2003

WHITE PAPER

"Solving the QoS Bottleneck in Video and Triple Play Networks enabling low CAPEX and OPEX "

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ABSTRACT

This paper presents Net Insight's network solution based on NG SDH/Sonet enhanced with extensive Ethernet functionality, improved channel utilization, multicast support for video distribution and an automatic control plane. The platform provides radically improved efficiency and manageability of existing network infrastructures while solving the QoS bottleneck for handling mission-critical IP data and video. Customers benefit from reduced cost in both CAPEX and OPEX through higher network utilization and superior manageability. This is obtained by combining the best in cost-efficient Ethernet data access and the latest advances in Next Generation optical transport technologies, such as LCAS, GFP, VCAT and GMPLS.

There is currently a strong market opportunity to explore the increasing demand for triple play services (voice, Internet, broadcast video, VoD, NVoD, etc.) over xDSL. According to Instat/MDR Group, approximately 60 million households worldwide will be able to subscribe to video over xDSL by 2006. We have already seen independent operating companies (IOCs) and independent local exchange carriers (ILECs) starting to implement these services in the US. Additionally, CATV operators are digitalizing their networks and have started to offer data and telephony services to subscribers. Content providers, such as UPC and Time Warner, are using fiber networks instead of satellites for content distribution. Furthermore, the professional media industry, represented by broadcasters, production houses, content owners and film companies spending nearly US$7 Billion yearly on satellite transmission services, is starting to use optical networks and Internet services for their B2B transport needs, e.g., to connect studios or production facilities and even arenas for sports events. Clearly, real-time and video will be a major part of the content in our future networks.

However, the convergence between the media community and the telecommunications industry has been held back by the lack of adequate network solutions to meet the requirements on quality of service, flexibility and reliability in a cost-efficient way. It is a common belief that overprovisioning can solve the problem with QoS in today's packet-switched networks. However, according to Datamonitor, overprovisioning is one of the biggest dangers in the RoI model to new services since it drives up CAPEX both on equipment and the underlying infrastructure.

In this paper, we will show how Net Insight's network solution, making use of GMPLS (Generalized Multi Protocol Label Switching) and NG SDH/Sonet technologies, can radically change the economics of offering video and triple-play services over existing public networks, in terms of both OPEX and CAPEX,. With a GMPLS-based NGN network, you can get a unified view and control plane for your entire network spanning from the packet layer, over bandwidth channels, wavelengths and the actual fibers. Bandwidth channelization and optical layers are used to guarantee quality of service even with a maintained high utilization (>95%) of the network.

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Background

In today's competitive market place, operators are faced with decreasing revenues from traditional telephony services combined with a flat rate price model for Internet services. There are three ways for the operators to maintain and grow profits:

- Increase the customer base
- Reduce the costs of operations
- Find new attractive services that bring in new revenue streams.

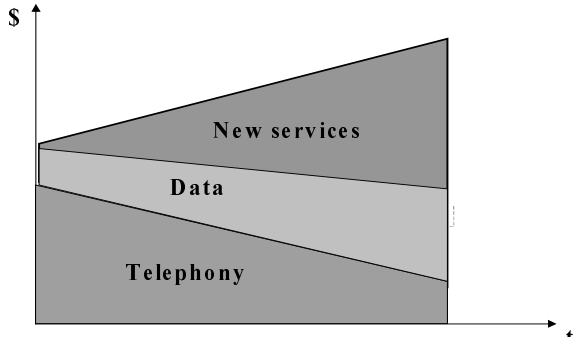

Figure 1. Operators' situation

To grow top line revenue and thereby increase the value of the company, telecom operators need to look at new services. The promise of triple play and the introduction of media services have been held back by costly network and access solutions. Recently, there have been large price reductions on servers and access equipment, but current network solutions are not adapted to handle a large amount of real-time critical data and video traffic. Net Insight combines efficient Ethernet access and next generation transport technologies to target this fast-growing market of media and triple play networks. In contrast to other vendors trying to adapt their old platforms to also handle video and mission-critical data, Net Insight has designed its NGN product platform to handle these new market requirements as well as the old ones. With Net Insight's network solution and new access and server equipment, the business case for triple play and new video services is very compelling and offers attractive pricing to the end customers for bundled services.

