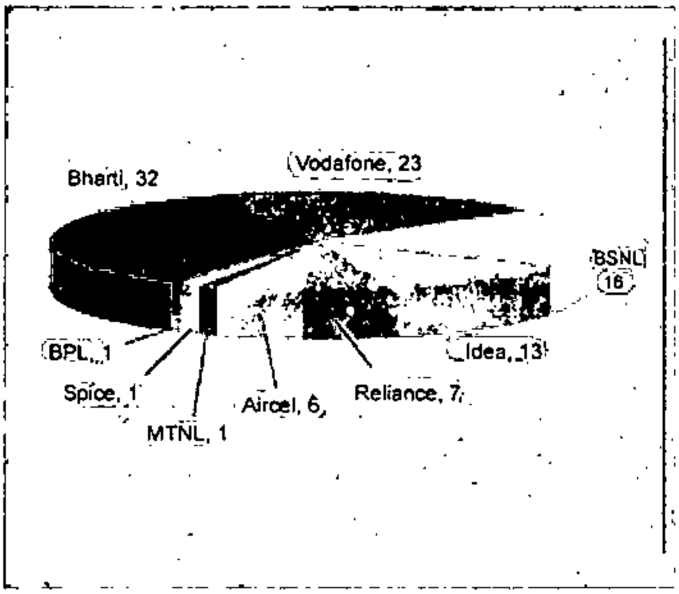


Source: TRAI

Fig. 10.7: Market share of GSM and CDMA in terms of subscriber base

FY 09 (%)

Private sector players have played an important role in the rapid growth of the wireless segment. The private players account for around 86% of the total wireless subscriber base. While public sector has been instrumental in the development of the wireline service, the growth in wireless subscriber base for these entities has been relatively slower compared to the private players. Currently 12 wireless service providers (including 2 PSUs) exist and compete in different regions. However, only 2 private players, Bharti and Reliance Communications, have nationwide presence along with state-owned entities, MTNL and BSNL, which together represent an additional pan-India presence. Many players have been taking initiatives to expand operations across the country. The GSM sector is dominated by players such as Airtel, Vodafone-Essar, and Idea Cellular, while the CDMA sector is dominated by Reliance and Tata Indicom. Bharti Airtel is the largest GSM mobile operator in India and has a subscriber base of 93.92 million followed by Vodafone-Essar, BSNL and Idea Cellular with a subscriber base of 68.77 mn, 46.71 mn and 38.89 mn, respectively. Reliance Communication is the largest CDMA mobile operator with a subscriber base of 52.65 mn followed by Tata Teleservices and BSNL that have a subscriber base of 35.12 million and 5.44 million, respectively. Only Reliance Communication and Tata Teleservices offer both GSM and CDMA networks.



Source: TRAI

Fig. 10.8: Market share of GSM in terms of subscriber base FY 09 (%).

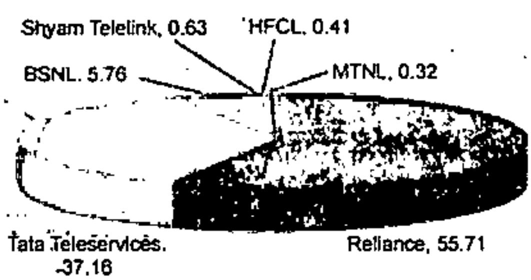


Fig. 10.9: Market share of CDMA in terms of subscriber base FY 09 (%).

SUMMARY

- The need for independent regulation had risen with the entry of private players.
- The subscriber base of the public as well as private players has grown rapidly post-liberalisation.
- BSNL and MTNL have been key players in the wireline service. Even though private players have been allowed to participate in fixed services since 1994, they only have around 13% contribution in the fixed line subscriber base (as on March 31, 2009).
- The wireless services have witnessed significant growth in the past few years. India primarily follows the GSM mobile system, in the 900 MHz and 1800 MHz band.

REVIEW QUESTIONS

1. Discuss Structural evolution of the Indian telecom industry.
2. Discuss the current structure of the Indian telecom industry.
3. Discuss different types of telecom subscribers in India.
4. Differentiate between the telecom sector in the pre-liberalisation era and telecom sector in the post liberalisation era.
5. Distinguish the national long distance and international long distance.
6. Explain the segment in the telecommunication industry.
7. Discuss about the market share in terms of subcriber base.
8. Describe the wireless subscriber market share of service wise (GSM and CDMA).

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CHAPTER 11 ORGANIZATIONAL STUDY OF BEL, C-DOT AND TELECOM COMMISSION

★ STRUCTURE ★

11.0 Learning Objectives
11.1 Bharat Electronics Limited (BEL)
11.2 Quality Policy
11.3 Research and Development
11.4 Resources and Investments
11.5 Centre for Development of Telematics (C-Dot)
11.6 Telecom Commission
- *Summary*
- *Review Questions*

11.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

- differentiate between the organization category and administrative minister.
- explain the centre for development of telecomatics (C-Dot).
- know about the resources and investments.
- define the research and development.
- discuss about the business excellence and standardisation.
- describe the bharat electronics quality institute.

11.1 BHARAT ELECTRONICS LIMITED (BEL)

Bharat Electronics Limited (BEL) was set up at Bangalore, India, by the Government of India under the Ministry of Defence in 1954 to meet the specialised electronic needs of the Indian defence services. Over the years, it has grown into a multi-product, multi-technology, multi-unit company serving the needs of customers in diverse fields in India and abroad . BEL is among an elite group of public sector undertakings which have been conferred the Navratna status by the Government of India.

