

# Maximizing the Profitability of Connectivity Services

## Acronyms

<b>3G</b>	Third Generation
<b>ATM</b>	Asynchronous Transfer Mode
<b>BGP</b>	Border Gateway Protocol
<b>CAPEX</b>	Capital Expenditure
<b>DSL</b>	Digital Subscriber Line
<b>DWDM</b>	Dense WDM
<b>EITO</b>	European Information Technology Observatory
<b>FR</b>	Frame Relay
<b>GDP</b>	Gross Domestic Product
<b>ICT</b>	Information and Communications Technology
<b>IETF</b>	Internet Engineering Task Force
<b>IP</b>	Internet Protocol
<b>IT</b>	Information Technology
<b>L2</b>	Layer 2
<b>L3</b>	Layer 3
<b>LAN</b>	Local Area Network
<b>LAN-IC</b>	LAN Inter-Connection
<b>LL</b>	Leased Line
<b>MAC</b>	Media Access Control
<b>MPLS</b>	Multi Protocol Label Switching
<b>OPEX</b>	Operating Expenditure
<b>QoS</b>	Quality of Service
<b>RFC</b>	Request for Comments
<b>SDH</b>	Synchronous Digital Hierarchy
<b>TDM</b>	Time Division Multiplexing
<b>VAS</b>	Value Added Services
<b>VLAN</b>	Virtual LAN
<b>VPLS</b>	Virtual Private LAN Service
<b>VPN</b>	Virtual Private Network
<b>WDM</b>	Wavelength Division Multiplexing

**T**his paper discusses the current and future network investment strategies for service provider connectivity networks. Existing connectivity services such as leased lines are an attractive profit source, however any investment strategy must support future profit generation from a new generation of connectivity services and various value added applications running on top of the connectivity layer.

## Investment dilemma of service providers

Despite the slowing economy and the collapse of the “get-rich-quick” dotcom industry, Internet traffic is still growing at an amazing rate, which doubles the traffic every one to two years. The one fact that may have been lost amid the dotcom gloom is that the Internet is a massive success.

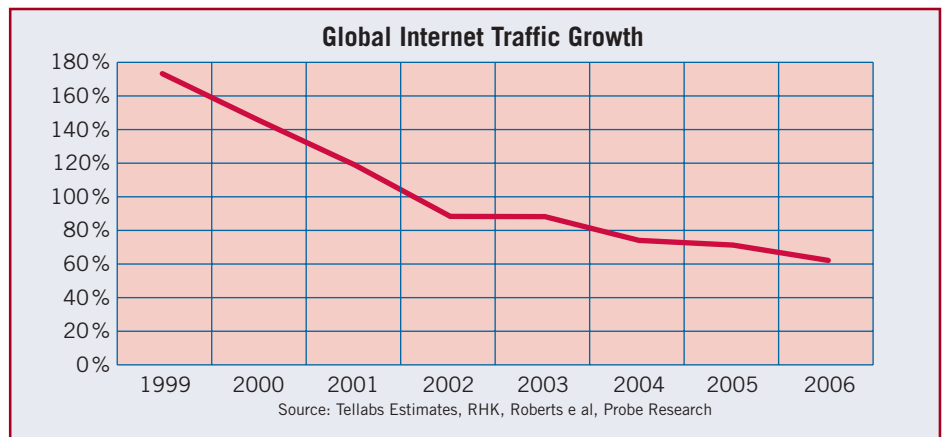


Figure 1: Global Internet Traffic Growth

Concurrent with this massive and continuing growth, enterprise users are slowly but surely migrating towards the use of web-based IP networked applications, which doubles the amount of traffic in corporate networks every two to four years (estimate is based on observing actual traffic in a number of business services access networks).

At present though, service provider revenues are not growing at anywhere near the same rate as traffic. According to the European Information Technology Observatory 2002 (EITO 2002), which is an ICT market monitoring body supported by the European Commission and the OECD, Internet revenues in Western Europe grew by 30% from 2000 to 2001. At the same time IP traffic is estimated to have grown over 100%. Worse still for service

providers, revenue per bit is falling more rapidly than the cost per bit of providing a connectivity service. Service providers have little choice but to meet the demand for traffic growth and so have to invest in new infrastructure, yet the falling revenue per bit and climbing cost per bit is destroying their return on investment. Similar problems of declining revenue per bit exist in all data services, and voice services — the core revenue on which many service providers were built and still rely — are also experiencing a decline in revenue per minute. The whole problem is compounded by the lack of available capital due to the depressed stock of most telecoms, IT and particularly Internet-related companies. What is needed is an investment strategy that allows service providers to maximise their profitability in the long term.

## Where do future service provider profits come from?

Today service provider's overall revenue is still dominated by legacy TDM voice services, but there is no growth left in these services and in 2000 data overtook voice as the larger proportion of global traffic. The only real growth driver for fixed-line voice traffic is dial-up Internet access, which will slowly disappear as customers migrate to broadband. Growth areas today are Internet, mobile telephony and switched data services.

The traditional billing model for carrier services has been very simple: either phone call minutes or the amount of provisioned bandwidth. The recent rapid declines in the price per bit and per minute are signs of the need for a fundamental change in this business model. The ability of service providers to generate profits with their traditional values, phone call minutes and data bandwidth, is eroding. To protect their long-term profitability they have to look at new revenue models and higher value services.

