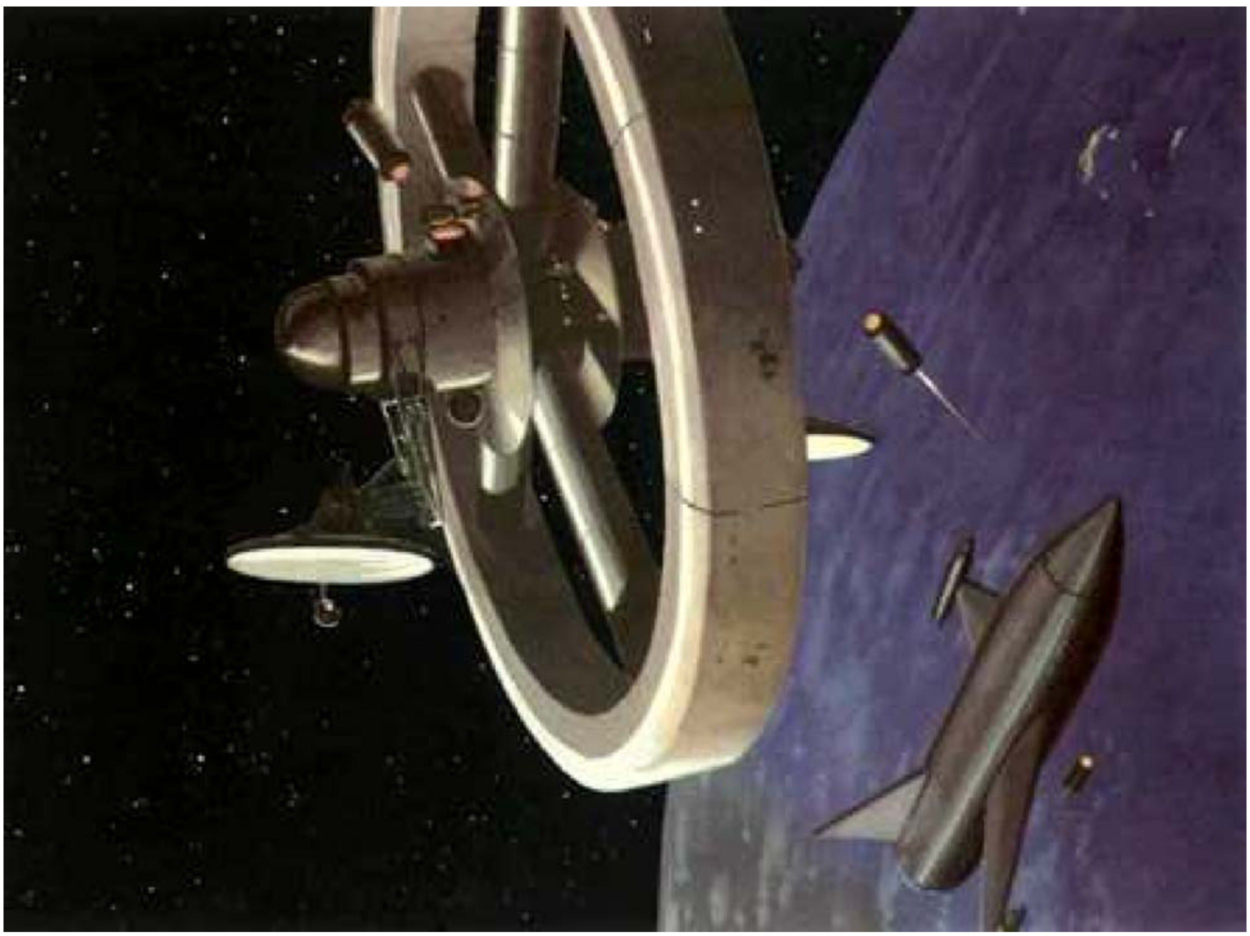
Telecom 2020: Transformation Strategies

Transformation strategies that carriers will follow as they adopt IP and Ethernet architectures for their wireline and wireless networks and services and how these strategies will transform their businesses and the industry as a whole.