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The growth and diversification of BEL over the years mirrors the advances in the electronics technology, with which BEL has kept pace. Starting with the manufacture of a few communication equipment in 1956, BEL went on to produce Receiving Valves in 1961, Germanium Semiconductors in 1962 and Radio Transmitters for AIR in 1964.

In 1966, BEL set up a Radar manufacturing facility for the Army and in-house R&D, which has been nurtured over the years. Manufacture of Transmitting Tubes, Silicon Devices and Integrated Circuits started in 1967. The PCB manufacturing facility was established in 1968.

In 1970, manufacture of Black & White TV Picture Tube, X-ray Tube and Microwave Tubes started. The following year, facilities for manufacture of Integrated Circuits and Hybrid Micro Circuits were set up. 1972 saw BEL manufacturing TV Transmitters for Doordarshan. The following year, manufacture of Frigate Radars for the Navy began.

Under the government's policy of decentralization and due to strategic reasons, BEL ventured to set up new Units at various places. The second Unit of BEL was set up at Ghaziabad in 1974 to manufacture Radars and Tropo communication equipment for the Indian Air Force. The third Unit was established at Pune in 1979 to manufacture Image Converter and Image Intensifier Tubes.

In 1980, BEL's first overseas office was set up at New York for procurement of components and materials. In 1981, a manufacturing facility for Magnesium Manganese Dioxide batteries was set up at the Pune Unit. The Space Electronic Division was set up at Bangalore to support the satellite programme in 1982. The same year saw BEL achieve a turnover of Rs.100 crores. In 1983, an ailing Andhra Scientific Company (ASCO) was taken over by BEL as the fourth manufacturing Unit at Machilipatnam. In 1985, the fifth Unit was set up in Chennai for supply of Tank Electronics, with proximity to HVF, Avadi. The sixth Unit was set up at Panchkula the same year to manufacture Military Communication equipment. 1985 also saw BEL manufacturing on a large scale Low Power TV Transmitters and TVROs for the expansion of Doordarshan's coverage.

1986 witnessed the setting up of the seventh Unit at Kotdwara to manufacture Switching Equipment, the eighth Unit to manufacture TV Glass Shell at Taloja (Navi Mumbai) and the ninth Unit at Hyderabad to manufacture Electronic Warfare Equipment. In 1987, a separate Naval Equipment Division was set up at Bangalore to give greater focus to Naval projects. The first Central Research Laboratory was established at Bangalore in 1988 to focus on futuristic R&D.

1989 saw the manufacture of Telecom Switching and Transmission Systems as also the setting up of the Mass Manufacturing Facility in Bangalore and the manufacture of the first batch of 75,000 Electronic Voting Machines.

The agreement for setting up BEL's first Joint Venture Company, BE DELFT, with M/s Delft of Holland was signed in 1990. Recently this became a subsidiary of BEL with the exit of the foreign partner and has been renamed BEL Optronic Devices Limited. The second Central Research Laboratory was established at Ghaziabad in 1992. The first disinvestment (20%) and listing of the Company's shares in Bangalore and Mumbai Stock Exchanges took place the same year.

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BEL Units obtained ISO 9000 certification in 1993-94. The second disinvestment (4.14%) took place in 1994. In 1996, BEL achieved ₹ 1,000 crores turnover. In 1997, GE BEL, the Joint Venture Company with M/s GE, USA, was formed. In 1998, BEL set up its second overseas office at Singapore to source components from South East Asia. The year 2000 saw the Bangalore Unit, which had grown very large, being reorganized into Strategic Business Units (SBUs). There are seven SBUs in Bangalore Unit. The same year, BEL shares were listed in the National Stock Exchange.

In 2002, BEL became the first defence PSU to get operational Mini Ratna Category I status. In June 2007, BEL was conferred the prestigious Navratna status based on its consistent performance. During 2008-09, BEL recorded a turnover of ₹ 4624 crores.

11.2 QUALITY POLICY

BEL are committed to consistently deliver enhanced value to our customers, through continual improvement of our products and processes.

Quality Objectives

- Effective and efficient design and development process, considering the present and future needs of customers.
- Enhanced customer satisfaction by on-time delivery of defect free products and effective life cycle support.
- Continual upgradation and utilization of infrastructure and human resources.
- Mutually beneficial alliances with suppliers.
- Continual improvement of processes through innovation, technology and knowledge management.

Evolution of Quality Management System in Bharat Electronics

Right from its inception in 1954, Bharat Electronics has understood the varying levels of quality and reliability requirements of its customers and has been striving to enhance their satisfaction level. The company has developed and improved Quality Systems and Procedures over the years.

Starting with an inspection oriented Quality system during the initial years, the company shifted its focus towards MIL-Q-9858 Quality Management System during the early Seventies.

During the Eighties, a number of initiatives were taken to improve the Quality Management System. They included release of documented QA manual; promotion of participative culture in the organization; launching of QC Circles & Suggestion Scheme, etc.

Introduction of TQM

Bharat Electronics adopted the Total Quality Management (TQM) philosophy in the year 1990 under the acronym 'TORQUE' which stands for Total Organisational Quality Enhancement. TORQUE is based on the premise that the quality of products and services is not only the responsibility of the production/shop floor personnel, but other support services also who have a role to play in meeting and exceeding our customers? expectations through supply of quality products and services.

Some of the critical business performance indicators like transactional cycle time, manufacturing yield, inventory turnover ratio, customer complaints, QCC presentations, quality cost, etc are monitored on a monthly basis through SAP and corrective actions are initiated for continual improvement.