**Carrier Retail Services in Western Europe**

Source: EIT02002. MEUR	1999	2000	2001	99/00	00/01
Fixed Network telephone services	111,667	111,361	109,633	-0.30%	-1.60%
Mobile Telephone Services	58,686	76,462	92,527	30.30%	21.00%
Switched data services	5,325	6,217	7,391	16.80%	18.90%
Leased line services	6,410	6,199	5,929	-3.30%	-4.30%
Internet and online services	9,474	15,152	20,140	59.90%	32.90%
CaTV services	7,383	8,453	9,554	14.50%	13.00%
Carrier services total	198,945	223,844	245,175	12.50%	9.50%

Figure 2: Carrier Retail Service Revenues in Western Europe

The convergence of Information and Communications technologies is one of the most important mega-trends impacting the future of telecommunications service providers. According to EITO2002 the total ICT services market in Western Europe was € 379 billion in 2001 (Carrier services alone were € 245 billion). The latest EITO forecast from October 2002 predicts, that despite the current economic downturn the combined ICT services market will grow 4%–5% per year in 2002 and 2003. There is every reason to believe that this growth has strong long-term fundamentals, as ICT solutions have been proven to improve the productivity of enterprise business processes. Actually economic problems drive enterprises to rationalize their operation, which often means outsourcing and growing use of ICT services.

As information and communications technologies converge there are both opportunities and threats for communications service providers as both they and the IT service providers chase a larger slice of this new larger pie.

The Internet is seen as the most likely fabric for the next-generation of converged ICT services. Examples of these might be hosting, e-commerce systems, e-learning services, content delivery, e-conferencing, storage, application delivery, remote access, multimedia messaging and security. These services also need not be confined to enterprises — consumers will also be looking for various forms of multimedia entertainment services. Even voice telephony will become just another ICT application in the very long term.

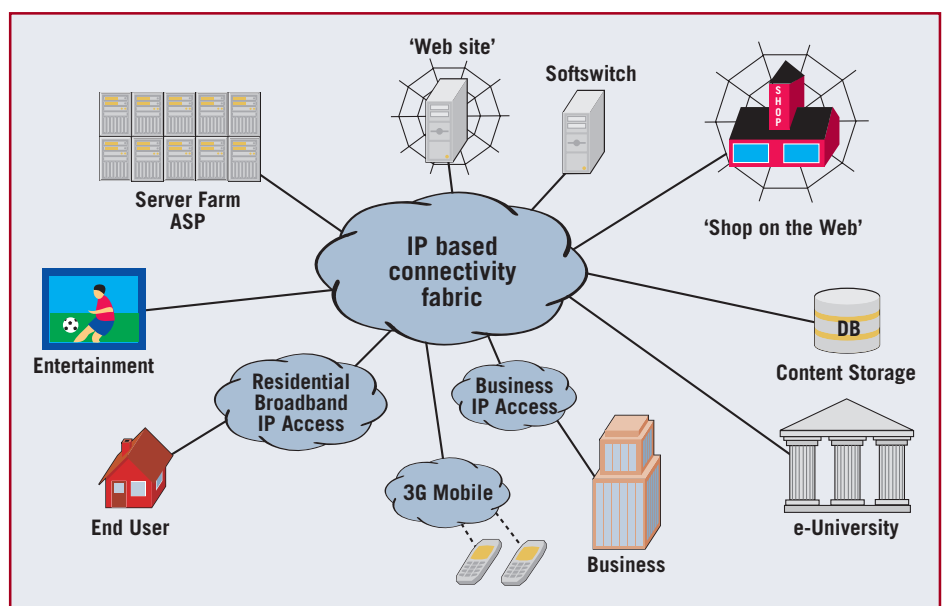


Figure 3: Converged ICT Service Creation Environment

The converged ICT service creation environment can be divided to three layers:

- Value Added Services Layer
- IP Connectivity Layer
- SDH/DWDM Transport Layer

End users need connectivity services, which give them access to the IP fabric (Internet Access) and which allow them to interconnect their Local Area Networks (LAN-IC). The IP fabric has both private and public parts. In the context of the enterprise, the private part means the internal LAN and the external part means the public Internet. In the context of the service provider the private part means its own Autonomous System and the public part means other Autonomous Systems.

All of the value-added services can be accessed using any form of connection including dial-up, DSL, cable modems, wireless and direct optical access.

Naturally the available access bandwidth may limit the use of some services. The value-added services are provided using server computers or maybe even specialised hardware like video servers. The key to economies of scale is that all the value-added services use the same IP fabric for connectivity. They do not have separate service-specific connectivity networks. The computing hardware will be based on bulk standard products, but

the software applications will be highly specialised for each particular service.

Internet Protocol (IP) is the enabler of the converged ICT service creation environment. The best strategy for service providers is to position themselves as significant Internet players with rational and long-term focused investments in a constantly growing IP network. The desired economies of scale can only be achieved in an open environment, where competition among a large number of value-added service providers creates a compelling service offering for the end users. This requires a change from the current network-centric closed and controlled architecture of the telecommunications network. Service providers have to facilitate this change, because the current model of selling voice minutes and bandwidth pipes clearly will not provide long-term profit growth. Value-added ICT services are the most promising additional profit source for service providers.

The ICT infrastructure is also a key strategic resource for any national economy. The state owned operators will be under direct pressure from national governments to support advanced ICT services and also other operators will get this pressure via government regulations. Even though converged ICT services are clearly the most promising long-term profit source, the short-term profit view of incumbent operators does not always

support investments in advanced services. However, from a national point of view an advanced ICT infrastructure is a clear competitive advantage in the global economy and any rational regulator will do its best to accelerate the availability of the required communications infrastructure.