The telecom industry is committed to the full scale adoption of IP and Ethernet and the replacement of the legacy voice and data technologies. The industry will have to generate profits with increasing traffic volumes by improving its efficiency through the simplification of services and networks and through the adoption of low cost technologies. This will result in new partnerships and new forms of industry consolidation in order to fully exploit the opportunities that will result from this transformation.



TelecomView

Author: Bob Larribeau Principal Analyst

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Author: Bob Larribeau Principal Analyst

Published by TelecomView
+1 415 259 5452
www.telecomview.info

info@telecomview.info

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1 Overview of Key Trends

The most important trend in the telecom industry is simplification - simplification of both services and networks. Simplification will make communications services easier for the providers to offer and easier for their customers to understand and use. The simplification of networks will include the consolidation of separate networks that provide similar services. With many carriers, this will include the consolidation of wireless and wireline services and networks.

Operators must simplify their networks to achieve the networking efficiencies needed to meet the huge growth in traffic expected in the coming decade. The cost of delivering such traffic must also become far cheaper. These are tough requirements but at least represent a known challenge; the services and business models that operators must embrace are less clear cut.

Until now, services and networks have been built around technologies. Frame relay technology was introduced and a frame relay network was built. ATM technology was introduced and an ATM network was built. In the wireless world, 2G, 3G, and 4G networks have been (or will be) built around 2G, 3G, and 4G technologies. Managing all of these networks is difficult and expensive for the service provider. Choosing among them can be complex and confusing for the customer. It has not been possible to mask the technologies from the users. Business users clearly want to be aware of them. Consumers may need to change handsets to move from one access technology to another as they select new services.

It is now clear that IP and Ethernet are the fundamental networking technologies that will unify operator networks. IP has become the common technology for voice, data, video, and multimedia communications. IP is also the fundamental technology for switching and routing on backbone networks. Carrier Ethernet has become the standard for traffic aggregation and service delivery at the edge of these large IP networks. These networking technologies will be used over all physical technologies, including Dense Wave Division Multiplexing (DWDM) for long distance optical transmission and Orthogonal Frequency Division Multiplexing (OFDM) in wireless networks.

1.1 Continuing Traffic Growth

One fundamental assumption of this study is that network traffic will continue to grow over the next decade at a similar rate as this and the previous decade. Network traffic has been doubling roughly every two years. This has had a profound impact on networks. By 2000 the amount of data traffic exceeded the amount of voice traffic in communications networks in the United States. Today voice traffic is only a small part of the overall traffic mix.

Early this decade, web traffic and email traffic were dominant. They were replaced by peer-to-peer traffic as Internet music distribution became popular. Today user-generated video is dominating networks, at least the backbone networks. It seems clear that in the next few years Telco IPTV traffic will come to dominate the metro networks, driven by demand for personalized rather than broadcast content.

It is never clear what the next major source of network traffic will be, but this doubling rate has been unabated for nearly 15 years. There is every reason to think that it will continue. Supporting this growth of network traffic must be a major part of any operator's future network plans.

There are two important implications of traffic growth between now and 2020:

- The traffic on these networks will increase by a factor of 100.
- The cost of delivering each Gbps of traffic will decrease by a factor of 100.

Since network revenues are not likely to grow significantly over this time, the cost of delivering each Gbps of traffic will have to decrease by the same factor that it increases over this period. This will permit the carriers to maintain or even improve their profitability. The combination of these two factors will be the major concern of network planners during the next decade.

1.2 IP for data, voice, and video

The dominance of IP for data application now seems to have been preordained. In the early part of the 1990s, ATM was expected to become the next switching technology to dominate telecom networks. ATM had the advantage that it could provide the Quality of Service (QoS) required for voice and video applications. At that time, it was well understood how to build ATM networks that would support these multimedia services, but it was not clear how to do it with IP.

