

Using Ethernet-over-SDH for Managed Bandwidth Services

Ethernet-based Wide Area Network (WAN) services, such as metro Ethernet over fiber or SDH, have become a new trend, and one which is widely considered to last for the foreseeable future. This is likely to replace classical WAN services such as PDH and Frame Relay in the longer term. Using the right technology, the huge SDH-based infrastructure provides an efficient long range transport vehicle for Ethernet traffic, including statistical multiplexing and service level guarantees.

The popularity of Ethernet is due to a number of reasons, not least the extreme cost-efficiency and the generally well accepted properties of Ethernet. The market potential for WAN services delivered with Ethernet interfaces is very substantial; Ethernet technology dominates the market for Local Area Networks (LAN), and Ethernet interfaces are ubiquitous, inexpensive and reliable. At the same time, the market for WAN services is growing. In the consumer market, DSL and cable services are gaining high momentum, and in business markets IT applications such as voice-over-IP and Storage Area Networks (SAN) are substantially increasing the requirements for WAN services. In addition, businesses are becoming more and more geographically diverse, with multiple local sites interconnected to a few main sites housing the company's core IT facilities.

Currently, the most popular WAN services are leased lines, Frame Relay (FR), ADSL-based Virtual Private Network (VPN) services and IP-managed bandwidth services. But there are drawbacks associated with each of these. Leased lines have limited flexibility, since bandwidth upgrades and adding new sites to the network often will require more or changed physical interfaces in routers. FR offers multipoint connectivity on single interfaces, but bandwidth upgrades still require physical interface changes in routers, and scalability is limited. ADSL-based VPN services have large coverage and are flexible; however, they are limited in bandwidth and scalability, and there are no service level guarantees. IP-managed bandwidth is typically only cost efficient at high traffic volumes, so it is generally not suitable for large numbers of customers, e.g., the Small- and Medium-sized Enterprises (SME), except in areas close to the Point-of-Presence (PoP) of IP core networks. Even though the service offerings outlined above are well established, none of them meet all the demands in the WAN market. These can be outlined as follows:

- Wide geographical coverage — many enterprises have sites located outside major cities, and SMEs with sites spread across several countries are not unusual.
- Scalable bandwidth at consistent physical interfaces — the bandwidth should be flexible within wide limits without the need for new or changed physical interfaces.
- Unlimited connectivity — the way sites are interconnected constantly changes. Changes to site numbers and network topology should require minimal physical changes in the network equipment.

- Well defined service quality — each customer and site may have very different needs and requirements for their network service. It should be possible to tailor the network service to each specific site and customer, and the operator must be able to guarantee the agreed bandwidth and service level for each customer and site.
- Simple configuration and operation — SMEs often have limited IT resources, whose main task is to handle the internal network and IT installation. WAN services must be simple and not require complicated configuration routines.
- Low cost — the market for WAN services has been characterized by falling prices, not least due to competition and new technology. Operators must be capable of providing low-cost services that are profitable.

Whereas no single traditional WAN technology meets all of these requirements, it becomes clear that the service characteristics mentioned above are all well addressed using Ethernet-based WAN services. Ethernet interfaces are truly scalable, extremely inexpensive, reliable and ubiquitous. Due to this, most WAN customers would prefer any data service to be provided via Ethernet interfaces. And, as voice-over-IP PBXs gain momentum in the market, the need for E-1 services and traditional WAN services will stagnate, whilst the need for Ethernet services will increase substantially.

But delivering an Ethernet interface to the customer is the easiest part of the exercise for operators. There is plenty of Customer Located Equipment (CLE) for delivering just that, based on the well-known WAN technologies mentioned above. The real challenges for the operator are in the access and backbone parts of the network. When providing Ethernet interfaces with scalability up to 1 Gbit/s, how will the rest of the network adapt to this, without massive upgrades of backbone capacity, accompanied by lots of wasted capacity due to the burst characteristics of the typical Ethernet traffic?

The answer is bandwidth sharing between multiple customers¹. Even though this is a basic part of both ADSL backbone networks, cable TV networks and other wide area broadband access technologies, these networks lack one important thing in order to be suitable for most SMEs as a WAN service; the ability to offer guaranteed bandwidth to each individual customer.

1: The original vision of ATM was the same. The more traffic that is handled at packet or cell level, the more statistical multiplexing is possible, and the more efficiently the network resources are used. However, the ATM vision failed to come true. The networks of the world are still highly partitioned into customer specific, application specific, technology specific and country specific sub-networks. Only a few basic network technologies have become ubiquitous all around the world: Synchronous Digital Hierarchy (SDH), Plesiosynchronous Digital Hierarchy (PDH) and voice services based on POTS and ISDN. IP is ubiquitous too, by way of being the "Internet" itself. However, IP and other packet-based services are Layer 3 services; when it comes to Layer 1, the transport technologies mentioned above are predominant in the wide area networks of the world. As a consequence, the potential for statistical multiplexing is high.