Starting from 1993, all Units / SBUs / Divisions of the company have been certified for ISO 9001 Quality Management System and ISO 14001 Environment Management System. Seven Units / SBUs (Ghaziabad, Panchkula, Kotdwara, Hyderabad, Military Communication, Electronics Warfare & Avionics and Export Manufacturing) are also certified for AS 9100 Aerospace Standards. The Central Software Development group of the company has CMMi Level 5 certification.

Thrust Areas of TORQUE

(a) Continual improvement of products and processes through deployment of Six Sigma methodology.

(b) Key processes stabilization and capability improvement through Statistical Process Control (SPC) techniques.

(c) Reduction of cycle time in all transaction areas.

(d) Improvement in quality of design through DFSS projects.

(e) Employee motivation and empowerment through self certification, QCC and Suggestion Schemes.

(f) Introduction of lean manufacturing concepts to achieve on-time delivery.

(g) Customer satisfaction surveys to measure and improve satisfaction level of customers.

Business Excellence

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The company has adopted CII-EXIM Bank Business Excellence Model to improve its overall strategic and operational excellence. Adoption of this Model since 2002 has helped the company in understanding the expectations of various stakeholders and in enhancing their satisfaction level.

The company has achieved the level of 'Commendation for Strong Commitment to Excel' and is striving to reach higher levels of excellence under the Model.

Bharat Electronics Quality Institute

A Quality Institute has been created in 1999 by the company to impart education / training to the company's officers, customers and suppliers on various facets of quality management. Regular training programs are conducted for all employees of the company. Courses on topics such as Six Sigma, design for Six Sigma, reliability & maintainability, lean manufacturing, SPC, Project Management, etc are conducted regularly at the Quality Institute.

Standardisation

Standardisation & Quality are two inseparable parts of the TQM process and they play a complementary role. A Corporate Standards Department established four decades back has evolved more than 4000 standards on drafting, materials, systems & procedures, manufacturing processes, quality & workmanship, etc. These standards have provided effective support in design, manufacturing, vendor development and process standardisation.

Quality Assurance Facilities

The company has established state-of-the-art test facilities like environment test chambers, high altitude test facilities, bump & vibration test facilities, calibration facilities for electronic test instruments, EMI / EMC test facilities, etc. The calibration facility is certified as per ISO 17025 standard by NABL. Facilities for Highly Accelerated Life Testing (HALT), Highly Accelerated Stress Screening (HASS) and Multiple Environment Over Stress Testing (MEOST), combined environmental testing (Thermal & Vibration) are established for enhancing product reliability.

Reliability & statistical software tools are used by the company to demonstrate, predict and measure quality and reliability characteristics

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and parameters of products during design, development, manufacturing and life cycle stage.

11.3 RESEARCH AND DEVELOPMENT

Research and Development is a key focus activity at BEL. Research & Development started in 1963 at BEL and has been contributing steadily to the growth of BEL's business and self-reliance in the field of defence electronics and other chosen areas of professional electronics.

BEL's R&D Policy is to enhance the company's pre-eminence in defence electronics and other chosen fields and products through Research & Development. Major R&D objectives of BEL is development of new products built with cutting-edge technology modules to meet customer requirements ensuring that the developed products are state-of-the-art, competitive and of the highest quality.

11.4 RESOURCES AND INVESTMENTS

All the 9 manufacturing Units of BEL have their own Development & Engineering (D&E) divisions. The role of these D&E divisions is to develop new products and obtain customer acceptance, generate new business, provide product lifecycle support and upgrades, develop processes and components as necessary.

Specialised core technology modules required by the D&E Engineers for product development are developed at several core Central D&E groups at Bangalore. BEL also has two Central Research Laboratories (CRLs) located at Bangalore and Ghaziabad, whose primary role is to work on critical areas of technology, develop enabling technology modules for use by D&E divisions and provide training to D&E engineers on emerging technologies.

Presently there are about 1450 engineers and 300 support staff in the R&D Divisions of BEL, concentrating on various projects. D&E divisions of BEL pursue various categories of projects: in-house development projects, joint development or ToT projects with DRDO / other national design agencies and ToT or joint development projects with foreign vendors. Usually, 45 to 60% of the turnover is from BEL designed products, 10 to 25% of turnover is from products designed by DRDO and other National Design Agencies and the remaining from foreign collaborations.

The annual R&D expenditure is around 4 to 5% of BEL's sales turnover. BEL regularly recruits young engineers based on the identification of required competencies for the R&D divisions. There are schemes for on-the-job training after placement and facilities for continuous learning for these engineers. There are recognition and reward schemes for excellence among R&D engineers.

BEL R&D units are recognised by the Department of Scientific & Industrial Research (DSIR) under the Ministry of Science and Technology, Government of India. BEL's Software Technology Centre at Bangalore has the recognition of Capability Maturity Model (CMM) Level 5 Rating from Software Engineering Institute (SEI) .

Areas of R&D Activity

R&D engineers are engaged in the development of new products, cutting edge technology modules, subsystem, processes & components in the following major areas:-

- Radars
- Sonars & Naval Systems
- Communications
- Command Control Systems
- Electronic Warfare Systems & Avionics
- Tank and Opto-electronics
- Broadcast, Satcom & Telecom
- Other products & systems
- Components

Core Central Groups under Central D&E support the product development groups with state-of-the-art technology modules in areas like Power Amplifier, Power Supply, RF & Synthesiser, Crypto, DSP & Datacom, Software and Radar Signal Processing. The Central Research Laboratories of BEL work in the areas of Materials & Micro-electronics, Information Systems, Embedded Systems & Networking, Sensor Signal Processing, RF & Microwave, Advance Computing and VLSI.