By 2000, the cost of switching using IP technology dropped to levels significantly below the level of ATM networks due to the introduction of IP interfaces that could operate at much higher speeds than ATM interfaces. Because of this, pure IP backbones became the standard architecture by 2000 and ATM was eliminated. These IP backbones have continued to grow since then and there seems to be no end to this trend.

The acceptance of the PC as the fundamental end device in enterprise networks accelerated the conversion to IP. Before the 1990s, most enterprise networks were based on terminals that used proprietary protocols and architectures, especially SNA from IBM. These proprietary terminal networks evolved to use proprietary Local Area Network (LAN) technologies, such as IBM's Token Ring.

The growth of PCs with their inexpensive Ethernet interfaces along with strong support for IP and Ethernet became a major factor leading to the dominance of IP throughout the 1990s. Support from the major PC operating system companies Microsoft and Apple made IP the obvious choice for the new generation of PC-based enterprise applications. This was a direct result of the growing popularity of the IP-based Internet. Everybody wanted to use the Internet. Consumer and business users all had a strong need to access the Internet.

IP Virtual Private Network (VPN) technologies were also developed that provided enterprises the ability to create private IP networks that sat on top of a public IP network. IP VPNs provided similar capabilities to Frame Relay and ATM VPNs that became a popular alternative to the leased line networks that predominated before 1990. However, the IP VPNs supported higher speeds at lower cost and integrated more easily with the public Internet.

Today ATM, frame relay, and the proprietary data communications schemes have fallen to the side. IP now dominates. QoS technologies and network design techniques have been developed that provide good voice and video quality over IP networks. There is nothing on the horizon that is likely to replace IP as the fundamental networking technology.

1.3 Ethernet and Fiber for Service Delivery

The popularity of Ethernet has grown hand-in-hand with the popularity of IP. The physical media has evolved from coaxial cable buses and twisted pair hubs that provided a shared media operating at 10 Mbps or 100 Mbps. It is now implemented with dedicated switched links to both twisted pair and fiber optic switches at speeds of 100 Mbps to 1 Gbps. Switched optical Ethernet switches now provide 1 Gbps to 10 Gbps. The latest versions of switched Ethernet will operate at 40 Gbps or 100 Gbps.

Ethernet started in the early 1980s as a technology to provide high-speed services for creating networks within an enterprise building. Ethernet quickly became the leading technology that supported the majority of PCs or workstations. This created a large population of Ethernet connected devices, which drove the cost of Ethernet technology to much lower levels than the SONET/SDH commonly in use by carriers at the time.

The development of switched fiber-based Ethernet extended the range of Ethernet links from 100 meters to between 10 and 100 kilometers, depending on the optical interfaces used. By 2000 competitive carriers formed that offered 1 Gbps Ethernet-based metro networking services. As the cost of Ethernet decreased and as its performance increased, the major incumbent carriers started to deploy Ethernet networks to support both consumer broadband and business IP networks.

Ethernet has two fundamental advantages. The first, and most important, is its low cost. This makes possible Ethernet-based services at lower prices than other services and technologies – a convincing argument.

Ethernet's second advantage is nearly as important as its low cost. Ethernet is a natural technology to carry IP traffic. It could provide much higher performance than frame relay and did not suffer from the "ATM tax" that came from the inefficiencies of mapping IP packets into small ATM cells.

After this start as a carrier service technology, Ethernet has been enhanced to handle more customer networks and to handle more end points using multiprotocol label switching (MPLS) and virtual private LAN service (VPLS) technologies that improve its ability to scale and manage traffic.

Consequently, Ethernet has become the standard network technology for delivering IP traffic from the edge of large IP backbone networks to both consumer and enterprise customers. There is no new technology on the horizon set to replace Ethernet for this application. It is also likely that Ethernet will become the standard technology for carrying wireless traffic from the cell stations to the backbone networks.