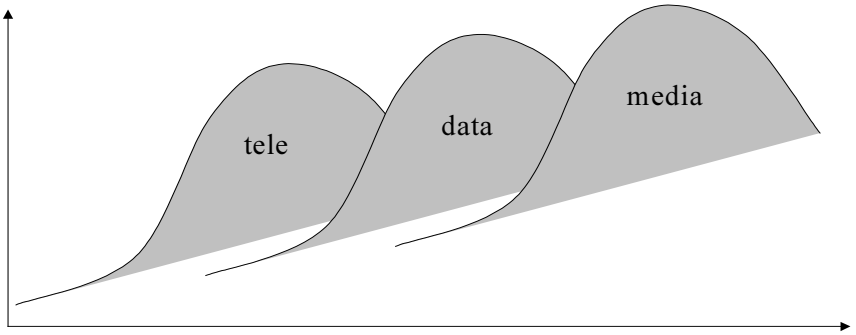

Figure 2. Media – The next level of convergence

Support and maintenance are major costs for the telecom operators, often far exceeding the capital investments. Using an automated control plane, such as the new GMPLS standard, with neighbor discovery, automated recovery, simple QoS management and signaled end-to-end provisioning, can significantly reduce the OPEX for the operators, as will be shown later in the paper.

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Enabling Media & Entertainment Services over the Internet

From a technology perspective, vendors and operators have for a long time pursued the goal of providing an integrated services network with the capability to transport both datacom and telecom traffic over the same infrastructure. This development started with with ATM (Asynchronous Transfer Mode), continued with IP and is now being pursued with (G)MPLS (Multi Protocol Label Switching) and NGN standardization within ITU. Development of communication technologies over the last decade has focused on packet switching.

Packet switching technology offers a dynamic and efficient application interface, and is also optimized for dynamic aggregation of best effort traffic. In packet switching, the packets are transported using resources (such as communication links and buffer space in switches/routers) that are statistically shared with traffic from other sources through the network, giving a flexible utilization of the network resources. However, since the resources are shared, it is very difficult to give guarantees on the transport.

Achieving an integrated service network has not been an easy task, primarily because of the underestimated complexity of introducing full QoS support in packet switched networks. Stateless priority schemes are however fairly easy to introduce, and have also to some extent been taken into operation. Even though this may seem to work fine for prioritizing e.g. a small number of IP-telephony calls over a large amount of best-effort traffic, a fundamental problem with the method becomes obvious when media oriented traffic starts dominating the bandwidth spectrum. The priority schemes currently proposed to solve the QoS problem (for example DiffServ and IEEE 802.3p) fail, as they only work when the relative amount of quality demanding traffic is small compared to the other traffic in the network. The requirements from a media & entertainment rich Internet has more or less been neglected.

It has also been argued that overprovisioning could solve the quality problem in packet switched networks. However, real-world data shows that overprovisioning is a very costly way of addressing the issue, since a substantial cost of a network is the fiber infrastructure and low utilization means that more fibers/wavelengths and more ports are needed. Recent research has also shown that the QoS problem is worse than expected and typically accumulates with the number of hops and the number of ports in the network [Bennet et al.][1]. Without putting restrictions on the network (such as the number of hops, topology, etc), it is possible to get as low as 10-20% utilization in the telecommunications network when trying to maintain the quality of service (QoS) needed for video services (see figure 3).

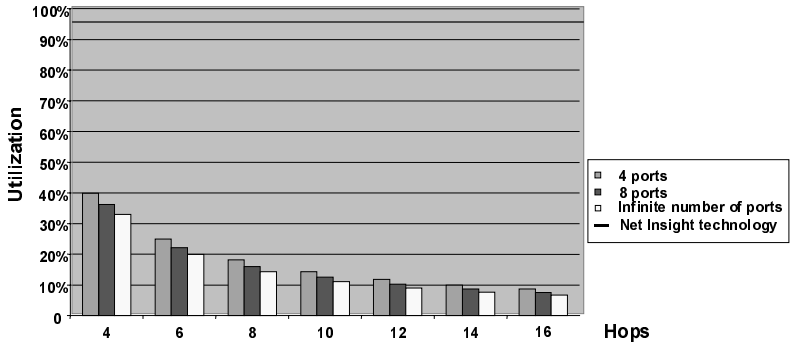

Figure 3. Utilization degradation for QoS traffic with increased #ports and network hops

[1] Bennett, et al, "Delay Jitter Bounds and Packet Scale Rate Guarantee for Expedited Forwarding", INFOCOM 2001.

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Solving the QoS Bottleneck

With the evolution of technologies such as NG SDH/Sonet and the Generalized MPLS (GMPLS) framework, we can make use of bandwidth channelization and the optical layer to do resource reservation and provision services end-to-end.

