Ethernet Business Services

February 2003

TELLABS' ETHERNET-OVER-SDH SOLUTION IS A COST-EFFECTIVE WAY OF TURNING AN SDH TRANSPORT NETWORK FOR VOICE ONLY INTO A FULLY INTEGRATED VOICE AND DATA NETWORK

This paper describes Private Line Interconnect and Internet Access services built on well known, easy to use and cost-efficient Ethernet technology carried by latest generation SDH equipment, thus leveraging on the large installed base of SDH networks.

Demand for Higher Bandwidth

Enterprise LAN bandwidth has exploded over the last couple of decades. In today's office personal computers and workstations are typically interconnected with servers at speeds of 100 Mbit/s — some even higher. Bandwidth in LAN backbone and campus networks is counted in Gigabits per second. Efficient workflow requires bandwidth.

Local server access, however is not the only requirement. Enterprise globalisation means that employees communicate with each other across the world. They use internal conference phones, video conferencing, e-mail and sharing of data servers, thus reducing travelling expenses and time. Efficient communication requires high bandwidth and low delay.

With today's businesses demanding increasing efficiency whilst at the same time reduced costs, the Internet has become an invaluable tool for marketing, e-commerce as well as for data mining. Access to the Internet via an Internet Service Provider (ISP) has become necessary for all businesses regardless of size.

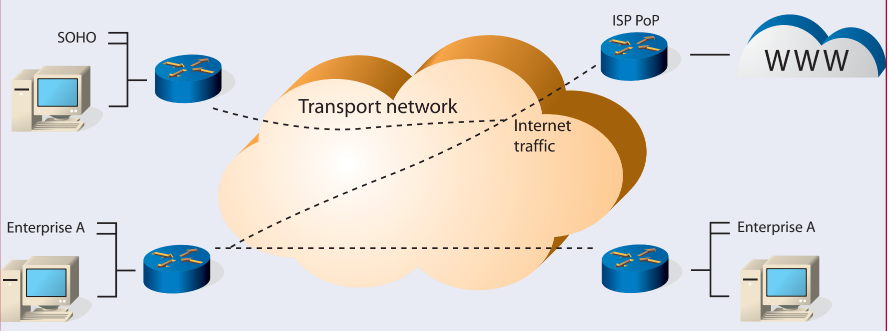
Figure 1 illustrates these basic applications of LAN-LAN and LAN-ISP point of presence (PoP) interconnects.

With increasing requirements for higher bandwidth, businesses are ever more concerned about operational expenses. A recent study by Analysys[1] showed that users want security, reliability and low cost. The service provided by the operator is critical to their business, and they want to be secure from eavesdropping and hackers, they want the service up and running at all times and they want it at minimal cost.

Common access speeds are n*64 kbit/s via ISDN, kbit/s to Mbit/s using xDSL and 2/34/45 Mbit/s up to STM-1 over PDH and SDH multiplexers. Current LAN equipment has to adapt to the telecommunication transmission formats, resulting in high interface costs. Calculations show that by replacing an STM-1 interface with a Fast Ethernet interface on the LAN equipment a customer can reduce his investment by $3-4000 with zero implications on part of the operator.

Another important element is the monthly recurring fee for leasing a circuit or gaining access to the ISP. Cost reduced interconnects will facilitate new services and create demand for more bandwidth.

Figure 1 — Basic Interconnect Applications



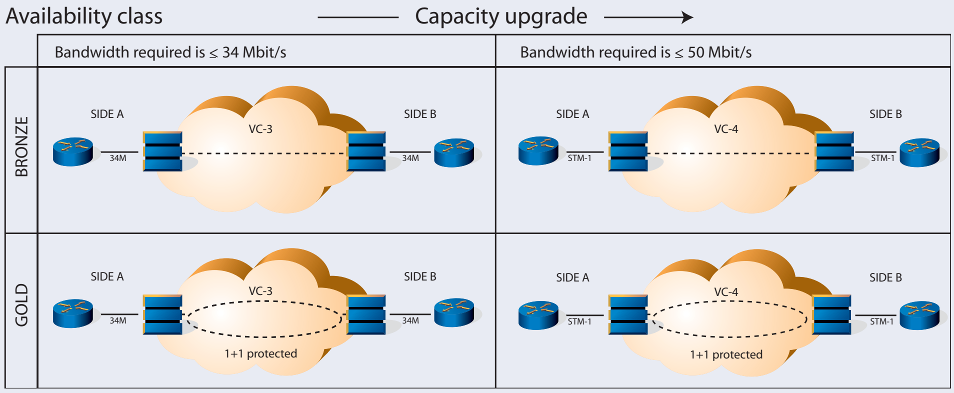
Private Line Interconnect

Enterprises and high bandwidth users, like ISPs, request private lines from the transport network operator because they can rely on the full capacity of the link and the security it brings. For the operator that uses standard SDH equipment with fixed rate PDH interfaces some issues are difficult to tackle:

The line interface has a fixed rate of 2/34/155 Mbit/s. At best n*2 Mbit/s is available. If the user has a 34 Mbit/s line and needs 50 Mbit/s he has to upgrade to 150 Mbit/s, and thus pays for more than actually required. This would typically lead to him postponing the order.