1.4 IP Packet for Wireless

The wireless networks have undergone major development during the last 30 years. Wireless services were introduced in the 1980s using proprietary analog technology. The switch to digital came in the 1990s with second generation (2G) digital technologies. The primary 2G technologies, GSM and CDMA, supported voice services at their introduction using legacy voice switching in their back end. Both of these technologies evolved to add relatively low-speed data capabilities after 2000 and are the dominant wireless technologies today. These 2G networks are capable of providing very good services but are limited in their ability to support data applications.

Third generation technologies (3G) were developed in the early part of this decade and began their deployment in 2003. The data speeds offered by these 3G networks have been improved so that 3G networks now offer downstream speeds in excess of 500 Kbps.

In spite of the improvement in data speeds that come with 3G networks, several issues remain. First, 3G networks are still tied to legacy voice technology and do not support voice over IP (VoIP). Second, their data network architecture is highly centralized, which limits performance due to the latency that this approach introduces. Third, new radio technologies have emerged that can make major further improvements in the data performance of mobile networks.

Work is now going on to define the fourth generation (4G) of mobile technology, which will use new radio technologies to support speeds of several megabits per second. It will incorporate VoIP technology and move away from legacy voice technology. It will also implement a flat IP network structure that will significantly improve network latency. This flat network will add the IP routing function at the base station level and eliminate centralized routing. This will improve latency because the base station will be able to route packets directly to their destination rather than sending them to a centralized router that may be hundreds or even thousands of miles away.

Today there is some debate over whether or not to invest in 4G technology. 3G technology is also adopting VoIP and flat IP architectures to eliminate those limitations. This will permit the 3G network operators to improve the performance of their networks and may delay the introduction of 4G technologies.

Data traffic is growing at a rapid rate on mobile networks (as it is on wireline networks). It seems inevitable that the growing needs for higher speed and more efficient data services will push mobile operators to 4G technologies. There is no reason to assume that the growth rate of data traffic on wireless networks will slacken over the next decade.

1.5 IP and Ethernet for Transport

The carriers' move to digital transport technology in the 1980s optimized their ability to carry legacy voice traffic. Their networks were organized around the 64 Kbps channel that carried an individual voice connection and enabled their aggregation into larger and larger channels. North America adopted the SONET hierarchy and Europe adopted the SDH hierarchy. Both approaches allowed carriers to bundle 64 Kbps voice channels into high-speed channels that ranged from 150 Mbps to 2.5 Gbps. The capacity of these high-speed channels later grew to 10 Gbps and 40 Gbps.

This approach worked well as long as the primary traffic on these transport networks was legacy voice. However, explosive growth of the Internet and IP networks in the 1990s and beyond has resulted in IP data traffic dominating transport networks. This created a mismatch. While the SONET and SDH approaches are very efficient for legacy voice, they are much less efficient for IP packet traffic.

The most efficient approach for IP packet traffic is to put all of the bandwidth into a single channel. This approach takes full advantage of the statistical multiplexing capabilities of packet networks and eliminates the need to carry individual 64 Kbps channels. Carrying these individual voice channels adds to cost without bringing value to an IP network.

Optical transport systems are now available that used Ethernet packet formats rather than SONET or SDH. These systems bring significant economies to IP packet-based communications and will be the basis of future transport networks.

Ethernet is becoming the only technology that will provides speeds of 100 Gbps or higher. SONET/SDH supports 40 Gbps today, but there are no plans to extend it beyond that. This means that the 100 Gbps transport networks that will be built during the next decade will be based on Ethernet technology.

1.6 Green Telecom for Carbon Reduction

The energy required for communications networks has been estimated by the Climate Group to be 2 percent of the global total. However, this energy use is increasing, especially in developing and emerging countries. The rapid expansion of mobile wireless services has made a significant contribution to this increase.

Service providers are making energy reduction an important priority. This is particularly true in Europe, where carriers have defined specific goals for energy reduction over time. The system vendors are responding to this requirement with significant energy reductions in their next generation wireless and wireline systems.