Channels based on Time Division Multiplexing (TDM), as compared to packet switched solutions, can inherently be made to guarantee the transport of data. The major reason for this is that the traffic that belongs to one stream is completely separated from other traffic throughout the network, and therefore there will be no congestion or delay variation in the network. In this way, the quality of service can be guaranteed with maintained high utilization in the networks.

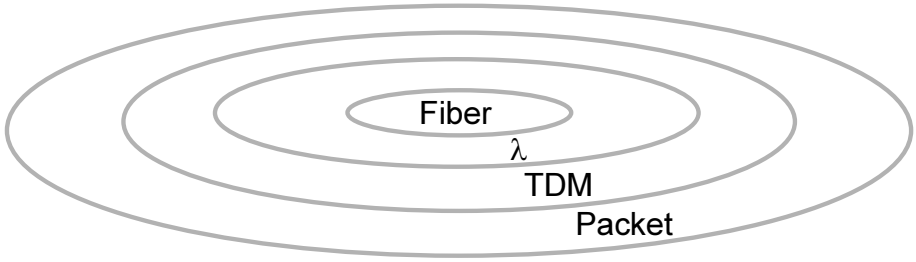

Figure 4. TDM in the transmission/switching hierarchy

The TDM layer operates between packet services and the wavelengths and adds the following functionality to the network:

- **Channelization of bandwidth** – Wavelengths are too coarse a unit for use in many applications (such as private lines, router interconnects, Internet exchange points). Service channels are normally not the size of a wavelength and it is most often not economically feasible to have one signal per wavelength.
- **QoS** – Packet networks can only prioritize and never give strict guarantees for a service. For traffic types in need of strict guarantees, such as leased lines, professional video transport, PDH transport and CATV distribution, the TDM layer provides a 100% quality service.
- **Monitoring and network maintenance** – The TDM layer facilitates functions such as performance monitoring, protection switching, framing, etc.
- **Simple and high performance** – TDM technology is very simple in its structure and therefore reliable and easy to manage.

However, despite the advantages, traditional TDM technology, as used in SDH/Sonet, also has a number of drawbacks, which has limited the applicability of SDH/Sonet in datacom networks. The technical challenges mainly have been the time-consuming process of establishing a SDH/Sonet signal, inefficient mapping of data onto the SDH/Sonet signal and the inflexibility of capacity changes in SDH/Sonet networks resulting in poor utilization. During the last years, there has been much work performed to solve these problems with NG-SDH/Sonet. These include LCAS for changing the bandwidth of a connection, Generic Framing Protocol (GFP) for mapping data on SDH/Sonet and virtual concatenation to make SDH/Sonet more flexible and increase the channel granularity. However, NG-SDH/Sonet still has a rather coarse bandwidth granularity with transport being performed at VC-3 or VC-4 levels. Also, for video and triple play applications, it offers a rather weak support for

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handling multicast over a meshed network and the provisioning is still performed from a centralized management system. Net Insight's NGN platform is based on NG SDH/Sonet and will therefore work fully interoperable with other NG-SDH/Sonet products. However, the platform includes a signaling control plane for fast and automated provisioning and for automated configuration and recovery schemes. Additionally, the platform includes multicast over any topology, the option of using unicast channels and an optional add-drop and DXC granularity on a sub-VC-12 (sub 1.5/2 Mbps) level using the ETSI standard DTM (Dynamic synchronous Transfer Mode) internally. This provides large cost savings in e.g., metro aggregation and triple play/CATV networks.

Net Insight technology

Net Insight uses a system based fully on existing standards, and follows the NG-SDH/Sonet and GMPLS framework, combining the best of Ethernet data access, next generation SDH/Sonet transport and automated provisioning and management.

The product platform provides a true integrated Multi-Service Provisioning Platform (MSPP) with native video interfaces and extensive Ethernet functionality. For data, IP/Ethernet (10/100/1000) interfaces are used, E1/T1 and SDH/Sonet interfaces are provided for transporting voice and DVB-ASI and SDI interfaces for video. The system can run directly on fiber, using physical Gigabit Ethernet optics or run on existing standard SDH/Sonet links (OC-3/STM-1, OC-12/STM-4, and OC-48/STM-16).