The list of global companies with whom BEL has technological collaborations for different state-of-the-art products are given below:

Sl.No.	Company	Product
1	ELBIT, Israel	Stand Alone Communication Unit Enhanced Tactical ComputerWireless Local Area NetworkSoftware Modules
2	ELOP, Israel	IOE & Hand Held Thermal Imagers
3	ELTA, Israel	Medium Range Battle Field Surveillance RadarHF/UHF Search Receiver System

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4	Tadiran, Israel	HF Manpack Radio,Vehicle Mounted HF Radio Set
5	Sextant, France	LCD Display Unit
6	Thales Air Defence SA, France	Upgrades of THD 1955 Radar
7	Thales Electron Devices, France	Mini Travelling Wave Tubes
8	Rhode & Schwarz, Germany	VLF/HF Receivers
9	Ericsson MW Sys, Sweden	SFM Trainer
10	Alenia Marconi System Spa, Italy	Surveillance Radar Element
11	INROS Ltd, Russia	Sonobuoys
12	Kelvin Hughes Ltd, USA	Colour Tactical Displays
13	Akon Inc, USA	Microwave Assemblies

11.5 CENTRE FOR DEVELOPMENT OF TELEMATICS (C-DOT)

The Centre for Development of Telematics (C-DOT) is the Telecom Technology development centre of the Government of India. It was established in August 1984 as an autonomous body. It was vested with full authority and total flexibility to develop state-of-the-art telecommunication technology to meet the needs of the Indian telecommunication network. The key objective was to build a centre for excellence in the area of telecom technology.

In the initial years, C-DOT triggered a telecom revolution in the rural India that was responsible for all-round socio-economic development. Rural India gained access to a whole new world of opportunities as they got connected globally. As part of its development process, C-DOT has spawned a wide base of equipment manufacturers and component vendors for the industry. The state-of-the-art R&D facilities at its Delhi and Bangalore campuses are comparable with the best in the world.

Within a very short span of time, telecom switching products ideally suited to Indian conditions started revolutionizing rural telecommunication in India in the form of small Rural Automatic Exchanges (RAXs) and medium size switches as SBMs for towns. This was followed by induction of higher capacity digital switches known as Main Automatic Exchanges (MAXs). C-DOT technology spread across the length and breadth of the country through its licensed manufacturers with very strong technology transfer methodology.

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Nearly 50% of present fixed line infrastructure, after allowing MNCs entry into the Telecom Market is from C-DOT technology and that in itself is a testimony to the Centre achieving its objectives fully. That C-DOT engineers have been striving to add value through regular up gradation to the fixed line infrastructure is a tribute to the commitment of C-DOTians to the original cause.

Beginning the journey with digital switching systems, C-DOT has transversed the complex Telecom landscape, developing products in the area of optical, satellite and wireless communication from circuit switching technology of yester years, C-DOT has proven its expertise in ATM and Next Generation Networks. From a purely hardware development Centre it has diversified into development of Telecom software solutions like IN, NMS, Data Clearing House etc. and has journeyed from a protected environment of closed market to an open and competitive market.

While developing the RAX/MAX digital switches, C-DOT also evolved processes and procedures for manufacturing the switches in the Indian Telecom Factories and facilitated setting up of a strong Indian Manufacturing and quality vendor base. Comprehensive methods for transfer of the Digital Switching Technology were evolved for smooth transfer of the R&D products. C-DOT's pool of talented engineers are sought after by many Telecom companies, including MNCs for the valuable expertise they gain by working on cutting edge technologies in the state-of-art laboratories of C-DOT. Over the years, C-DOT has come to be looked upon as a Centre of Excellence in Telecom; projects of National importance, such as Central Monitoring Systems for Telecom Security, are entrusted to C-DOT, by the Indian Government.

C-DOT has evolved, from a single mission oriented organization to an R&D centre, working on several important, cutting edge technologies. And, with the support it has been receiving from the Government, especially in Projects of National Importance, the Centre will strive to maintain its National relevance.

Organisation Category

"Centre for Development of Telematics" is a registered society (No. S/14839 of 1984) under the SOCIETIES REGISTRATION ACT, XXI of 1860.

Administrative Ministry

"Govt. of India, Ministry of Communication and Information Technology, Department of Telecommunications.

The management of C-DOT has a three-tier structure:

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The Governing Council	The Steering Committee Ring Committee	The Project Board
provides policy guidelines and approves the annual budget of the Centre.	has the role of reviewing and monitoring the performance of the Centre.	is responsible for the implementation of C-DOT's Projects and the day-to-day function of the Centre.

Manufacturing

C-DOT has already transferred the following technologies to various manufacturers.