Much of this energy use is in the access networks. The new generations of access systems are significantly reducing their energy requirements, especially 4G wireless systems and fiber-to-the-home systems.

2 Telecom 2020 Strategies

All telecom companies must understand how the transformation of the industry that will take place between now and 2020. They must define technology, produce, service and business strategies during the next decade that maintain if not increase their success. This will require each company to assess where the industry is going and what they can contribute to this transformation.

2.1 System Company Strategies

The important trends that will occur over the next decade are already evident today. They include the adoption IP networking, fiber, and 4G technologies. The trends toward content services and the evolution from service bundling to service integration are also clear.

IP and Ethernet technologies will continue to evolve and increase in performance. A new generation of fiber access systems will appear based on 10 Gbps or DWDM that will support 1,000 or more subscribers on a single fiber. 4G technologies will deliver a broadband experience over a wireless connection.

These trends have important implications for network architectures and for business strategies. Optical systems will take a stronger role in future networks. The traffic on these networks will grow by a factor of 100 while the cost per Gbps of delivered bandwidth will decrease by a factor of 100. These changes will have significant impact on the back office systems that support the new services.

The problem that every company faces is how to maintain its current business while it gets the products ready that it will need for Telecom 2020 networks and services. Defining a vision for 2020 is a key part of this process. This vision should be monitored and modified as new trends become apparent. This vision will provide a context for evaluating whether decisions made will have short-term or long-term impact.

Each company will need to define its own approach. The size of the company, its financial condition, and the markets that it serves are all important factors. The rest of this section discusses strategies for three classes of companies to show how individual strategies might be developed.

All of the system companies that serve carriers will need to develop products that evolve to support Telecom 2020 services and networks. These products should be able to support new technologies and provide improved performance and capacity by swapping modules rather than swapping entire systems. Wireless products should provide the flexibility to support 2G, 3G, or 4G services based on changing software rather than hardware. Service providers will be much more likely to select products that fit their strategic plans.

2.2 Service Provider Strategies

The evolution to the service and network strategies proposed in this report will proceed differently for each carrier. The path taken will depend on the current state of the carrier's network and on the requirements of the markets that it serves. It will be a difficult path for operators in their established territories but will be easier for operators building out new networks where they can use an Telecom 2020 strategy from the start.

This section discusses evolution strategies for operators in North America, though the discussion is generally applicable to operators in Western Europe and developed countries in Asia as well. Other strategies will be followed in developing countries where there will be a much higher reliance on wireless services and on basic voice and data services rather than on advanced services.

The changes in networks and services discussed in this report may require service providers to make fundamental changes in their businesses such. The organizations that build and operate services may be separated from the organizations that build and operate networks. Major new organizations that manage content may be created separately from the services and network organizations. AT&T has already moved in this direction by including both its wireline and wireless consumer services to a common organization and creating a separate network organization responsible for its networks. New ways of thinking will be required for success in this environment.

Partnerships will be an important factor in building the portfolio of products and services that will be required by 2020. Even the largest service providers in the U.S. will not be able to provide a full set of services on a national basis. Small wireline providers will need to partner with larger companies to add wireless services to their portfolios. Large wireless companies will need partners if they are to provide wireline broadband services across their full wireless service footprint.

These trends may also result in mergers and acquisition of carriers. New business combinations may be required to provide the services described in this report as a result of the integration of services and networks.

2.3 The Wild Cards

While the basic direction of carrier technologies is well understood, there are many aspects of future networks that remain unclear. There is consensus that the future will be IP and fiber-based, but difficult questions remain about business models and services.

It is always hard to predict the next hot Internet application. Most to date have been surprises. Similarly, many applications expected to be important fizzled. This will certainly continue; however, while it is near impossible to guess the next hot application, the assumption that Internet traffic will continue to double every couple of years is much less risky.

