CHAPTER 1

CURRENT PRACTICE AND EVOLUTION

SALAH AIDAROUS

The development of Internet protocol (IP) and its applications during the last decade make it one of the technological breakthroughs that will shape the new century. Its wide application possibilities make it attractive for service providers and their customers. However, its deployment faces challenges that need more attention from the academic community as well as industry. This chapter and the ones that follow address potential opportunities that IP-based networks and applications offer, and the challenges facing their deployment.

1.1 INTRODUCTION

IP-based technology trends and their impact on the evolution of networking (e.g., traffic value, expenditures) have changed the perception of the industry. Service providers are looking for new opportunities by moving their current environment to databased networking. At the same time, they are faced with the challenge of interworking with the current legacy environment. Manufacturers are responding to these requirements by introducing new technologies at the core and access networks.

Traditionally, a basic network consists of an access telephone switch connected to each subscriber by a dedicated wire pair (metallic loop). These switches, within a geographic area, in the incumbent local exchange carrier (ILEC) or the competitive local exchange carrier (CLEC), are interconnected to provide local calling. They are connected through points of presence (POP) to various interexchange carriers (IECs). The long-distance network can be a flat or hierarchal-based mesh. In a flat network, every switch is connected to every other switch directly, with calls arriving into the network at an originating switch and leaving

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the network at a terminating switch based on the dialed number. In this arrangement there are only two long-distance switches involved in the call. In the hierarchal-based mesh, a hierarchy switches exist where a call enters the network and traverse over four to five intermediate switches, depending on the originating and terminating locations.

This chapter provides the requirements of IP-based service management (what needs to be managed, management objectives, management applications). It discusses present opportunities and challenges in managing the resultant infrastructure. An overview of the book is given.

1.2 EVOLUTION OF NETWORK ARCHITECTURES

No one can ignore the current important role of IP-based networks and services in the business community, and the expectations the industry has build on the opportunities that will be available in the future. With the current growth of the electronic business (eBusiness) coupled with the phenomenal growth of wireless access, the move toward the electronic society (eSociety) is happening at a fast rate.

Public networks (voice) and data networks have been following different philosophies in their architecture and operations. Public networks have been conceived according to a connection (circuit switching) model, with guaranteed quality of service (QoS) and availability (7/24). This requires an operational model that satisfies the real-time and related requirements for voice. Voice is an important application that drives the business of a service provider. In general, subscribers are expected and ready to pay for using the network for either local or long-distance calls. On the other hand, transmitting data over public networks does not attract the same revenue as voice.

Since deregulation of the local network, this can be either ILEC or CLEC. Both serve a determined geographical area, and are connected to each other to provide local calling. They are also connected through POP sites to various IECs. Networks, as shown in Figure 1.1, consist of switches and transmission facilities that process and connect the calls.

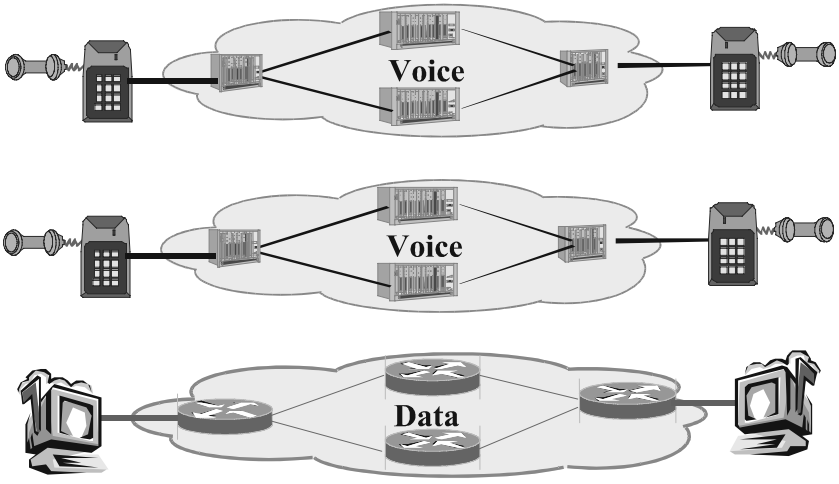

Figure 1.1 Public versus data networks.

IP-based networks followed a connectionless model (packet networks) with best-effort philosophy, which does not maintain the real-time requirements, and mainly satisfies data requirements (accuracy). The main focus was on voice over IP (VoIP) telephony, which was perceived as one of the main drivers for IP.

IPs best-effort philosophy is not optimally designed for voice conversation. Thus, the QoS, reliability and performance can't be guaranteed. There are a lot of basic telephony functions that need to be supported by IP-based networks. For example, dial tone, tone or pulse dial signals, ringing, busy signals, timeout signals, manual flash signals, automatic number identification, answering and disconnect supervision.

1.3 TECHNOLOGY BREAKTHROUGH

One of the major reasons for the time-division multiplexing (TDM) technology is the efficient utilization of costly transmission resources. With fiber and dense-wavelength division multiplexing (DWDM) technology, this constraint is no longer valid. Service providers have gone through massive deployment of fiber in their networks, even to the extent that they have highly underutilized backbone networks. In other words, the cost of bandwidth was not an issue.