Examples of new profit opportunities for service providers, in addition to selling voice minutes and bandwidth pipes, are total communications solutions for enterprise customers, connectivity fees from other value-added service providers and participation in value-added service creation. The key to maximising the profit potential of a service provider's infrastructure is a flexible, high-capacity IP network, which is content and destination aware, and which has the capability to provide variable QoS to allow tiered services. Of course it must also do all this at a minimal cost per bit. The rapid growth of IP traffic means that the connectivity infrastructure has to be constantly expanded. Therefore it is crucial for service provider profitability that they strike the right balance between the cost and the capabilities of the infrastructure.

## The Evolution of IP technology — Introduction of MPLS

The fundamental capabilities of IP networks are currently going through a change. A new protocol, Multi Protocol Label Switching (MPLS), has been introduced to the IP protocol family. The emerging capabilities of MPLS will allow IP networks to provide QoS, predictability and reliability similar to the legacy SDH and ATM networks. MPLS based QoS and protection capabilities are currently getting close to being standardised in the IETF, and interoperable production implementations from multiple vendors can be expected in one to two years time. The MPLS forwarding plane specification has already been stable and set for a long time, which means that new capabilities can be introduced with software upgrades without the need to replace hardware, assuming that the hardware was initially designed with these capabilities in mind. It should be kept in mind that the majority of the existing, installed base of IP routers were not designed for QoS and thus cannot be upgraded to support it.

In addition to its QoS capabilities, MPLS also enables IP networks to deliver new types of connectivity services. Two types of MPLS-based connectivity services are currently being standardised. The first

provides routed IP connectivity between multiple customer sites. From the customer's point of view the service provider network looks like a single large virtual IP router. This type of IP/MPLS based service is called a Layer 3 VPN (Figure 4). The public standards for providing Layer 3 VPNs are already relatively mature and interoperable multi-vendor implementations are now becoming available. The emerging industry standard for Layer 3 VPNs is the BGP/MPLS-based VPN mechanism. The specification for BGP/MPLS VPNs can be expected to reach RFC (IETF standards/recommendations are called RFCs) status within the next year.

Emerging IETF standards also provide very scalable solutions that enable IP/MPLS networks to offer native support for Ethernet services. These services are called Layer 2 VPN services (Figure 4). A simple VLAN/Ethernet point-to-point service is already very close to standardisation and interoperable multi-vendor implementations will be available shortly. Also a fully MAC-switched Ethernet service, called VPLS or Virtual Private LAN Service, is being standardised in the IETF and the first standards can be expected in one to two years time with standards-based multi-vendor deployments following within a year after that.

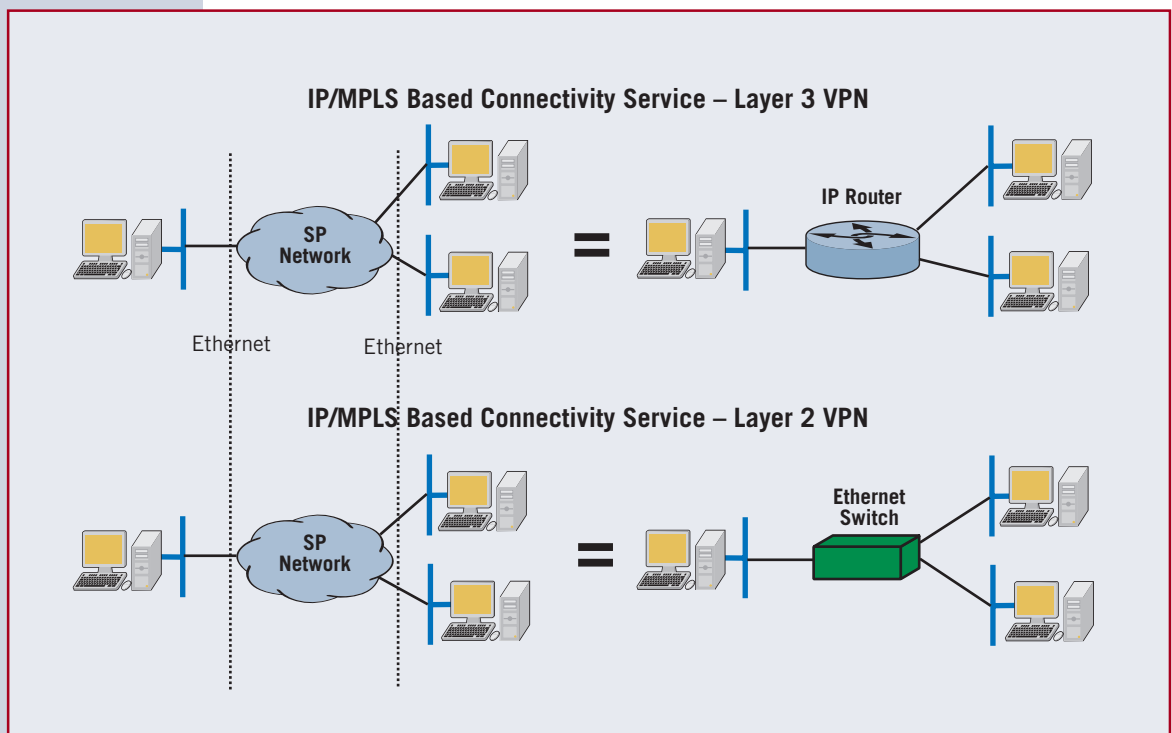


Figure 4: IP/MPLS Based Connectivity Services

One might think that the most native network for Ethernet services would be an Ethernet network. But on closer examination, it turns out that the Ethernet protocols have been designed for use in smaller LANs and do not scale to meet the needs of large service provider networks. IP/MPLS-based mechanisms are the preferred way of improving the scalability of switched Ethernet services. Pure Ethernet can be used at the edges of the network, but the core switching should be carried out by IP/MPLS. In addition to switched Ethernet services, point-to-point Ethernet leased lines are an attractive service and are most cost-efficiently provisioned using the SDH infrastructure.