An optical control plane is used to provision services, whether data, video or voice. GMPLS is being developed within the IETF and ITU to have an IP centric control plane and benefit from the development of MPLS. Net Insight early understood the benefits of an optical control plane for provisioning channels end-to-end. A signaling control plane, with enhanced GMPLS functionality for load balancing, mesh protection and multicast provisioning, has therefore been integrated in all products. Net Insight currently uses an overlay model but is looking at a migration towards a fully integrated GMPLS control plane when the standards are set and mature.

Using dynamic bandwidth channelization with signaled end-to-end provisioning, Net Insight can assure 100% QoS for IP video traffic, even with a network load of over 95%. This enables an extremely high utilization of the infrastructure investment, which reduces the overall CAPEX of the solution. For mapping data onto channels, a frame-based GFP (Generic Framing Protocol) scheme is implemented and LCAS (Link Capacity Adjustment Scheme) functionality is included for changing channel capacity during operation.

A NG-SDH/Sonet channel structure has the advantage compared to traditional TDM that channels of configurable size can be set up with a much higher channel granularity, both unicast and multicast. Net Insight can between Net Insight products provide an enhanced channel functionality, providing a non-hierarchical, higher granularity (nx512 kbps) and generic multiplexing layer, which means it cannot only multiplex traffic on existing SDH/SONET frames but also on physical Gigabit Ethernet links (see figure 5). With the cost advantage of Gigabit Ethernet transceivers compared to SDH/SONET's, this allows for very cost-efficient networking over dark fiber or wavelengths in access networks.

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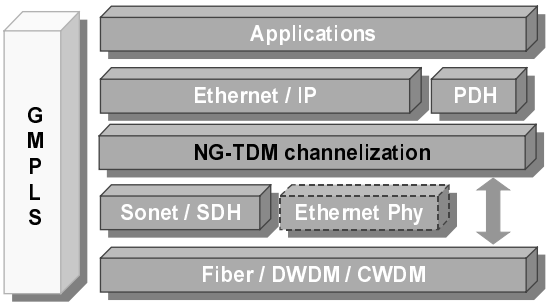

Figure 5. Net Insight protocol model based on NGN and GMPLS framework

Combining dynamic bandwidth channelization, efficient Ethernet access and an automated control plane enables a true convergence of data, video and voice services, with the reliability and quality benefits preserved, a much higher utilization of the underlying infrastructure and easy end-to-end management.

Technical benefits summary

To summarize, the most important improvements of Net Insight's solution with NG-SDH/Sonet interoperability and GMPLS support compared to traditional SDH/SONET are:

- **Configurable channel size** – Channels have configurable size, high granularity and they can be *symmetric or asymmetric* according to desire, thereby dramatically increasing bandwidth utilization.
- **Flexible topologies** – The data link topologies can be configured to build ring, bus, and/or point-to-point/mesh structures as desired.
- **Incremental scalability** – To upgrade a mesh link or a segment in a ring, link bundling can be used. With link bundling an extra link can be added between any two nodes to add capacity to the network. The system will use a link state protocol to regard e.g., two parallel 1Gbps links as a single 2 Gbps link. This allows for efficient upgrades and build-as-you-grow abilities.
- **Non-hierarchical switching** – Channels can be aggregated and switched on VC3/VC4 levels. However, channels can also be set-up end-to-end and switched on sub-VC12 levels. Links can be setup as desired to build large network structures, without affecting the characteristics of the transport.
- **Signaled end-to-end provisioning** – Channels automatically find their paths through the network during provisioning and re-routing due to faults, only requiring identification of end points. In-band signaling handles the setup through the network.
- **Multicast** - Channels can be point-to-multipoint, essential to the accommodation of media services of high quality to a large number of receivers. An example of such a service is IP based cable TV.
- **Generic transport** – The platform includes an option to run on both SDH/SONET and Gigabit Ethernet optics, leveraging on the cost-effectiveness of GbE components.

The next section will elaborate on and further explain these advantages.

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System Advantages

Configurable channel size through non hierarchical multiplexing

With Net Insight's system, a channel can be provisioned with any size in increments of 512 kbps, handling from both VC-12 and VT1.5 concatenation up to full link speed. Channels can fit the service instead of forcing the service to adopt to static network conditions. For example, a 10 Mbps IP or DVB-ASI service can be transported in a 10 Mbps channel. Unlike the case in a traditional SDH/SONET network, it is not necessary to let the service consume an entire 45 Mbps circuit. However, when communicating with e.g., other NG SDH/Sonet equipment, Ethernet streams are encapsulated in GFP and transported in standard concatenated VC-3/VC-4s.