The service is either unprotected or 1+1 protected in the transport network[1]. Hence only two availability classes are possible: *bronze* and *gold*.

Figure 2 — Capacity Upgrade and Service Classes



The problem of offering a 50 Mbit/s service is illustrated in Figure 2, covering both availability classes. The user wants to connect two routers with a bandwidth of 50 Mbit/s, but the operator can only offer a full STM-1 service as alternative to the current 34 Mbit/s service. Accepting this would imply that the user must equip both routers with expensive STM-1 interfaces and maybe pay for the full 150 Mbit/s bandwidth. With a tight budget the user may very well say no.

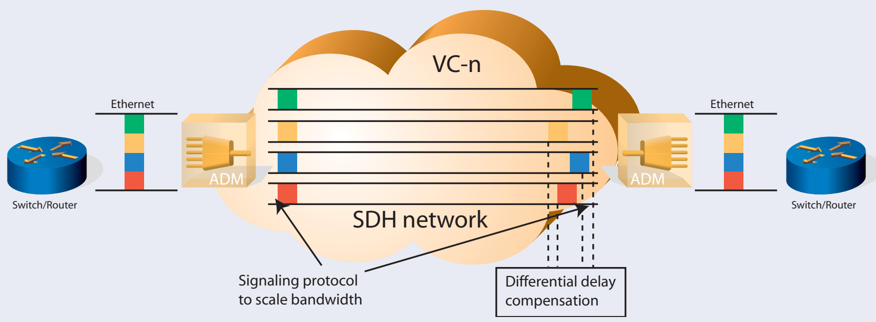
On the other hand, with a "pay as you grow" type of service the user most probably would say yes. The solution is Ethernet interfaces and scalable transport capacity.

Using the above scenario as an example if we were to exchange the 34 Mbit/s interface with a Fast Ethernet interface this gives us a lower cost router interface and the capability of growing the utilised capacity from 0 to 100 Mbit/s without changing the interface module. This is because packets sent over Ethernet interfaces are bursty by nature.

In addition users have the ability to, seamlessly turn up and down the bandwidth if we exchange the fixed VC-3 circuit with a number of virtually concatenated VC-12s[2]. A packet stream sent over a virtual concatenated channel is byte-wise applied the constituent channels in a round-robin

1: For simplicity 1+1 SNC protection is considered. Other means of SDH protection like dual homing, MS-SPRing and ring interconnect, can be utilised to differentiate the availablility, but overall the availability will be excellent, i.e. gold.

Figure 3 — Virtual Concatenation of VC-n Signals



fashion. See Figure 3. Due to different delay through the network the receiver must compensate for the differential delay before the packet stream can be output again. The capacity of the channel can grow and shrink in steps of VC-12 (or VC-3/VC-4).

By applying the recently standardised link capacity adjustment scheme (LCAS)[3] the capacity can be adjusted without any service degradation. Furthermore, if a member of the concatenated group is temporarily failing the link remains in service albeit at a lower capacity.

This feature can actively be used for network protection as is illustrated in Figure 4, provided the equipment can handle a differential delay for virtual concatenated signals larger than the standardised 125 usec[2]. In this case the service will only be interrupted in the time it takes to readjust to fewer members.

Figure 5 illustrates how the capacity can be upgraded in multiples of VC-12[2] (here from 17 to 25, corresponding to a bandwidth of 34 Mbit/s