## Today's network architecture

As stated above, the volume of data traffic in public networks has exceeded the volume of voice, and in a couple of years data will completely dominate the traffic mix. Therefore the connectivity layer of the public network needs to be optimised for data, even though voice will remain the most important revenue source for a long time.

Today operators typically have four separate large networks:

- TDM voice network for fixed and mobile voice services;
- SDH network for leased lines, bandwidth wholesale and general transport;
- IP network for Internet and other smaller IP services;
- ATM network to provide the core switching for Frame Relay services and to provide an access multiplexing solution for DSL and 3G mobile traffic.

Other data networks also exist (X.25 for example), but they are not important considerations in the future of networking.

Bandwidth wholesale is an important class of services, because it enables competition in the delivery of retail services to end-users. It should be noted that wholesale services (bandwidth, voice and IP wholesale) are excluded from the revenue numbers of Figure 2. Bandwidth wholesale Leased Lines provide a similar-sized revenue source for service providers as retail Leased Lines. Wholesale Leased Line revenues are still growing — if slowly — whereas retail leased line revenues are in decline as retail services migrate towards packet-switched wide-area solutions.

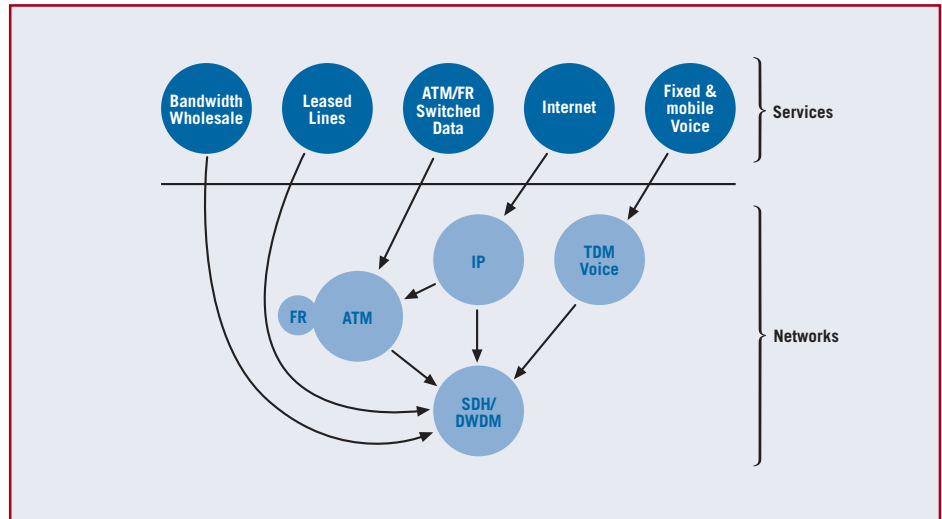


Figure 5: Today's communications services and networks

The IP and ATM packet/cell switched networks and the voice networks run on top of an SDH/DWDM transport network and are often therefore seen as overlay networks.

There are some deployments today with alternative architectures, for example where TDM voice is being transported over ATM. These systems have received significant media hype but the reality is that these deployments represent only a short-term fix for networks exhausted of capacity. The real long-term trend is towards using the IP network for packet-based voice switching.

## What is the way forward?

So far this article has raised a number of questions: If VoIP is the destination then what is the route? How should service providers evolve towards an IP-based ICT service creation environment? Is a converged network a way to save costs or should the service providers maintain multiple networks? Which of the existing networks can be eliminated and what is the substituting technology?

What makes the answers to these questions so critical is the current economic situation, which has slashed the capital available to service providers. Any investment now requires much greater scrutiny than just a few years ago.

Previously, many cost optimisation proposals were made based on introducing a new networking technology, which could support the old legacy services in addition to some new services and would reduce the need for many overlay networks. For example, during the '90s ATM was often positioned as a single network for all services. It seems logical that a single network for all services would reduce costs but this does not stand up to more detailed study. If the dominant end-user network architecture had been based on ATM, then ATM would have dominated the public network and would have indeed provided the lowest cost for a single network for all services. However, end-user data networks have converged to IP over Ethernet, and end-user voice networks have remained TDM-based. Thus the opportunity to converge to ATM has been lost. It should be noted that this is not to say that ATM is dead. In fact the opposite is true. Frame Relay services are growing at the moment, and ATM provides the core switching for Frame Relay. DSL is one of the most important consumer and small-business Internet access mechanisms and DSL-multiplexers are mostly ATM-based. The first 3G mobile radio access networks will also be ATM-based. FR together with DSL will keep ATM networks growing for a long time to come, but ATM is no longer expected to become the single convergence layer for public network services.