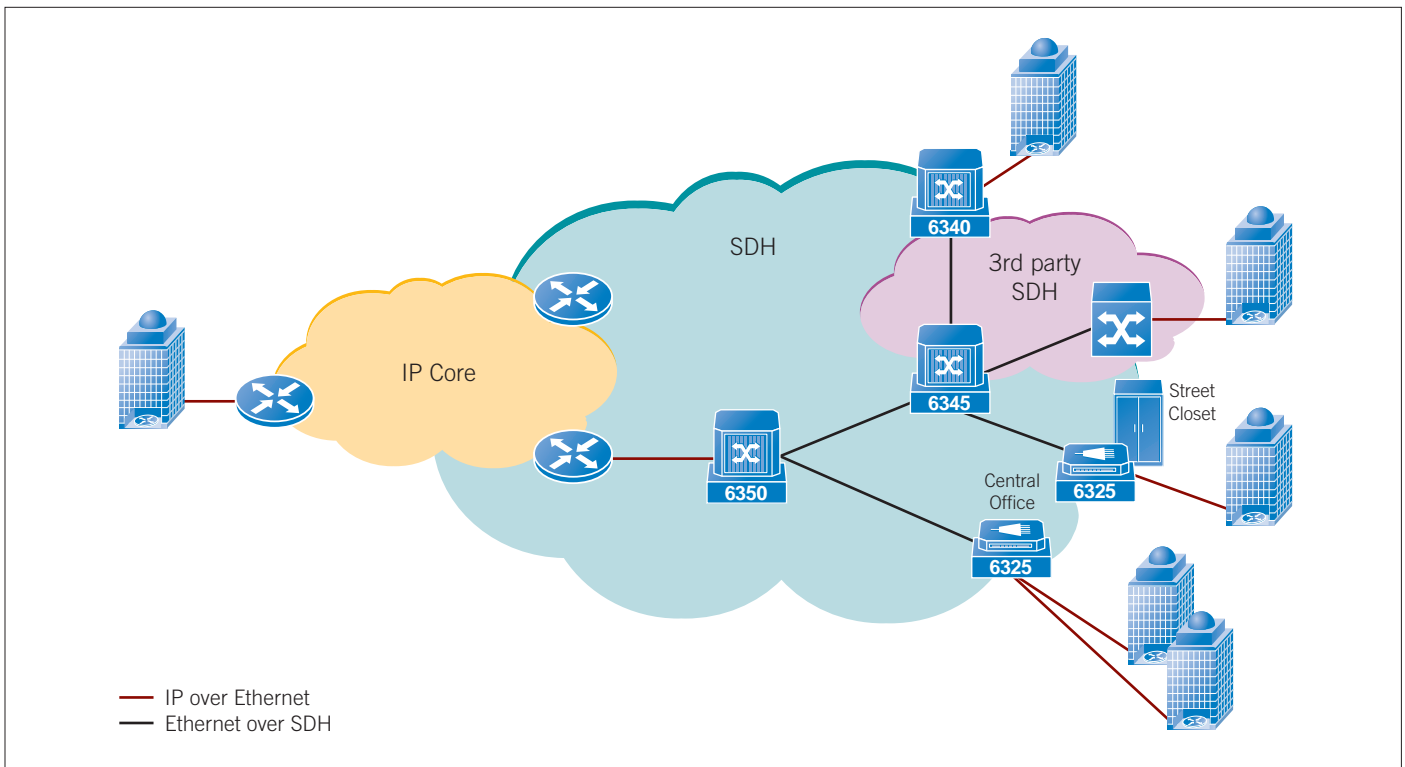


Figure 1: Connecting customers outside reach of the IP core

Optimize Profitability with Ethernet-over-SDH

The main advantages of Ethernet-over-SDH are the ability to carry Ethernet traffic over long distances, handle traffic from many customers in common pipes and at the same time offer tailored, agreed service levels to each single customer.

The following example will illustrate this. Operator A is a large operator in Country A, providing a wide spectrum of WAN services to its customers at a countrywide level. Most of these services are carried in a common SDH optical backbone, covering most parts of the country. An additional IP/MPLS core network has been established using IP-over-fiber in the core and IP-over-SDH towards the edge of the IP network. The SDH backbone is terminated at all central offices, i.e., it reaches all areas within a maximal distance of four kilometers to the nearest SDH PoP. The IP/MPLS network has points-of-presence in larger cities across the country.

As a result of competition and decreasing price levels on WAN services, Operator A needs to optimize the profitability of its existing network base. One obvious way of doing this is to squeeze more traffic into the same bandwidth on one hand, and on the other to address new customer segments with new services, without spending large amounts on network upgrades.

The established SDH backbone network represents a huge investment, and it can carry immense amounts of traffic, often without expensive rebuilds for DWDM or CDWM equipment. If this network can be utilized even more flexibly, without the need for major rebuilds, it may provide new business opportunities for Operator A. One obvious opportunity is to expand the scope of managed bandwidth services, by lowering the entry barriers to enable smaller businesses to use managed LAN services with Quality of Service (QoS) guarantees. However the IP/MPLS core network does not have sufficient coverage to reach critical mass in this customer segment, and the business case for managed IP services does not allow for major optical network builds to extend the coverage.