It is also difficult to predict how service providers will build their networks, that is, which facilities they will build themselves and which facilities they will lease from wholesale carriers. Some of these decisions will be made on a business case basis and other will be based on how services are structured.

In reading this report, it is important to keep this uncertainty in mind.

3 Telecom2020: Transformation Strategies

The ***Telecom 2020: Transformation Strategies*** report expands on these themes. As shown in the following table of contents. This report discusses:

- How services will converge across technologies and networks. Users will be able to subscribe to a single service that covers wireline, wireless, voice, and data.
- How service providers will become major content providers and are likely to become content producers as well.
- How home and business networks will change and how service providers will take an important role in the management of these networks.
- How networks will change and how the metro networks will change, to accommodate ever increasing loads of TV and video traffic.
- How VoIP will become the fundamental technology for delivering wireless and wireline voice services.
- How back office systems will change to support a much more dynamic service deployment environment.
- The important regulatory issues that will determine the rate at which carriers can move to a Telecom 2020 architecture.
- The importance of green technologies in the evolution of the telecom industry.
- Profiles of six service providers that have already adopted important parts of a Telecom 2020 strategy.
- Strategies for systems companies and carriers as they evolve to 2020.

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Glossary

The following terms and organizations have been referred to in the text.

Acronym	Definition
API	Application Program Interface
ARPU	Average Revenue per User (Usually monthly)
ATV	Asia Television Limited
Billion	1,000,000,000 (1,000 Million)
BRAS	Broadband Remote Access Server
BT	British Telecom
CAPEX	Capital Expenditure
CNO	Cable Network Operator (See also MSO)
CPE	Customer Premise Equipment
CPGA	Cost per gross add
DSL	Digital Subscriber Line
ETSI	European Telecommunications Standards Institute
EU	European Union
FCC	Federal Communications Commission
FNO	Fixed Network Operator
GHz	Giga Hertz
HD	High Definition
Hz	Hertz
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
INO	Integrated Network Operator
IP	Internet Protocol
IP v 6	IP version 6
IP/MPLS	IP/ Multi Protocol Label Switching
IPTV	Internet Protocol TeleVision
ISP	Internet Service Provider
ITU	International Telecommunications Union
kbps	Kilo bits per second
KDDI	Japanese Mobile Operator
kHz	Kilo Hertz
km	Kilometer
kW	Kilowatt
LLU	Local Loop Unbundling
Mbps	Mega bits per second
MHz	Mega Hertz
Million	1,000,000
MPEG	Moving Picture Experts Group
MPLS	MultiProtocol Label Switching
MSO	Multimedia Services Operator (See also CNO)
MTV	Music Television
NGN	Next Generation Networks
NPV	Net Present Value

Acronym	Definition
NPVR	Network Personal Video Recorder
NRA	National Regulatory Authority
NTT	Nippon Telegraph and Telephone Corporation
OPEX	Operating Expenditure
OSS/BSS	Operational Support System/Billing Support System
PATS	Publicly Available Telephone Service
PBX	Private Branch Exchange
PCCW	Pacific Century CyberWorks Limited
PDA	Personal Digital Assistant
PSTN	Public Switched Telephone Network
PTT	See PoC
PVR	Personal Video Recorder
QoE	Quality of Experience
QoS	Quality of Service
SDH	Synchronous Digital Hierarchy
SHE	Super HeadEnd
SIP	Session Initiation Protocol
SMS	Short Message Service
SONET	Synchronous Optical NETworking
SS7	Signaling System 7
TE	Traffic Engineering
TISPAN	See ETSI
TV	Television
UK	United Kingdom
US	United States
VHO	Video Hub Office
VLAN	Virtual Local Area Network
VoD	Video on Demand
VoIP	Voice over Internet Protocol
VPLS	Virtual Private LAN System
VPN	Virtual Private Network
VSO	Video Serving Office
WACC	Weighted Average Cost of Capital
WAN	Wide Area Network

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