After a lot of hype around convergence, the connectivity fabric of most service providers still typically consists of two different overlay networks (ATM and IP) and the SDH/DWDM transport network (see Figure 5). There is a good reason for the existence of these three separate connectivity networks. Each network provides the most cost-efficient way of delivering its native services, and the combination of three networks has a lower total cost of ownership than trying to provide all connectivity services from one network. This shows that convergence for the sake of convergence does not make any sense. Trying to use a technology to provide services that it does not natively support, does not lead to cost savings. If you have paid for networks, and you can operate them profitably while meeting demand then you should not touch that network. A single next-generation-network is not desirable, even from an architectural perspective, simply for its own sake.

In the short term the best way forward is clearly to keep on investing in the existing network architectures and the existing services. Any kind of service portfolio change always requires up front investments, before the long term revenue increases and cost savings can be realised. This has meant putting major network changes on hold at the moment for most service providers.

Then again, nothing lasts forever, and even the current cash crunch for service providers will come to an end. This paragraph was written in September 2002. At this time some people were predicting that investment growth in telecom infrastructure will resume in late 2003 and others were saying that it will happen in 2004. Whoever is right, the only certain thing is that the communications business has healthy fundamentals. Ignoring the 1998 to 2000 “perfect storm” created by simultaneous market liberalisation, the mobile telephony revolution, crazy venture financing and the booming success of the Internet, the growth rate of the communications service business has historically been slightly above GDP growth. The healthy investment rate for communications service providers has historically been about 15 to 20 percent of revenue. It can be expected that in one or two years the communications business will return at least to the type of growth experienced before 1998.

When the investment budgets return in one to two years’ time, the key megatrends that should drive service provider’s connectivity infrastructure investment strategy are:

- Information and communications services are converging, and the Internet together with IP-based enterprise networks will form the fabric of the future ICT service

creation environment. The profitability of service providers depends on their ability to take a share in the converged ICT service revenue streams.

- All end user data networks are converging to an IP over Ethernet architecture. Enterprise internal voice networks will follow in a few years due to the low cost per bit in the corporate LAN. Public voice services will follow in the longer term.
- The fundamental connectivity services needed by end users are Internet access, Local Area Network Inter-Connection (LAN-IC) and voice communications. All other services will be ‘value-adds,’ built on top of these basic connectivity types. Examples of such ‘value adds’ are hosting services, e-commerce related services, e-learning related services, content services, e-conferencing services, storage services, application services, remote access services, multimedia messaging services, security services and multimedia entertainment services.

Figure 6 highlights the fundamental customer needs, current services and the current network architecture.

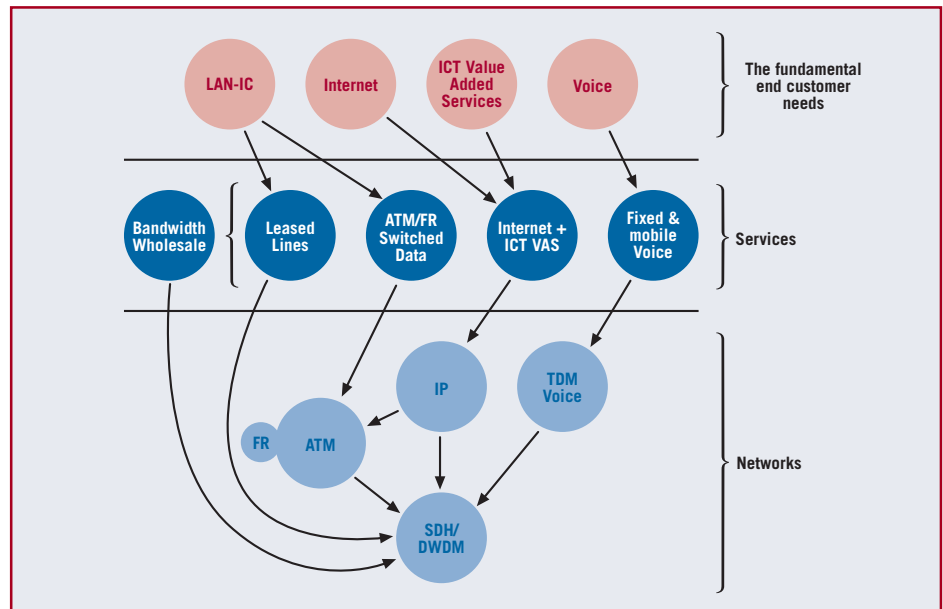


Figure 6: End customer needs, communication services and communication networks

The following more detailed facts also need to be taken into account when planning network strategy for the coming years:

- Data service revenues are growing more rapidly than voice service revenues.
- The revenue generation of voice networks is shifting towards wireless networks.
- An increasing share of traffic is IP. By the end of this decade more than 95% of all traffic in public network will be generated by an IP-based end user device.
- Internet traffic is doubling at least every one to two years, and LAN-IC traffic is doubling at least every two to four years.
- Growth of fixed-line voice traffic is in single digit percents per year — the traffic volume may even be declining.
- Data is becoming an important revenue source for wireless networks, and many future wireless data service concepts are based on Internet connectivity.
- At some point the ubiquity and low cost per bit of IP connectivity will justify migration from TDM voice networks to the use of VoIP in the public network. Voice transport will migrate first and voice switching will follow. This may take 7 to 12 years, but it will happen.

Given the facts listed above it is quite clear, that service provider's main investments need to be directed towards expanding the IP infrastructure. The most promising opportunities for convergence are where the IP network is able to replace some of the other networks in Figure 6.