Figure 1.2 shows how the future network is based on the technology advancement of IP-based equipment. There are number of factors that cause packet delay in such a network:

1. Transmission link
2. Multiplexing buffer
3. Processing
4. Switching
5. Routing
6. Coding

Subjective voice quality is very sensitive to the total round-trip delay and should be held to a minimum (not to exceed 200 ms). Total delay also impacts the use of echo cancellers and their specifications. On the other hand, as shown in Figure 1.3, the advancements in data networking technology from superrouters to photonic routers and ultimately

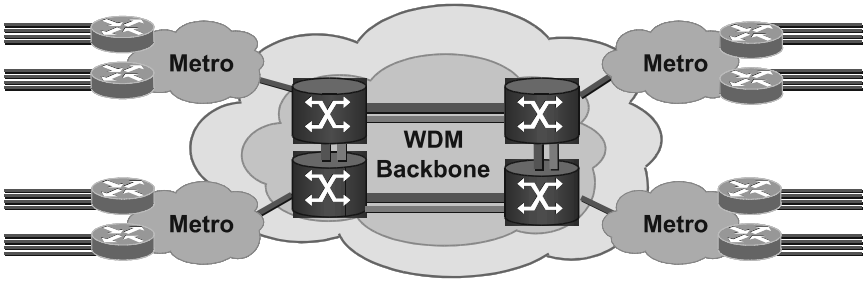

Figure 1.2 Next generation non-TDM world.

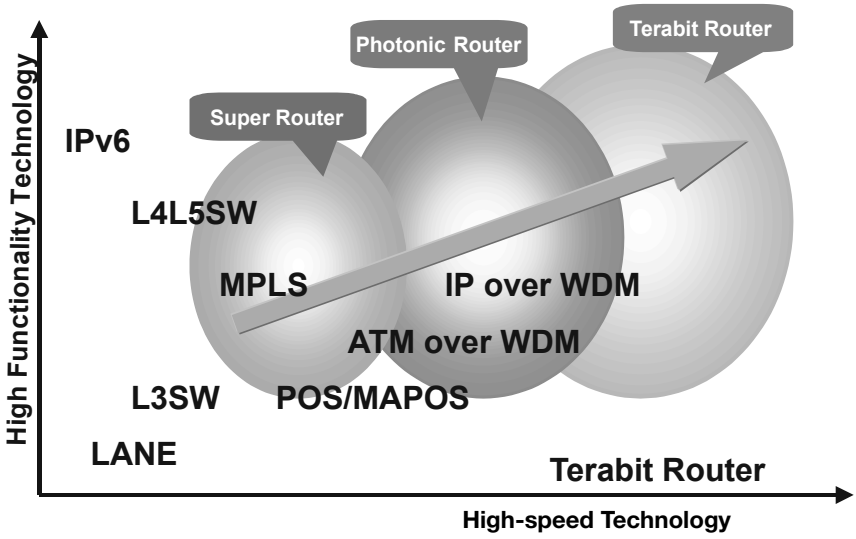

Figure 1.3 Evolution of data networks technology.

to terabit routers will handle many of these issues. This has been driven by the evolution of DWDM and switching technology.

1.4 IP MANAGEMENT CHALLENGES

The traditional business model has been influenced by the scarcity of resources and use by service providers. When bandwidth became available, the business model shifted to customer QoS and relationship management. It is clear that generating revenue was the main business objective of Internet service providers (ISPs). With the current downturn in the telecom industry, that has changed to survivability of the ISP.

Network management has been evolving in the public network over the last two decades. With the declining cost of technology and the rising cost of software, it became clear to service providers that capital is no longer a major decision in operating the network. Expense to operate and maintain, this capital is the key factor for successful business. This has not been the case for IP-based networks (e.g., Internet), where less attention was given to end-to-end network management.

Examining the current status of IP-based networks, there are many major challenges facing service providers in their operations and management. Figure 1.4 is a simplified representation of the major operations and management function needed to provide and maintain services to the service providers' customers.

It is clear that business objectives and marketing activities associated with IP are well developed. There is a good buy-in by the market and industry to the importance of IP-based networks and services.