Product/Technology	No. of Manufacturers
265P RAX - Rural Automatic Exchange	14 (List)
SBM RAX	12 (List)
DSS MAX - **Digital Swtiching Systems Main Automatic Exchange**	12 (List)
NSE -	11 (List)
IVRS -	11 (List)
ATM - **ATM Core Switch, Multiplexers and Interfaces.**	1 (List)
TDMA-PMP - **Time Division Multiple Access- Point-to-Multi-Point**	6 (List)
ISD –16 VSAT -	2 (List)
256 AN RAX - **Access Node Rural Automatic Exchange**	8 (List)
HDSL Modem -	3 (List)
Enhanced IVRS (EVC) -	4 (List)
CSTM-1 -	3 (List)
IDR VSAT -	1 (List)
STM1-CPE -	1 (List)

11.6 TELECOM COMMISSION

The Telecom Commission was set up by the Government of India vide Notification dated 11th April, 1989 with administrative and financial powers of the Government of India to deal with various aspects of Telecommunications. The Commission consists of a Chairman, four full time members, who are ex-officio Secretary to the Government of India in the Department

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of Telecommunications and four part time members who are the Secretaries to the Government of India of the concerned Departments. The composition of the Commission is as follows:-

Designation	Name
Chairman	Shri P.J.Thomas
Member(Finance)	Smt. Vijayalakshmy K. Gupta
Member(Production)	
Member(Services)	Shri S. C. Misra
Member(Technology)	Shri Chandra Prakash

The part time Members of Telecom Commission are

1. Secretary (Department of Information Technology)
2. Secretary (Finance)
3. Secretary (Planning Commission) and
4. Secretary (Industrial Policy & Promotion).

The Telecom Commission and the Department of Telecommunications are responsible for policy formulation, licensing, wireless spectrum management, administrative monitoring of PSUs, research and development and standardization/validation of equipment etc. The multi-pronged strategies followed by the Telecom Commission have not only transformed the very structure of this sector but have motivated all the partners to contribute in accelerating the growth of the sector.

SUMMARY

- BEL are committed to consistently deliver enhanced value to our customers, through continual improvement of our products and processes.
- Bharat Electronics adopted the Total Quality Management (TQM) philosophy in the year 1990 under the acronym 'TORQUE' which stands for Total Organisational Quality Enhancement.
- The company has achieved the level of 'Commendation for Strong Commitment to Excel' and is striving to reach higher levels of excellence under the Model.
- A Quality Institute has been created in 1999 by the company to impart education / training to the company's officers, customers and suppliers on various facets of quality management.

- The Centre for Development of Telematics (C-DOT) is the Telecom Technology development centre of the Government of India. It was established in August 1984 as an autonomous body.

REVIEW QUESTIONS

1. Discuss the Organizations of BEL, C-DOT and Telecom commision of india.
2. Explain the telecom commission.
3. Differentiate between the quality assurance facilities and bharat electronics quality institution.
4. Discuss about the introduction of TQM.
5. Describe the thrust areas of TORQUE.
6. What is quality policy? Explain in details.
7. Know about the evolution of quality management system in bharat electronics.

CHAPTER 12 MOBILIZING THE RESOURCES FOR EXPENSION

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★ STRUCTURE ★

12.0 Learning Objectives
12.1 Introduction
12.2 Issues and Challenges Faced by the Industry
12.3 Opportunities for the Industry
- *Summary*
- *Review Questions*

12.0 LEARNING OBJECTIVES

After going through this chapter, you will be able to:

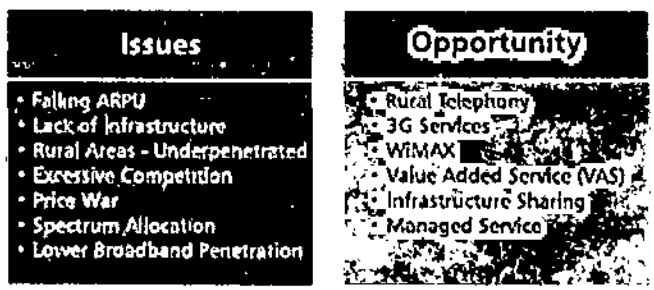
- differentiate between the organization category and administrative minister.
- explain the centre for development of telecomatics (C-Dot).
- know about the resources and investments.
- define the research and development.
- discuss about the business excellence and standardisation.
- describe the bharat electronics quality institute.

12.1 INTRODUCTION

The Indian telecom industry has come a long way since its liberalisation era. The industry has witnessed exponential growth especially in the wireless segment in the last few years. The plethora of telecom services evolved over the years, ranging from basic telephony to voice, video and data services, Wimax, WLAN and VPN, and bandwidth on demand to virtual private networks have catalysed revolutionary changes in the business operations for the service sector, i.e., IT, BPO and also the manufacturing sectors etc, besides providing millions of people access to new technology.

Even though the sector has reflected promising growth, the teledensity in India still remains at a very low level compared with international standards and thus providing tremendous opportunity for future growth. In the medium-term, the industry is expected to continue to record good subscriber growth as a result of low penetration levels, heightened competition; a sustained fall in minimum subscription cost and tariff that increase affordability for lower-income rural users, expansion of coverage area by mobile operators, and government support through schemes such as the rural infrastructure roll out funded by subsidies from the Universal Service Obligation (USO) Fund. The Indian telecom sector offers unprecedented opportunities in various areas, such as rural telephony, 3G, virtual private network, value-added services, et al. Nonetheless, the lack of telecom infrastructure in rural areas and falling ARPU of telecom service providers could inhibit the future growth of the industry.

Exhibit 5.1: Major Issues & Opportunities



Source: D&B Research

Fig. 12.1: Major issues and opportunities

12.2 ISSUES AND CHALLENGES FACED BY THE INDUSTRY

Rapidly Falling ARPU

The competitive intensity in the telecom industry in India is one of the highest in the world and has lead to sustained fall in realisation for the service providers. Intense competitive pressure and cut throat pricing has resulted in declining ARPUs. With increasing number of new entrants in the telecom space the competitive intensity is likely to continue, putting further downward pressures on the telecom tariffs. Thus, the telecom companies might have to grapple with further decline in ARPUs, going forward.