The retail data services that today generate the highest revenue are Leased Line, Internet access, Frame Relay and ATM. The key enabler of a profitable path to network convergence is that the majority of traffic growth in Leased Line, Frame Relay and ATM services is in providing Internet access or LAN-IC. Since end customers have already converged to a single IP over Ethernet

data network architecture, the vast majority of growth is in natively packet-based, IP traffic. This traffic is not natively TDM, Frame Relay or ATM. Interfacing the end customer's IP over Ethernet network and the provider's TDM, Frame Relay or ATM service is both complex and expensive. Enabling the IP infrastructure to tap the available LAN-IC revenue streams would immediately open major new revenue potential for the IP infrastructure. This would also create a significant opportunity to rationalise the network infrastructure as many services could be provided from one network. The capabilities of MPLS are the key enablers of this type of convergence.

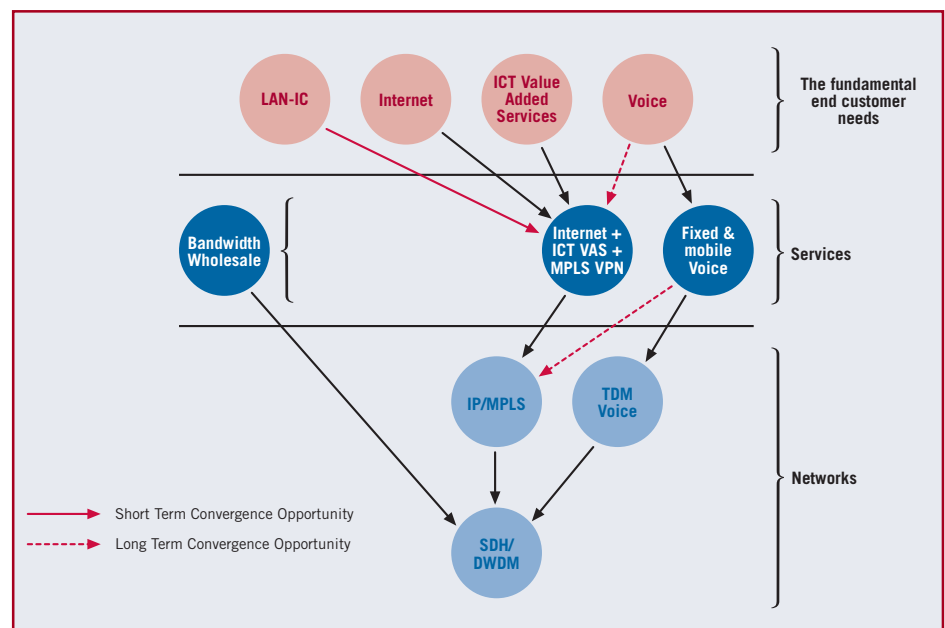


Figure 7: Profitable Network Convergence

The popularity of the LL, FR and ATM services is based on their quality of service, predictability and reliability. To satisfy customers currently relying on these attributes in their LL, FR and ATM services, IP networks need to match these attributes.

It is important to note that the evolution considerations presented above are driven by data volume, even though voice revenue is still the largest revenue stream for service providers. The motivation is that data will dominate the traffic mix in public networks. The evolution of voice services and voice switching are very important and definitely an important area for service provider investments. Yet, the small percentage of voice traffic volume in public networks means that optimising the network for voice connectivity is not a good idea. It is lower in cost to adapt voice services to use the most cost-efficient connectivity alternative. Most of the time the existing SDH-based TDM connectivity solutions have sufficient capacity to meet the needs of fixed-line voice services. To prepare for the future migration of voice to IP, any investments in new IP infrastructure should be made in equipment that is capable of supporting QoS.

While retail services can realistically converge to a single packet-based network, the same is not true for operator-to-operator bandwidth

wholesale. TDM Leased Lines and optical wavelengths are the most practical methods for delivering bandwidth wholesale. Due to regulatory and operational reasons it is very difficult to replace TDM Leased Lines in operator-to-operator wholesale transactions. In addition to wholesale, the SDH/DWDM network is also needed as an access and transport network for the packet-switched connectivity layer.

Mobile voice networks need more capacity with the introduction of new 3G technology, but due to the bandwidth limitations that are set by the air interface, voice represents a larger percentage of overall traffic volume than in a fixed network. The next investment in the connectivity layer of mobile networks will be an ATM multiplexing layer on top of the SDH layer to optimise the network for similar volumes of voice and data, rather than just data.

## Maximising profit generation potential with IP/MPLS

At this point it is very important to consider the path to maximising profits from connectivity services. If several alternative solutions are available, with similar QoS, reliability and predictability characteristics, then maximum profits can

be generated with the lowest cost infrastructure. The minimum costs can be achieved when the chosen service framework supports minimum cost interfacing to the end customer and when the chosen networking technology can natively produce the required services without expensive adaptations. This is the reason why service providers today have three connectivity networks. Each produces one type of service in the most cost efficient way. SDH is the most cost efficient way of delivering leased lines. IP infrastructure is the most cost efficient way of delivering Internet services. ATM is the most cost efficient technology for ATM services (and also Frame Relay if for practical rather than theoretical considerations)

As end customer networks are converging to an IP over Ethernet architecture, the most cost efficient end user interface is Ethernet and the most cost efficient connectivity services are IP and Ethernet-based services, which can be natively supported with an MPLS infrastructure.

