Migrating to IP? It's a Short Journey

Many standards have been hailed as the future of communications. It was Integrated Services Digital Network (ISDN) in the 80s, then Asynchronous Transfer Mode (ATM) in the 90s and now it is Internet Protocol (IP).

This time, however, there seems to be consensus, comments Antti Kankkunen, Tellabs Chief Technical Officer, Managed Access Systems. "IP really is the future," he says. "It is ubiquitous, scalable and provides standards of interoperability unmatched in the IT and telecoms worlds."

Most people in the broadband industry will agree that eventually all communication services will be based on IP. Where people do disagree is when and how this is going to happen.

"Turning the IP network to a ubiquitous multi-service offering requires investments to yet another networking infrastructure. With the current financial climate, few companies are able to start a massive new network build out," says Kankkunen. Fortunately, they don't have to. Much to the surprise of many, the existing telecoms network is well suited to delivering IP while continuing to offer the existing services that remain profitable or necessary. Synchronous Digital Hierarchy (SDH) is the future, not the past. Leveraging the existing infrastructure is often the most viable way to expand the IP network from economical point of view.

SDH will Almost Get You There

SDH plays a major role in networks, but alone it is not enough. Critics cite three main problems with using SDH.

1. Because of the voice legacy, SDH can only deliver three bit rates: 2Mbps, 34Mbps and 155Mbps. If a customer demands 12Mbps, this appears to be an awkward demand to meet. Not only does 12Mbps not fit neatly into the structure, but also there is no 12Mbps interface to plug in at the customer end.

2. Bandwidth can only be statically allocated in SDH. If the customer asks for 12Mbps, you need to give 12Mbps, 24 hours a day, seven days a week. Yet typically IP data traffic is sent in bursts. It is unlikely that the customer will use the entire 12Mbps for even a tiny fraction of that time, making this system expensive to the user.

"Prices fall when the same bandwidth can be sold many times taking into account the rise and fall in demand. It may not sound honest at first, but without this 'statistical multiplexing', we would all be paying a lot more for our Internet access," states Kankkunen.

3. SDH based solutions are considered to be very expensive.

There is a one-word answer to all three of these problems cited by critics: Ethernet.

Just Add Ethernet

Ethernet is the most commonly used data interface and switching technology in the world. Practically all enterprise networks are built on IP over Ethernet architecture. The Institute of Electrical and Electronic Engineers (IEEE) has standardised Ethernet, and these basic standards are well supported by the worldwide communications industry. It is fair to say that it is a well-proven technology.

There are several reasons why Ethernet is so popular. The probability of packet loss in a well-designed Ethernet switch is as low as in any other well-designed packet switch. In addition to the current standard 100Mbps Ethernet, 1Gbps Ethernet is also common, and 10Gbps Ethernet has just been standardized, making it a very flexible solution. Ethernet devices are also proportionately very cheap.

The most important reason behind the popularity of Ethernet is ease of use. Ethernet devices are highly compatible with each other and can be connected together without any configuration work.

Ethernet is one of the few truly plug-and-play technologies. As a service provider connects Ethernet stations to switches and then connects these switches to each other, the network automatically learns the location of each station without any need for the user to carry out any configuration activities.

When considering all these factors, it is easy to see why Ethernet is so popular, and why it is such a compelling solution to the limitations of SDH.

Combining Proven Technologies

SDH can transport voice channels, IP packets, ATM cells, Frame Relay (FR) frames or Ethernet frames. It is important to note that even without any modification the existing infrastructure can deliver the complete portfolio of services. Kankkunen says: “What is needed is optimisation, not radical restructuring. Ethernet and SDH are proven technologies, with great strengths and carrier-class quality of service. Put them together and you have an architecture for the future.”

Solution 1. Give Customers what (Bandwidth) they Want

Back to the customer who wants 12Mbps. A simple multiple of two would give 12Mbps. This is a bit rate that SDH handles naturally, so why not give six 2Mbps links? This technique, called Virtual Concatenation (VC), has been around as a concept since 1996, but for some time it was only available in the most advanced SDH equipment. Now support for VC is widespread, which only leaves the problem of an interface. The answer of course is Ethernet, the most common interface available. Apply a 10/100Mbps Ethernet interface to the customer end of the SDH network and the need is satisfied.

Solution 2. Multiplex up, Bring Prices Down

Service providers often overbook bandwidth by anything up to 50:1, massively reducing the cost to them and the customer. Imagine multiplying your Internet access bill by 50 and you can see that this is an important functionality for any system to have. The answer again is Ethernet. By integrating Ethernet switching functionality into the SDH devices in the network, they can be enabled to perform statistical multiplexing.