Further, with the telecom companies moving their focus to the rural areas for driving the future subscriber growth they might not witness a commensurate increase in revenues. In fact, the risk of steep decline in ARPUs will increase going forward as the telecom companies penetrate rural markets that are characterised by higher concentration of low-income, low-usage customers. A higher-than-expected decline in ARPU poses a risk of reduction in margins of service providers. Alternatively, telecom operators are turning their focus to steadily increasing the minutes of usage (MoU) to counter the sustained fall in ARPUs. Likewise, the growth of the VAS is also crucial for some improvement in the ARPUs of operators.

Lack of Telecom Infrastructure

Lack of telecom infrastructure in semi-rural and rural areas could be one of the major hindrances in tapping the huge rural potential market, going forward. The service providers have to incur a huge initial fixed cost to enter rural service areas. Further, as many rural areas in India lack basic infrastructure such as road and power, developing telecom infrastructure in these areas involve greater logistical risks and also extend the time taken to roll out telecom services. The lack of trained personnel in the rural area to operate and maintain the cellular infrastructure, especially passive infrastructure such as towers, is also seen as a hurdle for extending telecom services to the under penetrated rural areas.

Rural Areas Continue to Remain Under Penetrated

A rural teledensity of merely 15% point towards the fact that a majority of Indian population still do not have access to telecom services. The rural India seems to have remained untouched by the telecom revolution witnessed in the last few years. A huge 'digital divide', which is reflected by the enormous difference of 74% between the urban and rural teledensity, reiterates this fact.

However, with the urban markets reaching a saturation point, the telecom service providers are penetrating rural areas for driving future growth. Thus, the service providers entering new rural markets might witness substantial increase in subscriber base. The expansion in the rural areas, however, has increased the risk of further decline in the ARPUs. Nonetheless the revenue growth from these regions is unlikely to match the surge in the subscriber base.

Excessive Competition

Another major concern that has come to the forefront in the recent past has been heightened competitive intensity in the industry that has correspondingly fuelled the price war between industry players.

The Indian wireless market is one of the world's most competitive markets, with 12 operators across 23 wireless 'circles' and 6 to 8 competing operators in each circle. The auction of new 3G licences and the introduction of mobile number portability (MNP) are likely to heat up competition in the industry, going forward.

Spectrum is the most important resource that is required for providing mobile services. Given that spectrum is a finite resource, the availability of the same would be inversely proportional to the number of operators. Thus, larger the number of service providers smaller will be the amount of spectrum available to each of them.

Scarcity of spectrum leads to higher capex on deployment of mobile networks for the operators as they need more cell sites to improve service quality. Further the growing usage of spectrum and the resultant scarcity may lead to re-use of spectrum and increase chances of congestion in networks leading to constraints on service quality.

Evidently, the competition in the industry is expected to intensify further with the entry of new players, both domestic as well as foreign players. With the competitive intensity of the industry already at such high levels new operators might find it difficult to gather significant share in Indian telecom market. While the new players may benefit from a faster network rollout through tower sharing, they will face challenges in terms of high subscriber acquisition costs and lower ARPU customers.

Price War Between the Service Providers Putting Pressure on Margins

The ever-increasing competitive intensity in the sector, with licenses and spectrum in several circles allotted to newer operators, is also a concern and could lead to unrealistic pricing levels to grab subscribers. The pricing strategy of per second billing already has taken the price war between telecom operators to the next level. The intensifying price war could put significant downward pressure on the industry revenue growth. Further, the ongoing price war and the concomitant decline in telecom traffic could raise the entry barrier for new companies.

Spectrum Allocation

3G Spectrum availability is one of the major concerns for the industry. Lack of adequate spectrum which is the most integral part of the mobile telephony sector could hamper its growth severely. However, the spectrum allotment has been the most controversial issues in the Indian telecom sector.

The smooth process of scheduled 3G and BWA spectrum allocation is likely to be one of the key factors affecting the industry dynamics, going forward. Given the highly-competitive nature of the Indian telecom industry on one hand, and limited licenses in the 3G network on the other, the risk of excessive biding by the service providers has increased. Irrational bidding, especially in some circles, might render 3G services financially-unviable. Further, there exists a risk of delay in allotment of proposed spectrum to the service providers who have successfully bid for the 3G spectrum.

Regulatory Charges

The regulatory charges in the telecom sector have a complicated structure because multiple levies impede the smooth implementation of telecom projects in India. Given the continuously-declining ARPUs, and the extremely-low tariffs, sustianing the current growth rates of the industry requires urgent attention towards rationalising the convoluted tax structure in the sector.

Table 12.1: Structure of Regulatory Charges

Regulatory Charges	Service Tax	License Fee	Spectrum Charges	USO
% age of revenue	12, 36%	6% to 10%	2% to 6%	5% included in license fees

TRAI has recommended to the DoT committee to phase out the multiple levies in this sector with a single levy in a phased manner. Further with regard to license fees, which currently stand at 6%-10% of total revenue, TRAI has suggested that it be reduced at a uniform rate of 6% across all licences.

Lower Broadband Penetration

The Indian economy remains highly underpenetrated in terms of broadband connections. High cost of devices (PC and laptop), high internet charges and lower wireline connections have been some of the major factors inhibiting broadband penetration. Broadband is one of the key catalysts for economic development and major initiatives by both the government and service providers are needed to increase its penetration.

Other Growth Inhabiting Factors

While the implementation of mobile number portability is likely to aid improvements in quality of service, it is also likely to increase the churn out ratio significantly. The service providers are likely to turn to the VAS as a service differentiator; however, widespread VAS deployment is restricted due to language and illiteracy.