Traditional telecom infrastructure is developed to optimize the transport of 64 kbps bidirectional circuits by providing bandwidth in fixed rates suited for this purpose. Legacy SDH/SONET networks are therefore optimized to multiplex signals in increments of 1.522 Mbps, 45 Mbps, 155 Mbps, etc. (or 2.048 Mbps, 34 Mbps and 155 Mbps in Europe). This causes problems with utilization when trying to fit new services into existing networks since data and media signals do not conform to the telecom rates. For example, MPEG coded video with VHS quality requires 4-6 Mbps capacity, HDTV typically requires 19-50 Mbps depending on compression and most production video uses 270 Mbps. This, in combination with the flexible bandwidth requirements from pure datacom services, makes configurable sizes of channels essential for efficient bandwidth utilization.

Additionally, a significant part of the media related traffic is unidirectional, or at least asymmetric. Again, support for asymmetric channels are often key for bandwidth efficiency. In practice, this can provide up to 100% increase in network utilization.

Supports any network topology

Net Insight uses a distributed switching architecture where each node can switch any-sized channels. In combination with the dynamic optical control plane, the system therefore supports all relevant data link topologies, including point-to-point, mesh, dual bus, ring and dual ring links. This enables operators to have flexible network topologies, simplifying network engineering and decreasing the network expansion costs significantly.

Importantly, the topologies support crucial reliability functions such as self-healing dual ring structures and automatic alternative path re-routing of channels at link or equipment failure. Furthermore, such service restoration can be provisioned to use either full 1+1 protection for critical services, with a down-time of less than 50 milliseconds, or the simpler alternative of so-called service re-routing (mesh protection), with a typical less than one second down-time. With mesh protection and the per channel 1+1 protection capability, the utilization can be increased up to 2X compared to legacy transport networks when all traffic must not be 1+1 protected.

Incremental scalability – pay as your grow

With inherent switching combined with GMPLS management features, such as neighbor and path discovery, the network can easily scale in number of nodes, and still maintain the reliable transport characteristics.

The network is simply expanded by interconnecting several links between nodes. Different links can also run at different link speeds. Links and topologies are automatically detected using the link state protocol and for a node, two 2 Gbps links will be treated as one 2 Gbps

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trunk. It is thus possible to build out your networks step by step, by adding just another mesh link or node. This is in contrast to for example existing SDH/SONET networks, where all nodes connected to the same ring need to be upgraded at the same time.

To avoid the hierarchical structure of current SDH/Sonet networks, all network nodes incorporate add/drop multiplexing and switching in a single platform, further improving network efficiency and simplifying network planning. This means a link can be added between any nodes to increase capacity between nodes or to add another ring or access node.

Furthermore, the switching delay is very short and always constant for a channel. Multi-hop channels therefore display the same properties as a channel on a single link. The only difference is that a multi-hop channel has slightly longer delay. Due to the strict resource allocation, and since no dynamic buffers are used for switching data, there cannot be any overflow or congestion inside this network.

Signaled end-to-end provisioning

To achieve high utilization and low-cost operation, it is crucial that the provisioning of services over the networks be a simple task to perform. This is one of the main objectives of GMPLS and from the beginning, end-to-end provisioning and an automated control plane has been key in the Net Insight system.

Net Insight's equipment uses in-band signaling (optical control plane) for automatic service set-up. More specifically, a separate channel is at all times used for specific control information such as signaling, path selection information, resource management and bootstrapping.

With automatic in-band provisioning, channels can be established by specifying channel end points only. The signaling protocol also allows for changing the capacity of a provisioned channel during its existence. In practice, this means that services are provisioned in a very short time using simple point-and-click management, not resorting to hours or days waiting for clarification, identification, and verification of suitable circuit paths. Pioneer Consulting described the advantages of using an optical control plane in its 2002 GMPLS report, showing that a fully integrated GMPLS can reduce both CAPEX and OPEX with up to 55% (see figure 6) while enabling new revenues.