The QoS capabilities of next-generation IP/MPLS networks are actually better suited to the requirements of existing and future end-user applications than the QoS capabilities of ATM. IP over Ethernet networks emit packets in bursts, and a packet based QoS framework with statistical multiplexing capabilities is the best match to this type of traffic. This is the cornerstone of the strategy, which

positions IP/MPLS as the convergence platform for switched data connectivity services. The real end-user requirements for reliability, predictability and QoS can be fulfilled by the native IP/MPLS solution without having to make any compromises and without having to introduce complex and expensive adaptation layers. Using the native solution is the key to cost efficiency.

The best way to achieve the minimum cost converged network is to introduce a new set of attractive IP/MPLS based services, and work towards end-user convergence based on these services. The enabler of this convergence is the fact that end-users have already converged to a single data networking architecture: IP over Ethernet, and that end-users are already volume users of the other major IP service- Internet connectivity. The proposed set of services is simply the most cost efficient way of serving IP over Ethernet end-user networks.

## Sounds too simple. Can this really work?

The way to make end-users change their services is to offer a better price/value ratio than they get currently. Connectivity services tend towards declining prices over time and service provider profit is of course key. Therefore every new offering has to

initially increase revenue, to leave room for the erosion that will inevitably follow so the best proposition for the substitution of LL, FR and ATM is much more bandwidth at a slightly higher price. It is very important to try to protect the existing LL, FR and ATM revenues. Therefore the pricing of IP/MPLS services has to be such, that they are an attractive substitute for existing services only if the end-user simultaneously subscribes to a higher bandwidth service.

The window of opportunity for service substitution from legacy to IP/MPLS services opens when the end customer wants to upgrade the service bandwidth. At that point two options are available. Either provide a higher bit-rate service using the legacy network or migrate the user to a new service. While higher speed is the new value the end-user is looking for, the migration to an IP-based service also simplifies the end customer's network. With an Ethernet service interface, end customer OPEX and CAPEX can both be reduced. This is especially true when the bit rate upgrade is such that the end user cannot continue using the current TDM, ATM or Frame Relay service interface without additional investment. It is almost invariably lower in cost for the end-user to switch to an Ethernet service interface rather than to buy a higher capacity TDM, ATM or Frame Relay interface to the end user device (see Figure 8).

Figure 8: Example end user router interface pricing

Interface Type	List Price	Price per Mbit/s
2M G.703	\$1300	\$650
34Mbit/s G.703	\$8500	\$250
Fast Ethernet (100Mbit/s)	\$2000	\$20

Migrating to IP and Ethernet-based services relieves the end-user from the need to maintain competence in the wide area network associated with TDM, ATM and Frame Relay technologies. Competence in IP and Ethernet is much easier to find within end-user organisations, because these are the chosen technologies for the end-user network anyway. This is the key to end-user OPEX savings.

An additional requirement for any kind of service migration is that the new service has to be very reliable and the provisioning of changes has to take place smoothly. Carrier-class design practices and an advanced intelligent network management system can help service providers achieve both of these requirements.

The migration to an IP/MPLS-based network will be a long process. Replacing old telecom services with new

ones is always very time consuming and difficult. This is addressed by one of the unique advantages of MPLS-based IP services as the legacy ATM, Frame Relay and Leased Line services can be used as access connections to MPLS VPNs. The end-user network can be migrated to MPLS VPNs using existing access connections on those sites, which do not need a bandwidth upgrade. These legacy sites can be gradually migrated to Ethernet service interfaces as the end-user upgrades the access speed at these sites. A number of service providers in the world are already following this strategy and have proved its viability. The unique interoperability between IP/MPLS and legacy networks maximises the reuse of installed equipment and minimises investment overlap between the old and the new.

Additionally, very cost-efficient access solutions for MPLS-based VPNs can be provided by Ethernet-based access multiplexing. The most attractive proposition is the integration of Ethernet capabilities in to the existing SDH infrastructure, as this provides a way to leverage the installed base of equipment for new services.

There are of course LL, FR and ATM services that cannot be substituted with new IP-based offerings. For existing customers these can easily be continued on the existing networks as normal. For new customers the answer is trickier if

the legacy network and installed base is not to be expanded. Technically it is possible to offer LL, ATM and FR services over an IP/MPLS infrastructure by deploying suitable adaptation layers and when legacy services represent a small percentage of total traffic this may be the lowest cost approach. However until demand for these services has fallen to a sufficiently low level, delivering these services over an IP/MPLS network would be costly and complex. In the short term, extending the existing network may be more attractive.

## Suggested strategy for future connectivity network investments

The most profitable direction for the network connectivity layer is to introduce a new set of connectivity services, which can fulfil the basic end customer needs of Internet Access and LAN-IC. These should have an Ethernet service interface towards the end customer and be natively produced in a single, converged IP/MPLS infrastructure.

The cost of interfacing to the customer is minimised with an Ethernet service interface and either IP or Ethernet-based protocol stack between the operator and

the end customer. The cost of the network is minimized, since a single network can carry both growth traffic types: Internet and LAN-IC. The profit potential of the network is maximised with the full set of MPLS-based QoS capabilities, further augmented by the reliability and predictability enabled by MPLS capabilities and carrier class IP/MPLS network elements.

At the same time it is best to keep the existing legacy services in the legacy networks. Migration to a single infrastructure will be the result of end-users converging to services, which are more cost efficient to produce in the IP/MPLS environment. It should be noted that end-users have already converged to an IP over Ethernet network architecture, and that IP/MPLS based services are the best match to their needs. It is simply a question of the service provider offerings following the development that has already taken place in the end customer networks.