Figure 4 — The Link Remains in Service Despite Failing Members

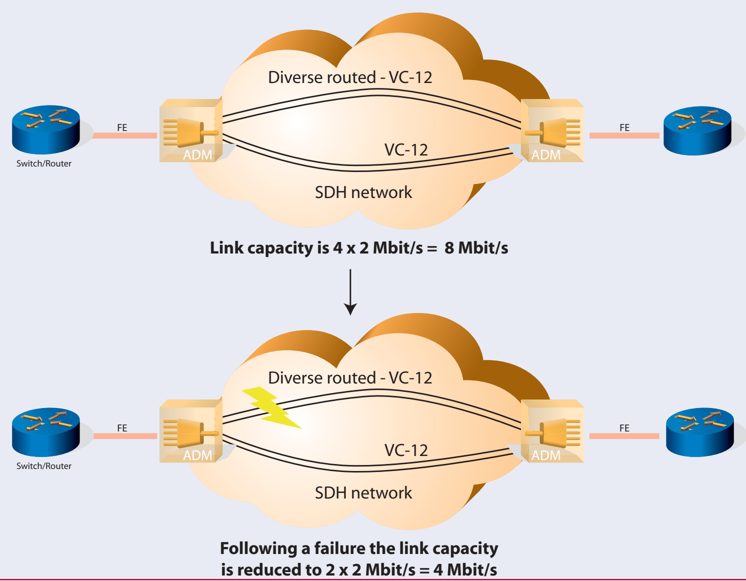
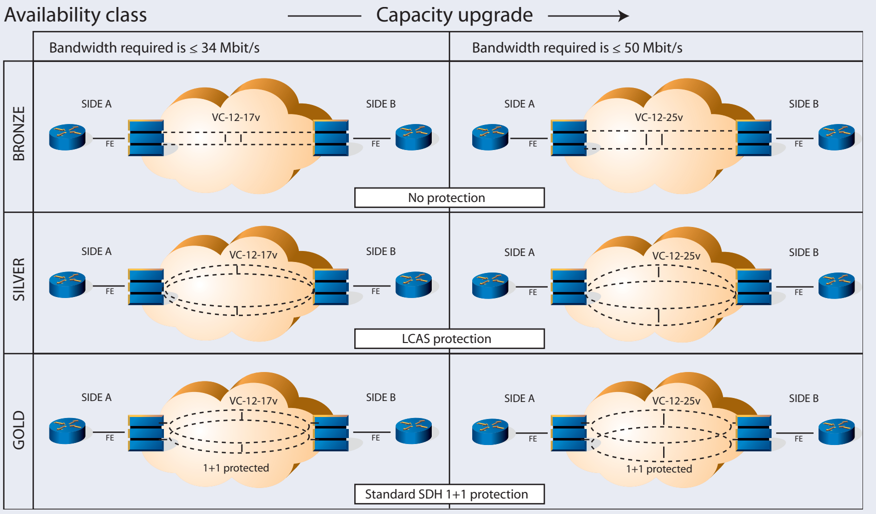


Figure 5 — Service Classes with Ethernet and Virtual Concatenation



and 50 Mbit/s, respectively). Furthermore, the level of availability can be fine tuned in three basic categories, *bronze, silver, gold*, based on no protection, protection using LCAS and standard 1+1 protection. Notice that the latter two can be combined so that only some of the member signals are 1+1 protected.

In summary

- A low cost Ethernet interface is introduced on the transport platform
- "Pay-as-you-grow" services are supported by a scalable interface *and* scalable link
- Differentiated services can be created by tuning the link availability to the user's requirements

Internet Access

As mentioned previously all businesses — small as well as large — require access to the Internet. An Internet service is by nature "best effort". Delay and delay-variations are perceived to be minimised by over-provisioning capacity to the links connecting the routers. "Best effort" is what the user expects, and "best effort" is what he usually gets. The problem is that he wants to pay accordingly.

The "Internet Access" described here is a service where the user gets high bandwidth in bursts at a lower cost (compared to a leased line), and the operator can minimise the investment by over-subscribing the transport network.

2: A virtual concatenated link based on VC-n signals consisting of X memebers is donated VC-n-Xv.

Figure 6 illustrates the basic principles of the Internet Access service in which an enterprise router is connected to the provider router at a bandwidth of maximally 10 Mbit/s. Six enterprise routers are connected to the Ethernet switch (A), each at a rate of 10 Mbit/s. This switch is connected to another switch (B) at a rate of 10 Mbit/s, and so are 9 other switches, totalling 10 tributary connections. Switch B is connected with the provider router, which is connected to the general IP network — the Internet — over a single Fast Ethernet connection.

The operator has thus designed the network with a 1:6 over-subscription in switch A, and none in switch B. The enterprise users have a mean access rate of 10 Mbit/s /6 = 1.6 Mbit/s and can burst up to 10 Mbit/s.

Security is very important and is ensured by assigning each enterprise a separate Virtual LAN (VLAN) ID[4].

Other access rates, switch-interconnect bandwidth and over-subscription ratios in multiple levels can of cause be applied to suit a specific network.

In a straightforward network design all enterprises get their fair share of the bandwidth simply based on the statistical nature of packet transmission in a network whose links are not overly committed.

In a more optimised design priority mechanisms are also applied to assure fairness.