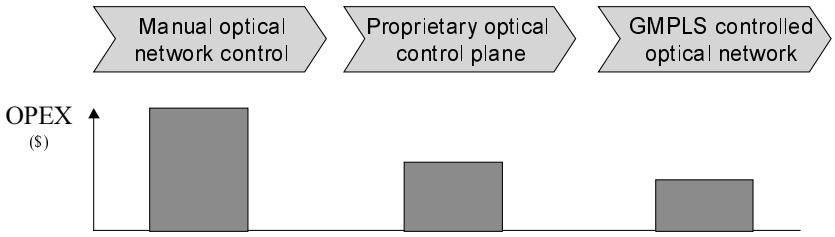

Figure 6. Cost advantages using a GMPLS-like optical control plane

QoS capable multicasting

A substantial part of next generation media-rich Internet services will be based on distribution services, requiring efficient multicast or broadcast over the network. One big problem with today's IP infrastructure is that it does not support the high level of QoS needed for such multicast sessions. To offer support for multicast QoS, Net Insight's system can provision all channels to have any number of receivers. Mapping for example IP/MPEG

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services on top of the quality preserving TDM channels solves the QoS problem for multicast very elegantly. On top of this service, normal IP multicast functions such as IGMP can be used, e.g., for choosing which TV channel to look at in an IP TV network environment.

Network Management

Simplifying network management was a guiding principle in the development of Net Insight's system. The platform can be used in different network environments, from long haul backbone networks all the way down to access networks.

The toughest requirements are found in the metro aggregation and access where automatic configuration, provisioning and maintenance are needed in order to make it economically attractive.

Therefore, most functions in the network are autonomous, yet configurable. To achieve this goal, the following key features are included:

- **Automatic channel establishment –** Uses a signaling protocol for establishing channels, including path selections through the network.
- **Full network control –** Possible to manually configure the paths through the network.
- **Automatic neighbor discovery** – When a new node is connected to other nodes, or is started up, it exchanges information, such as address, with the other nodes.
- **Automatic topology discovery** – The topology of the data link (bus, ring, dual ring or point-to-point) is automatically discovered and maintained.
- **Automatic resource allocation** – The allocation of resources on links automatically adapts to the requested service requirements at start-up, during operation and in case of failures.
- **Data link fault management** – Node and link failures are detected and handled automatically. Two different protection schemes are offered and can be combined in a network solution, 1+1 channel protection and mesh protection.

The management of the network and the provisioning of the network services are handled through standard management interfaces such as SNMP, http and CLI. The management network for reaching the nodes in the network can both be in-band or out--band: For **out-band management** each node is reached through local Ethernet or serial interfaces and the management network is a separate network. The **in-band management** network is an overlay network and uses data channels that are totally separated from user data channels. Since user data channels are never terminated in a network node, users cannot get access to a node as is often possible in today's IP networks, further enhancing the security in the network.

Network Services

A Net Insight network provides a general infrastructure that can transparently transport all types of traffic. There are basically two types of services, streaming services that transparently transport traffic through the network and datacom services where aggregation of traffic is done using packet switching.

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Isochronous transport services

For isochronous services, like PDH (E1/T1, E3/T3), SDH/SONET and video such as uncompressed SDI and DVB-ASI transport streams, the transport service offers a completely transparent “bridge” or “tunnel” from ingress interface to egress interface.

For bi-directional, symmetric traffic like PDH, the service offered is bi-directional, symmetric tunnels, and for unidirectional traffic like SDI video, the service is a unidirectional tunnel. The size of the tunnels are typically predefined to match the respective traffic type, except for the DVB-ASI service where the channel can be set up with configurable capacity to adopt to the payload requirements.

Also, the operator can decide whether or not to use 1+1 protection for the individual service.

Data services

For asynchronous data traffic with identified reliability and quality of service requirements, such as streaming, IP/MPEG video or guaranteed VPNs, end-to-end uni- or bi-directional tunnels are offered (IP tunnels, Ethernet tunnels, or ASI tunnels). These tunnels maintain characteristics similar to the ones used for streaming synchronous services but are set up with configurable bandwidth.

In contrast to isochronous transport services, data services are always offered with configurable bandwidth. Mapping data packets to channels at the edges of the tunnels makes sure that the tunnels are used exclusively for the desired traffic, as identified using interface, port, Ethernet/VLAN address, or similar sorts of information.

Channels are either dedicated, as in the case of a video stream, or shared, which is typically the case in aggregating IP traffic from an edge router or DSLAM up to the Internet POP. For shared channels, the system works similar to a dynamic POS network, but where the channel sizes can dynamically be set up to accommodate the actual traffic demands.

For distribution data services, point-to-multipoint (multicast) tunnels are available. In the case of multicast IP traffic, one or several IP multicast streams are mapped to a multicast tunnel. Attaching to different multicast groups, e.g., when zapping between different IP TC channels is accomplished by using standard protocols like for example IGMP (Internet Group Management Protocol).