## Alternatives to IP/MPLS services

The alternative to migrating customers slowly over time to a single IP/MPLS network is to keep on investing to multiple, separate networks or to try to immediately move customers to the new converged network. In either case, SDH networks will definitely keep growing, because they are used as the transport

solution even for IP or ATM services. With the first option there is clearly a lost cost-optimisation opportunity to replace the ATM network with an IP/MPLS offering. Continuing to invest in the existing networks is of course the easiest solution, but if a service provider buys into the vision of integrated ICT services and continued Internet growth, then everything that service provider does now must move towards this vision. Every new service and infrastructure change must incrementally move in the right direction. This must become the guiding criteria for introducing new services and for directing network investments. Large investments to increase the capacity of the legacy ATM network are simply not a sound strategic choice, if the service provider agrees with the mega-trends of Internet and converged ICT services.

The other alternative is the immediate migration of all services to a converged IP network. This can be supported by emulating the legacy services with the converged IP/MPLS network. This is technically possible using the emerging standards-based solutions being developed by the IETF. However, this is simply repeating the exercise that was carried out with ATM and it will produce an expensive solution, with complex adaptation requirements. Though technically possible it is economically ineffective, as the fully converged ATM network has turned out to be. Trying to

add enough functions to an IP network so that it could produce Leased Line services indistinguishable from an SDH Leased Line would simply cost too much and be too complex to manage. The same applies for ATM services.

This type of emulation can be an important temporary migration tool. However, the cost and complexity of the solutions that are needed to make an IP/MPLS network look exactly like an FR/ATM network are so high that this is not a viable long term strategy. Homogenous networks with Ethernet service interfaces and IP-based control planes lead to the lowest long term OPEX and CAPEX. Any deviation from this standardised mass solution means increased cost and complexity, which is against the long-term goal of minimising the total cost of network ownership.

From the technical point of view, there is little point in investing large sums of money to enable IP/MPLS to look exactly like SDH or ATM, when the native characteristics of IP/MPLS are an exact match with the end customer needs. The proposed strategy is strongly reliant on the continuing convergence of end customer networks towards IP over Ethernet, but currently there are no alternative trends in sight.

## Summary

The rapid growth of Internet and other data traffic combined with a much slower revenue growth rate decreases the profitability of communications services. The trends of decreasing price per bit and decreasing price per minute hurt both the voice and data service revenues of traditional communications service providers. Traffic growth is forcing service providers to invest in new infrastructure at a time when capital is scarce. It is critical for service providers that they choose a network investment strategy that maximises their long-term profitability.

Information and Communications Technology services are slowly converging. The converged ICT service creation environment is expected to contain three layers:

- Value Added Services Layer
- IP Connectivity Layer
- SHD/DWDM Transport Layer

This convergence will create new opportunities and threats for communications service providers. The total, addressable market increases with the addition of IT services. At the same time competition becomes more intense

**How to reach us:**

**North America**

Tellabs  
One Tellabs Center  
1415 West Diehl Road  
Naperville, IL 60563  
U.S.A.  
+1.630.378.8800  
Fax: +1.630.852.7346

**Asia Pacific**

Tellabs  
9 Temasek Boulevard  
#43-02 Suntec Tower Two  
Singapore 038989  
Republic of Singapore  
+65.6336.7611  
Fax: +65.6336.7622

**Europe, Middle East & Africa**

Tellabs  
Abbey Place  
24-28 Easton Street  
High Wycombe, Bucks  
United Kingdom  
HP11 1NT  
+44.870.238.4700  
Fax: +44.870.238.4851

**Latin America & Caribbean**

Tellabs  
13800 NW 14th St.  
Suite 190  
Sunrise, FL 33323  
U.S.A.  
+1.954.839.2800  
Fax: +1.954.839.2828

as the IT service providers increasingly start competing with traditional communications service providers.

Service providers must maximise the profitability of connectivity services and at the same time increase their addressable market size by capturing a share of the value-added service revenues through connectivity fees from other service providers or by directly offering value-added services to end users. Revenues from connectivity services can be improved by moving from selling pipes to selling solutions. This means selling higher value services by taking total responsibility for the networking needs of enterprise customers.

Rationalising the connectivity infrastructure is the key to minimising the cost of providing connectivity services and thus the way towards the highest profits. Today, service providers have three different networks for connectivity services: SDH, IP and ATM. The growth of the Internet forces investment in the IP network. Wholesale services and transport applications force investment in the SDH network. The opportunity to

optimise costs through convergence exists through a new set of IP/MPLS-based retail services, which can fulfil the needs today fulfilled with LL, FR and ATM. Internet traffic and LAN-IC traffic can be brought together on the same infrastructure with minimum costs and maximum profitability.

The lowest cost network with maximum revenue generation potential is the result of standardising on a small number of mass solutions and deploying them for all needs. The mega trends are Ethernet service interfaces and IP or Ethernet-based retail services. The main enabler of convergence to this future architecture is the fact that end-users have already converged to an IP over Ethernet architecture. IP and Ethernet based services are the most natural way of serving these end-user networks. The crucial factor for acceptance of new services is that they are able to match the predictability, reliability and QoS capabilities of legacy solutions. An IP/MPLS-based infrastructure with advanced management solutions and carrier class equipment is able to do just this.

*The following trademarks and service marks are owned by Tellabs Operations, Inc., or its affiliates in the United States and/or in other countries: TELLABS®, TELLABS and T symbol®, and T symbol®.*

*Any other company or product names may be trademarks of their respective companies.*

© 2002 Tellabs. All rights reserved.  
74.1309E Rev. A 11/02