Figure 7 illustrates a typical three-tiered Internet Access services network that includes the

Figure 6 — Principles of the “Internet Access” Service

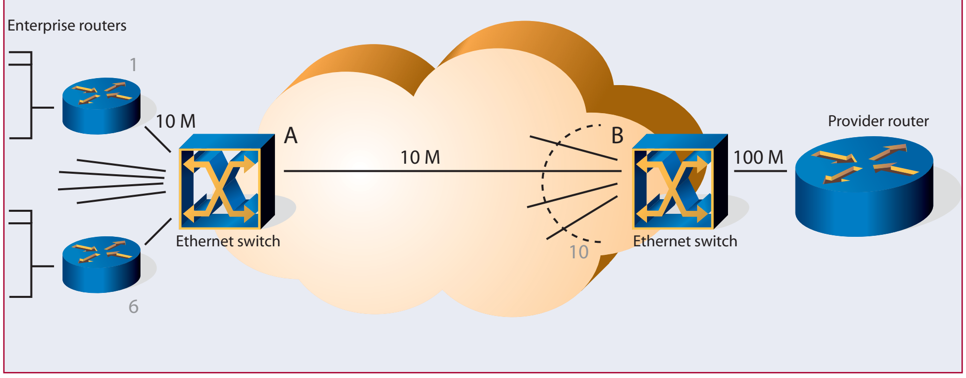
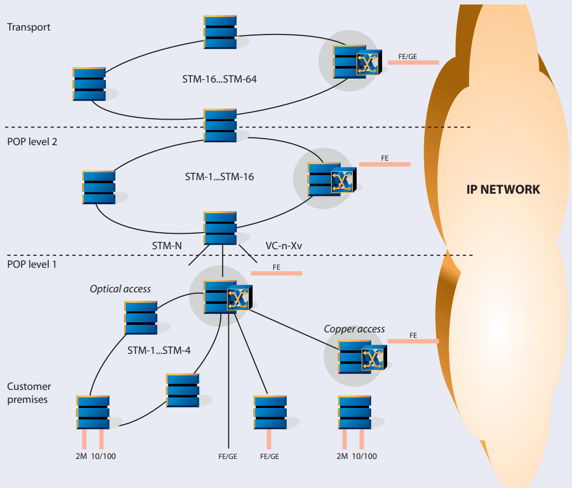


Figure 7 — Internet Access Network



elements. The Internet hand-off point is determined by many factors, like number of customers, customer bandwidth and concentration ratios, but is shown in all tiers for generality.

The switches are connecting over virtual concatenated VC-ns, bringing the previously described scalability and resilience into the network design.

The enterprises can access the switches in various ways:

Optical fibre

- The enterprise router has a 10/100/1000 fibre interface, which connects directly to the switch
- If the interface is electrical (10/100/1000 BaseTX) a customer premises access node can convert to a scalable virtual concatenated signal. The access nodes can be connected in star and ring topologies

Copper twisted pair

- The enterprise router has a 10/100BaseTX interface, which carried over xDSL connects to the switch

In summary the Internet Access service

- gives the user a scalable, high average bandwidth connection with burst capability, and
- is a new revenue generating, managed service, which gives the operator transport capacity savings and IP-hand off from many customers on a single Ethernet interface

Management

Savings in capital expenditure are not worth much if they result in increased operational expenses. That is why the Internet Access transport service has to be supported by an efficient service provisioning system, which

- associates Ethernet switches and physical links
- allows creation of virtual LAN networks associated to customers in a point-and-click fashion
- consistently provision service parameters, and test service establishment
- can gather performance statistics to document observance of service level agreements
- can detect, diagnose and circumvent network failures that affect service

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: +1.630.798.2000

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 North West 14th Street
Sunrise, FL 33323
U.S.A.
+1.954.839.2800
Fax: +1.954.839.2828

Summary

High-bandwidth, low-cost LAN-LAN and LAN-Internet interconnect services are vital in a world of gigabit LAN speeds and global communication.

Fortunately, Ethernet and new SDH technology lends its way to cost-efficient and scalable networks.

Replacing PDH circuits between enterprise routers with lower cost Ethernet interface and a scalable virtual concatenated link the network operator can now offer managed “pay-as-you-grow” private line interconnect services, and differentiated services based on tuning the private line’s availablility to the user’s requirements.

Private line services can be supplemented with Internet Access services based on shared bandwidth. The user will have a connection to the Internet with high average bandwidth and the capability to burst in even higher bandwidth. Users are seperated on individual virtual LANs, the set/up of which is handled by a well/proven management system, common for all transport elements. It is a service that is scalable in capacity, when useres demands increase, and in numbers of users.

References

[1] Tim Hills, 2001, “Market Realities of IP-VPNs”: *Analysys Research Report*

[2] ITU-T Rec. G.707, 2000, “Network Node Interfaces for the Synchronous Digital Hierarchy (SDH)”

[3] ITU-T Rec. G.7042, 2001, “Link Capacity Adjustment Scheme (LCAS) for Virtual Concatenated Signals”

[4] IEEE Std 802.1Q-1998, “Virtual Bridged Local Area Networks”

74.1200E Rev. B 2/03