The chapter “Network Solutions” below will illustrate how these types of services are combined in some exemplified scenarios to deliver a full multi-service environment.

Network solutions

Net Insight enables customers to increase revenues by permitting them to implement new services and enter new markets. Customers also benefit from increased utilization of the existing network. High utilization means fewer fibers/wavelengths needed, fewer ports and therefore less equipment.

Net Insight solutions are especially targeting:

- **Triple Play and CATV networks** enabling cost efficient distribution of high quality voice, data, TV and video related services.

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- **Professional Media Networks**, interconnecting geographically separated production facilities, with reduced cost and enhanced quality for contribution and production.
- **Metro Aggregation Networks**, for effective aggregation of legacy SDH/Sonet, PDH, ATM and new revenue-generating Ethernet-based services such as Ethernet leased line, video conferencing, company TV and telemedicine, etc.

Service rich broadband access networks

Triple Play over xDSL - Broadband access over xDSL is one of the fastest growing networking markets. These networks were initially built to only handle high-speed Internet access. The low margins for only offering Internet service combined with the threat from cable operators offering triple play services over their cable infrastructure has led more operators to trial or deploy triple play over xDSL to increase their revenues per subscriber. Instat/MDR Group estimates that approximately 60 million households worldwide will be able to subscribe to TV and video services over xDSL by 2006.

Net Insight offers a Video-Empowered Ethernet™ solution for efficient delivery of guaranteed quality video, voice and Internet service over the same infrastructure. While other of today's solutions have problems with very low utilization when introducing broadcast TV and video solutions, Net Insight can maintain a utilization over 95% with guaranteed QoS for the IP video services.

Traditionally, xDSL aggregation was performed over ATM access networks using STM-1/OC-3 uplinks from the DSLAMs. However, migrating to a triple play service over ATM requires multiple STM-4 uplinks for the video, which means upgrading to new DSLAMs, new ATM switches and often, new modems capable of handling multiple PVCs. This becomes very costly and many operators are taking the opportunity to move to an IP/Ethernet centric solution using Gigabit Ethernet for the DSLAM uplink. Net Insight offers a Gigabit Ethernet access solution with enhanced QoS and multicast functionality for very efficient triple play networks. Video traffic is separated from other traffic via the inherent bandwidth channelization, which ensures a strict QoS even at very high load in the network. TV and video traffic experiences only one hop from head-end to subscriber and the video traffic bypasses the BRAS (Broadband Remote Access Server), which allows the BRAS functionality to be centralized further reducing CAPEX and OPEX. Additionally, Net Insight products can tunnel STM-1/OC-3 in parallel with the Ethernet traffic, enabling a migration with both ATM and Ethernet in the aggregation network.

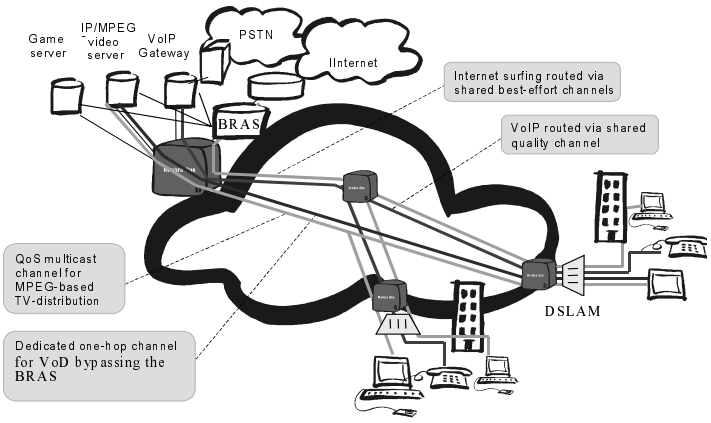

Figure 11 Service rich broadband network

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CATV transport networks - CATV networks are being upgraded for more effective video transport and for allowing more interactive data and video services. Net Insight offers a multi-service CATV transport solution with MPEG video transport, over either ASI or IP/Ethernet interfaces, combined with effective data transport. The quality of the video traffic, whether over ASI or IP/MPEG, is always guaranteed due to the inherent service separation. Compared to traditional point-to-point STM-1/OC-3 solutions, the capacity of the underlying network infrastructure can be utilized up to 3-4 times better.

Most video servers use Gigabit Ethernet for sending interactive video and Video on Demand (VoD) services. Since Net Insight's products can offer full quality transport for IP/Ethernet traffic in parallel to the ASI multicast, these services are easily added to current CATV networks. Many existing CATV networks are being built on top of existing SDH/SONET networks. However, since Net Insight's products can run over existing SDH/SONET networks, or directly over dark fiber and wavelengths, the operators can choose the best combination.