The deployment of 3G services is likely to help the emergence of new VAS. Mass acceptance will be crucial for the success of 3G services in India. Comparatively higher cost of handsets required for accessing

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3G services is likely to be one of the major roadblocks in mass 3G adoption in India.

12.3 OPPORTUNITIES FOR THE INDUSTRY

Rural Telephony – Connecting the Real India

With the urban markets fast reaching their saturation points for telecom services, especially the voice telephony services, the vast rural market holds a huge potential to drive the future growth of the telecom companies. In fact, the teledensity in rural areas is just about 15%, which reflects the extent of opportunity left untapped for telecom companies, going forward. Further, the government initiatives for increasing telecom connectivity in rural areas are also likely to aid the telecom service providers to extend their services in the unconnected rural areas. Initiatives such as USO Fund and infrastructure sharing would be instrumental in increasing the coverage of telecom services in the far-flung areas. Penetration in rural areas will not only support the growth of telecom service providers but also boost demand for equipment and telecom infrastructure.

3G Services – Potential Growth Driver

Currently the 3G deployment in India is at a very nascent stage. In fact, 3G services have been launched very recently (February 2009) in India. The 3G services will be instrumental in stimulating future growth of the telecom industry. The 3G services will not only facilitate business through provision of high-speed data and content rich services but also will play a pivotal role in bridging the urban-rural divide by facilitating faster mobile deployment in rural areas. Introduction of 3G will be beneficial to the Indian BPO industry by increasing their competitiveness. In India, where mobile cellular penetration is much higher than that of fixed telephone lines (nearly 30 mobile cellular subscriptions per 100 inhabitants as compared with less than 4 fixed telephone lines per 100 inhabitants in 2008), mobile broadband through 3G will drive broadband penetration. The inherent benefits of economies of scale and faster time to market of 3G services will benefit service providers. The high-end customers may get attracted to these services and provide a first-mover advantage to the initial entrants in the 3G space. The launch of 3G is also likely to facilitate introduction of various VAS such as video calling, gaming, high-speed Internet access and other data services, which in turn might provide some support to the falling ARPU.

The Indian government has planned to sell the spectrum for 3G services through an auction and thereby create a competitive environment that offers better services to consumers. Auction of 3G and broadband spectrum will be done through e-auctioning which shall be executed by a specialised agency to ensure transparency in the selection process. Bids would be invited from domestic, as well as foreign players. New players would also be allowed to bid which in turn is likely to usher technology innovation, increase competition, lead to prompt roll out of services and provide more choices to customers at competitive prices.

With the allotment of the 3G spectrum, the pressure on the 2G spectrum is likely to ease especially in the heavy traffic areas. Moreover, freeing 2G bandwidth might help the operators to cater to additional subscribers without significant additional investments. Given the comparatively high cost of handsets and 3G services, the deployment of 3G services is likely to be limited to high-end customers. Thus, initially the 3G spectrum is expected to be used for voice services, whereby the wireless subscribers might experience improvement in service quality. Going forward, the 3G spectrum is expected to attract major investments and open new growth avenues for the telecom sector.

Worldwide Interoperability for Microwave Access (WiMAX) – Reaching the Last Mile

In the wireless communication arena, WiMAX technology has emerged as one of the most significant developments. Deployment of WiMAX would not only enable the provision of high-speed internet services through high bandwidth spectrum but also prove to be a useful mode of communication in inaccessible terrains. WiMAX could be used as an alternative to cable and DSL for providing broadband access in rural areas and hence could be a major factor driving the growth of Indian telecom services, especially the wireless services. Moreover, it is likely to facilitate the propagation of the e-governance services such as telemedicine, e-learning et al through broadband, particularly in the rural areas. Given the fact that WiMax deployment does not require significant resources, it will also be an economically-feasible option to cater to rural communication needs.

Mobile Value Added Service (MVAS) – An Opportunity to Increase the ARPU

The value added services segment is rapidly emerging as a potential revenue generator for the telecom services industry. Given that a substantial part (around 60%) of the total VAS revenue goes into the kitty of the service providers, the development of this segment is likely to offer them an opportunity to support their falling ARPU. The increasing acceptance and usage of mobile commerce services is also likely to boost the VAS segment. Mobile banking is likely to emerge as a major

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growth driver in the near future given the issuance of M-banking guidelines (June 30, 2008) issued by the RBI and increasing demand for this service.

The demand for new VAS services is likely to surge given that increasing number of younger generation has started using mobile services and are more inclined to adopt the VAS services. With the implementation of mobile number portability, the service providers would be encouraged to constantly develop new VAS as a service differentiator and retain their existing customers and attract new ones. The introduction of the Next Generation Networks would help in bringing down the cost and roll out time of new MVAS and provide impetus to the growth of the VAS, going forward. Further, with reduction in prices of the feature rich handsets capable of accessing many of the VAS services the demand for the MVAS is set to increase in the future.

Infrastructure Sharing – A Profitable Proposition

The rapid expansion in subscriber base has brought to the fore the challenge of increasing and upgrading the telecom infrastructure to maintain quality of services. In the recent years, infrastructure sharing has emerged as a profitable proposition for both the parties involved, as for the tenant it lowers capex and opex, and for the owners, it is an additional source to earn revenue. It would lead to considerable reduction in initial set-up costs for new service providers and existing service providers planning to enter new service areas. Infrastructure sharing might assist the service providers to reduce their operating costs. The cost saving through infrastructure sharing could be passed on to the customers thereby augmenting their affordability. Further, with infrastructure sharing, the companies can reduce the time required to roll out the telecom services in the rural areas. The sharing of telecom infrastructure by companies could lead to optimum utilisation of these resources and thereby improve efficiency.