The enabling technology is Ethernet-over-SDH. By combining the traffic from many smaller customers into common SDH pipes of tailored size, it is possible to connect customers all over the country without the need to deploy IP/MPLS edge routers at all central offices. This is achieved by adding Ethernet-over-SDH capabilities to the network nodes at PoP sites, and then establishing central gateways to the core IP/MPLS network where necessary. In this way, both established and new service types can be offered.

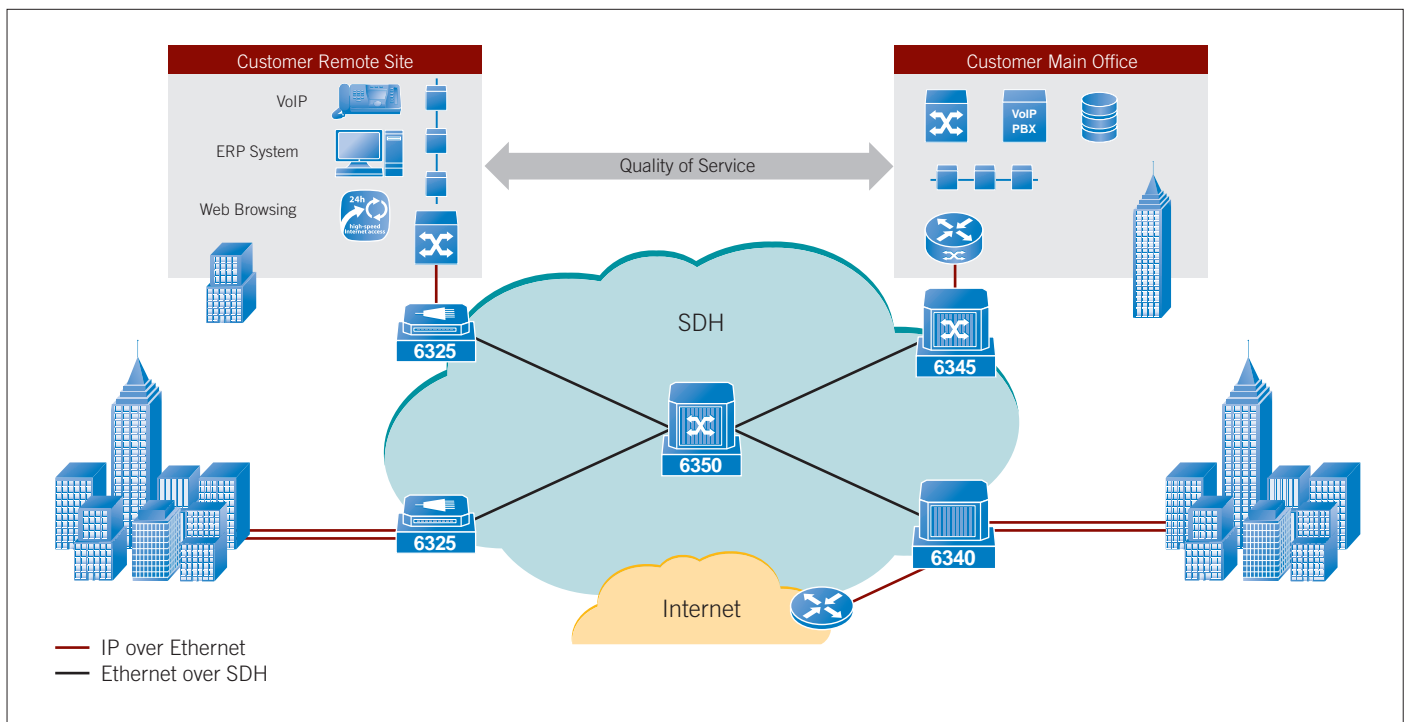


Figure 2: Providing Ethernet WAN services with quality of service

- The coverage of managed IP services is expanded using Ethernet-over-SDH as a transparent connection between the CLE router and an IP/MPLS edge router. In this way, Operator A can sell smaller chunks of bandwidth to many smaller customers and still provide advanced managed IP services. The central IP/MPLS edge router may only need one interface to carry traffic from customers located in a larger area.
- New Ethernet connectivity services can be offered. Such services include Ethernet leased line, Ethernet Private Line and Ethernet Private Network. These services represent a less complicated way of interconnecting customer sites than IP VPN with QoS — there is no need for firewalls, IP address translation, etc. The entry costs for customers are lowered, the operator has lower costs for customer support, and at the same time attractive new service variants, also with QoS, can be provided to customers.
- Multimedia content services, such as cable TV, video-on-demand and video streaming, have substantial demands for traffic optimisation and concentration. Ethernet-over-SDH may play a significant role in the support of such services. Traffic can be delivered to residential customers over ADSL connections, but the distribution and backbone networks need massive upgrades in order to offer video services to consumers. The combination of QoS management and statistical multiplexing optimizes the bandwidth utilization, and this may, in the end, lead to a reduced need for new fiber deployments in the network.

In conclusion, Operator A can realize significant business potential by introducing SDH network nodes capable of Ethernet-over-SDH with QoS. The Tellabs range of Ethernet-over-SDH enabled solutions provides the advanced tools necessary to realize the full potential of the existing SDH network.

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