Solution 3. Cheap as (Ethernet) Chips

There are two components to the supposedly high cost of SDH. Firstly, the actual systems themselves are seen as expensive when compared to IP routers and Ethernet devices. This is a myth. Today's carrier-class IP routers are very expensive devices, and the price per port easily outweighs that of equivalent SDH systems.

From the outside, Ethernet devices do appear cheaper. But without significant alterations, these switches cannot perform a comparable function to SDH devices. Once the Ethernet switch has been upgraded with support for quality of service fitted with fibre transmission interfaces and placed in a suitable enclosure for exchange installation, it no longer looks like such a bargain.

Secondly, interfaces between SDH equipment and routers are expensive, typically the most expensive module available for a router. The answer to this is to replace them with Ethernet interfaces, the cheapest and most common interfaces available.

Provide Absolute Quality of Service Via Ethernet

Any technology used to deliver home and business services has to be of sufficient quality, reliability and manageability to meet the customer's demands. This is defined as quality of service, and can be sub-divided into two types: absolute quality of service and relative quality of service, often called class of service.

Supporting Class of Service with Ethernet

Standard Ethernet has full support for class of service. This works by assigning different priorities to each packet of data. The switch or router then makes the decision to pass packets along their way or to drop them, based on their relative importance. Some packets obviously get better treatment than others do. Voice packets, for example, have a 'high priority' label to make sure they arrive at their destination and maintain the quality of a phone call.

Handling Priority Packets

Absolute quality of service in packet networks can be characterised by bandwidth, delay, delay variation and packet loss. Because of these requirements, absolute quality of service has only been applicable in private IP networks where all parameters are controlled, and not on the public Internet. However all these elements can be addressed by integrating Ethernet switching functions into SDH.

Firstly, take the issue of bandwidth. In a private network, the administrator knows there is sufficient bandwidth available for all the company's users as he has all the parameters under his control. Capacity is cheap in a local network, so it is quite feasible to build a network with bandwidth to cope with any possible demand. Capacity on the wide area however tends to be more expensive, and it is not realistic to buy so much bandwidth that there is always enough.

What is needed is a way to limit the flow of traffic into a network, and through every link within it, so that there is always enough bandwidth to move the priority packets. While standard Ethernet/SDH interfaces are quite capable of limiting the flow at the edge, standard Ethernet does not provide any mechanism to reserve bandwidth for priority packets inside the network.

This would seem to imply that switched Ethernet cannot be used for transporting services with strict bandwidth guarantees. In practice, however, the lack of resource reservation mechanisms are not a problem. The solution is in network design. When Ethernet is used to provide guaranteed bandwidth services, the network topologies are simple 'stars' (see Figure 1) and the traffic is multiplexed from the end user towards an IP router with Multi Protocol Label Switching (MPLS), another quality of service technology.

Saving Money with a "Star" Design

The motivation for this design is saving physical ports in the IP/MPLS router and thereby saving money. As already noted, the IP router is one of the most expensive pieces of telecoms equipment available today, especially with the added interfaces. As long as Ethernet is used for

simply multiplexing traffic towards the IP/MPLS switch, the availability of bandwidth for guaranteed bit rate services can be assured with correct configuration of the network. Put simply, it must be ensured that the sum of bandwidth in interfaces A1 to AN is less than the capacity of interface B (see Figure 1 below).

Eliminating Congestion with Bandwidth Management

The remaining three absolute quality of service parameters, delay, delay variation and packet loss, all depend on the congestion status of the network. Congestion can be eliminated with proper bandwidth management. Where bandwidth management is properly handled, quality of service capabilities equivalent to any other packet switch can be achieved in integrated SDH/Ethernet systems.