A step forward in infrastructure sharing is the proposal of TRAI to include those rural and remote areas in its purview that are not covered by wireless signals with assistance from the USO Fund.

Managed Service – Outsourcing in Telecom

Managed Services typically involve the outsourcing of a specific technical function or capability to a Managed Service Provider (MSP). It is an alternative to in-house management or traditional outsourcing since firms/enterprises do not have to transfer complete control over assets/operations to the MSP but rather can contract or outsource specific management challenges for a shorter period of time.

With the rapidly-growing subscriber base, managing infrastructure and networks is becoming increasingly difficult for the service providers.

Therefore, many service providers have been outsourcing their infrastructure or network management operations completely or partially. Given the increasing demand for the managed services, the telecom equipment vendors could have an opportunity to take up more roles in the value chain by entering into managed service contracts.

Managed Services are fast-emerging as an attractive proposition for many enterprises that do not want to dedicate human resources and capital toward acquiring and administering technology infrastructure. It also allows the telecom service providers to focus on their core activities, to develop new and innovative products and services so as to distinguish themselves from other players in this highly-competitive market.

The service providers can gain significantly in terms of cost reduction and improved efficiency in operations from the economies of scale that an MSP can offer.

Opportunities in Other Service Segments

Investing in technologies such as NGN, 3G, WiMAX, is likely to open up new frontiers of business. Some services such as IPTV, VPN etc. are expected to gain some momentum in the medium to long run.

Virtual Private Network (VPN) – Create Your Community

Virtual Private Network, also known as closed user group (CUG), is a private data network that provides connectivity within closed user groups via public telecommunication infrastructure. The option is less expensive as it relies on sharing of public infrastructure. This service was first availed in India by corporate units that required VPN services to connect to their branch offices.

IPTV

Internet protocol television (IPTV) also referred as 'triple play' offers internet, television and telephone services on a single platform. IPTV provides the telecom service providers an opportunity to widen the gamut of existing services and is likely to be beneficial for large players in the telecom sector. Given the lower broadband penetration, the usage of IPTV is likely to be restricted to metros and some urban centres.

The Indian mobile subscriber base is likely to sustain the rapid growth recorded in the past few years. Presence of skilled labour pool, improving telecom infrastructure, favourable demographics, rising disposable incomes of consumers, declining tariffs, increasing demand, growing attraction for mobiles with new features and greater availability of handsets at lower prices, are expected to continue driving the growth of the telecom sector, going forward.

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However, the companies are likely to encounter a more challenging business environment in the near future, given the sustained fall in ARPUs, rapidly increasing competition and consequent pressure on margins and regulatory risks. Companies with good rural coverage, better operational efficiency, and superior quality of service are likely to stay ahead of competitors.

The government has proposed to achieve a rural tele-density of 25% by deploying 200 mn-connections at the end of the Eleventh Five Year Plan, given that more than 70% of the population lives in villages. The optimum utilisation of USO fund and increase in mobile services might help the government attain this goal. The government's thrust on welfare programmes such as community development, education and health and rural connectivity can also be facilitated through satellite communications, internet connections et al. Besides, broadband connections for all gram panchayats and public healthcare centres, secondary and higher secondary schools and provision of 3G services to all cities/towns with more than 0.1 mn population is also likely to be achieved during the Eleventh Five Year Plan. It is also visualised to link block headquarters and the nearest exchange through the State-Wide Area Networks (SWAN) connectivity. Major initiatives such as e-Agriculture, e-Health, e-Education, rural BPOs are slated to increase internet penetration as they set the base for increasing acceptance of the same.

During the Eleventh Five Year Plan period, ₹ 2,670 bn worth of investments are projected to be made in the telecom industry and the public sector is expected to have a 33.50% share in the same, while the private sector is expected to contribute 66.50%. Further, a total of 650 mn connections (including 66 mn wired and 584 mn wireless connections) are expected to be achieved by the end of 2012. The growth process in this ever-evolving sector needs to be backed by a strong R&D support. The active participation of the private sector in R&D would ensure greater benefits for the sector. Further, the government also envisions making India a hub for telephone equipment manufacturing that is expected to be achieved through telecom specific special economic zones (SEZs) and by setting up Export Promotion Council to promote export of telephone equipment and services.

SUMMARY

- The Indian telecom industry has come a long way since its liberalisation era. The industry has witnessed exponential growth especially in the wireless segment in the last few years.
- The ever-increasing competitive intensity in the sector, with licenses and spectrum in several circles allotted to newer operators, is

also a concern and could lead to unrealistic pricing levels to grab subscribers.

- While the implementation of mobile number portability is likely to aid improvements in quality of service, it is also likely to increase the churn out ratio significantly.
- The value added services segment is rapidly emerging as a potential revenue generator for the telecom services industry.
- The rapid expansion in subscriber base has brought to the fore the challenge of increasing and upgrading the telecom infrastructure to maintain quality of services.

REVIEW QUESTIONS

1. Discuss the Major issues and opportunities of telecom industry in India.
2. Explain the price war between the service providers putting pressure on margins.
3. Differentiate between the spectrum allocation and regulatory charges.
4. Discuss about the opportunities in other service segment.
5. Describe the state-wide area networks (SWAN).
6. Define the opportunities for the industry.