In the network design area, there are many activities that address the issues of congestion, performance, reliability, QoS, charging, provisioning, security, and maintenance. One critical issue is the lack of a model of the user base and load factors. For example,

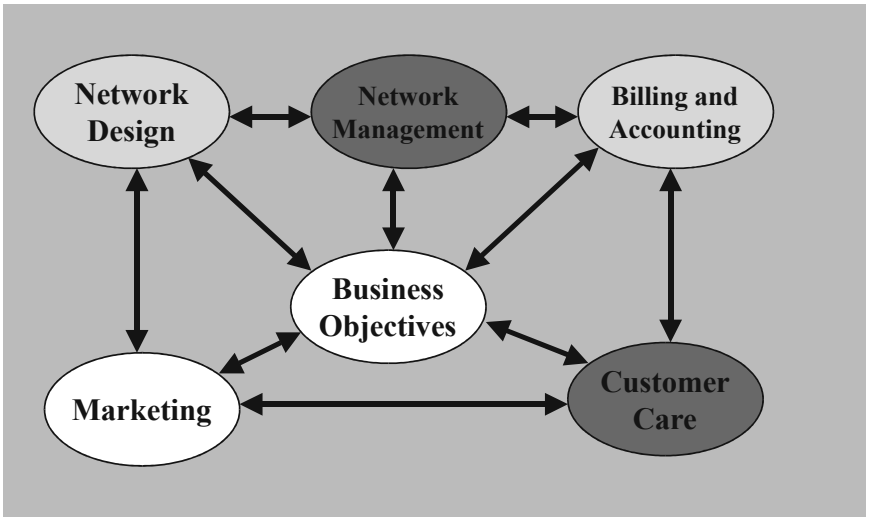

Figure 1.4 Operations and management processes.

traffic control is static in IP but dynamic in the public switched telephone network (PSTN). Measurement criteria, monitoring, and maintenance tools are needed to support QoS and reaction to traffic flow. Classes of QoS and guaranteed minimum performance of network delivery provided traffic parameters need to be offered. Security of information over IP networks is critical from an eBusiness perspective. Security of access jeopardizes the ability of the ISP to provide service.

Billing for packet-based services is an area that started to get more attention in the last years. Both ISPs and SPs are looking for a mechanism for billing for IP-based services. There is no agreement on time, bandwidth, throughput, or flat-rate billing, among others. However, there are several tools for collecting an IP data record (IPDR).

Customer care does not exist in the overall picture of IP networks. It took the public network over 10 years since divestiture to realize the importance of customer care as a survivability issue for their business. It should be expected that IP-based networks should not follow the same strategy. Customer care should be considered at an early stage!

Network-management functions have been receiving less attention and the industry started to realize their importance in sustaining a successful business model for the IP-based network and services. Availability, performance, QoS, and reliability are hard to measure and to guarantee.

1.5 IP/PSTN INTEGRATION

IP interconnection to the PSTN requires that computer hardware and software emulate the PSTN signaling and transmission functions in such a way that the customer can make a call without noticing any difference in that function or in the quality. This will require that signaling conversion, echo cancellation, and other service features are supported by the IP-based part of the network. One big challenge that is facing the industry is the evolution of the current infrastructure to the required IP-based one.

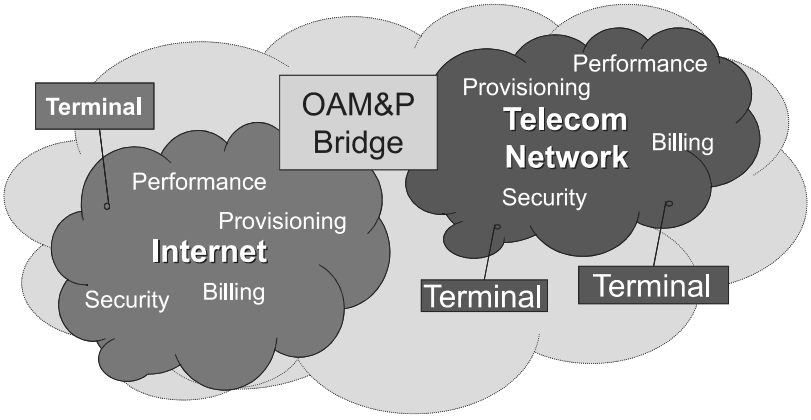

Figure 1.5 Internet and PSTN convergence.

Figure 1.5 shows an interworking approach rather than the replacement approach, which was dominant for many years. The main reason to the interworking approach is the desire of service providers to preserve their current network investment and avoid any major expansion to their capital.

Interconnection to the PSTN requires that the IP network emulate the transmission and signaling characteristics in such a way that a user can make a call to the PSTN, and neither end can notice any difference in the quality of function and transmission. This will require that the operation, administration, maintenance, and provisioning (OAM&P) bridge provides the proper data protocol conversions (for voice, signaling, and echo cancellation) to achieve a satisfactory service.

Interconnected IP to PSTN has to support both residential and business customers. Each uses a wide range of services. There is a need to support the interworking of ISDN, SS7, H.323, for example. Customers may have significant investments in customer-provided equipment (CPE) to interconnect to the various services with standard serial and parallel interfaces which will need to be connected or rerouted to IP transport equipment. This may require reengineering and/or replacement in order to work with IP transport equipment.

1.6 SUMMARY

This chapter and the book itself describe how IP-based networks and applications can be used to create opportunities to enable services of value to the user. After summarizing these opportunities, it is clear that more work needs to be done in QoS for IP services that include end-to-end real-time requirements (e.g., VoIP), eBusiness, security of access and applications, performance of applications, and network reliability. Billing is another area that needs to be considered. The evolution of IP-based networks is also considered, along with current developments in optical technology.