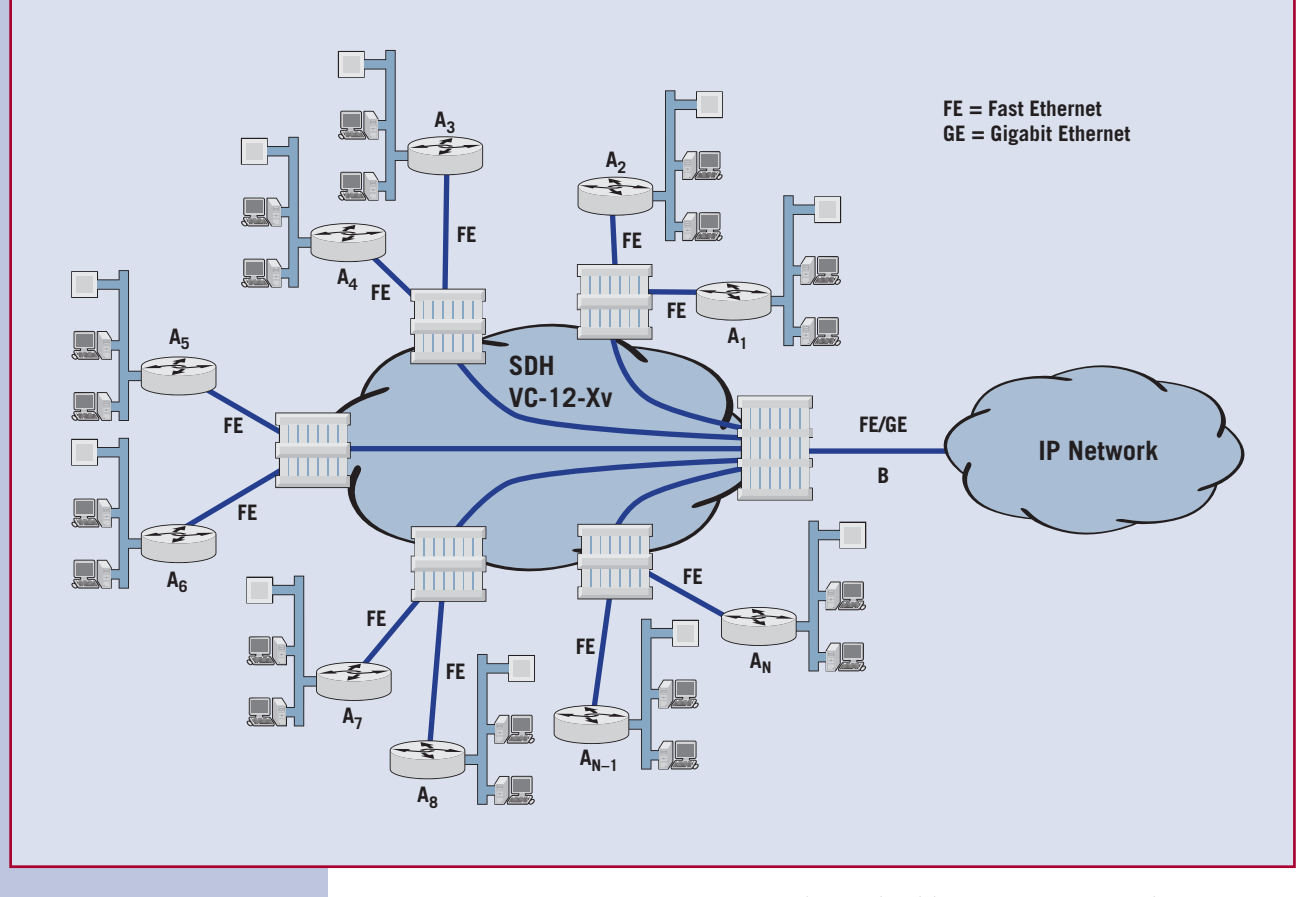

Figure 1. Bandwidth Management in Ethernet Access

Secure Communications

One important issue to address is security. If a network is to carry private IP traffic, it needs to be capable of secure connections. However, Ethernet standards also provide a solution.

Each customer's access interface can be allocated to a different virtual local area network (VLAN), isolating customers from each other. Once the VLANs have been enabled, there is no way one customer can gain access to another customer's resources. The security of the VLANs is equivalent to the security of other widely used standards available today, such as ATM and FR.

SDH + Ethernet = Cost-effective, Carrier-class, IP Networking

Many vendors are promoting investment in totally new packet-based transport infrastructures. These metropolitan area Ethernet vendors claim that pure packet systems are the most cost-efficient way of extending the reach of the Internet. The proposal is to cap the existing SDH infrastructure and build a new Ethernet-based infrastructure which will handle all of the traffic growth.

It is true that the weight of Internet traffic in transport networks is increasing all the time. However, the existing voice network is still very strong and customers want to be able to purchase leased lines. The transport of choice needs to be able to support existing services in addition to Ethernet traffic.

SDH is proven and operates as a well-established workhorse in current networks. "It is the best technology we currently have and it is going to be even better when features like virtual concatenation, Ethernet interfaces and Ethernet switching capabilities are integrated with existing SDH systems. In many cases the use of Ethernet over SDH makes more business sense than investing in new packet-centric infrastructure," says Kankkunen. "Nothing is as low cost as the solution you already have."

"Tellabs delivers cost-effective solutions that enable service providers to deliver new revenue-generating services quickly and cut operational expenditure. The fact is that Ethernet capabilities can be added to existing SDH equipment at a lower cost than buying all new elements. Ethernet with SDH is easily the most cost-efficient way to migrate the existing infrastructure into the Internet era."

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