Professional Media networks

The evolution of optical communication allowing high bandwidth transport in combination with dramatically falling prices on fiber capacity has made media communication over optical networks a very competitive alternative to satellites and tape delivery. Satellites are expensive and cannot offer the capacity or the QoS with short delays that can be provided by optical networks. Media network solutions, based on next-generation optical transport technologies, can radically change the economics of digital-media content distribution and contribution

Point-to-point solutions over fibers or SDH/Sonet connections are currently used for enabling the QoS required for professional streaming services. However, the low utilization and costly equipment has so far held back this evolution.

Net Insight's product platform supports transport of the media industries' own formats with maintained quality and with optimal network utilization. A transparent media tunnel, whether SDI, DVB-ASI, or IP, connects directly to the studio end equipment, replacing costly conversion equipment (see figure 7).

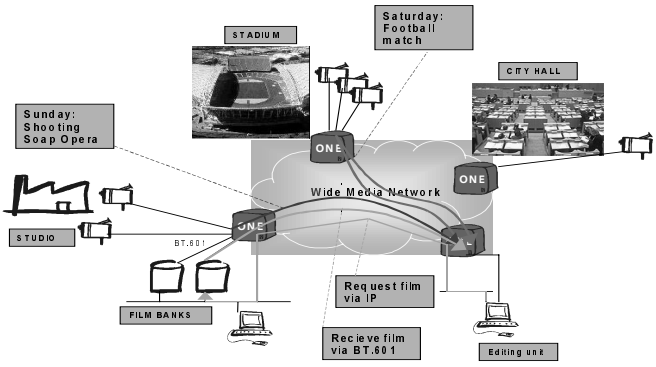

Figure 7. Media network

Increasingly more media traffic is sent via compressed IP or DVB-ASI channels. Being connected to a media wide area network simplifies footage trading and enables faster turn-around times in production. Net Insight's product platform also enables uncompressed SDI video to be sent between studios at geographically separated areas, with studio quality in terms of jitter and wander, allowing full quality throughout the production. In the same

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infrastructure, it is still possible to combine the video transport with other services, such as traditional IP services and voice. This creates e.g., the possibility of remote control of editing machines and cameras. Net Insight's optical media solution allows for faster production with maintained full quality, less need for conversion and compression equipment at remote sites, higher reliability and less need for e.g., expensive encryption compared to satellite communication. For further information on media networking, please read the Net Insight white paper on this topic.

Summary

Net Insight develops data and video networking equipment that combines 100% QoS with maximum network utilization and multicast to provide a network with superior efficiency. Customers benefit from significantly reduced CAPEX and OPEX, which protect and enhance their existing infrastructure investment, while providing the ability to launch new TV and video related services.

Net Insight solutions are developed for excellent fit into:

Triple Play and CATV networks - enabling cost efficient distribution of high quality voice, data, TV and video services.

Professional Media Networks - interconnecting geographically separated production facilities, with reduced cost and enhanced quality for contribution and production.

Metro Aggregation Networks - 100% QoS, high granularity, high utilization and easy management enables a cost efficient and competitive multi-service network with a clear handling and future migration for today's legacy services based on SDH/Sonet, FR, PDH and ATM.

Net Insight combines the best in cost-efficient Ethernet data access, NG-SDH/Sonet and the latest advances in optical transport technologies to cost-efficiently enable metro aggregation, triple play and media services over public network infrastructures.

Net Insight's platform makes it possible to transport video in real-time over large fiber networks as compressed IP traffic or as uncompressed 270 Mbps digital video signal. Net Insight's solution is presently being used by broadcasters to transport video content and by broadband and telecom operators seeking to provide video, voice and data cost effectively in order to differentiate their offerings to attract and retain subscribers.

By using dynamic NG-SDH/Sonet channels with end-to-end provisioning, all types of traffic such as IP, Ethernet, SDI and ASI video etc. can be routed over their own separate channel, which helps minimize issues of jitter, packet loss and traffic delays. The solution is based on international standards and is compliant with the emerging NG-SDH/Sonet and GMPLS standards. All products have been developed so that they can be integrated with existing infrastructures. Standardized interfaces to the established technologies allow operators to upgrade their existing networks to better utilize the capacity, while at the same time it will be possible to offer additional and comprehensive services.

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