IP TRANSPORT TECHNOLOGY IN THE CABLE BACKBONE

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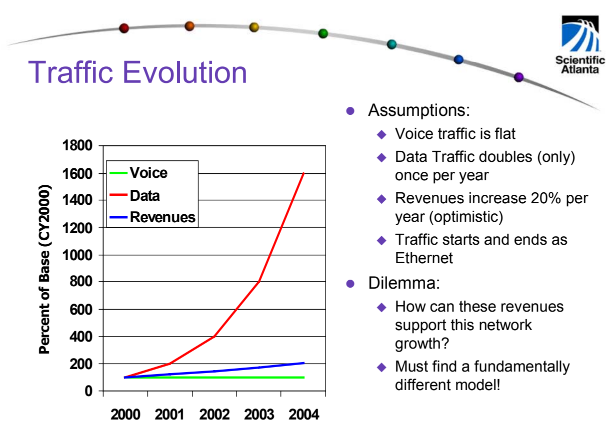
Cable operators who have successfully introduced cable modem, voice, and other interactive services to residential subscribers, as well as those penetrating the lucrative business-to-business [B2B] market are beginning to drive a very different backbone traffic pattern, both in volume and composition. We are forecasting a continued growth in IP data as a percentage of the total primary ring traffic. In order to prepare, the cable operator must shift his attention toward the upgrade of the transport network.



Transport Backbone Requirements

For a cable operator and their CLEC affiliate to be competitively positioned, the transport network must meet certain requirements.

Scalability - Ability to cost effectively scale to multiples of tens of Gigabits [Gbps] of transport capacity. As voice, video and data services grow the network should expand on a pay as you go basis.

Low Cost per Gbps – includes initial costs and operational costs. Remember, bandwidth growth outpaces service revenue growth so we need a new model.

Support of Voice, Video, Data Services – The ability to transport analog/digital video, circuit switched voice, and IP data using a wide variety of interfaces over a single integrated network. It is our belief that IP based traffic will soon comprise the majority, and must be specifically planned for.

Delivery of Next Generation Differentiated Services – The network must support service creation through extensive software Quality of Service [QoS] control, and subsequent monitoring and billing of these services through Service Level Agreements (SLAs). This is particularly important in the B2B market place.

Network Resiliency – 99.999% network uptime, redundant hardware and switched ring or mesh topologies.

Simple but Powerful Network Management - In addition to the critical monitoring and fault isolation capabilities, the ability to simply "point and click" provision the network is very important.

Today's Network Architectures

In touring any major cable headend facility today, you are likely to see one of the following architectures:

1. Multiple networks
2. Metro DWDM [Dense Wave Division Multiplexing]
3. SONET multi-service provisioning platforms [MSPPs]

Most often found is the system with multiple networks simultaneously operating in the cable backbone, each over a dedicated fiber. Distances allowing, you may find analog/digital video on a SONET or proprietary digital network, cable modem likely over a router network, voice and other data transported on ATM. As service traffic grows, a second or third network is often replicated; expect this first in cable modem services as additional CMTS are required. This multiple network approach quickly consumes a majority of available dark fibers and will proliferate facilities with multiple transport platforms.

The introduction and deployment of metro DWDM technology allows the cable operator to reclaim many fibers for future use. Though, two problems still remain. Because metro DWDM platforms typically map a given stream onto its own wavelength, they do not provide a means for efficient flexible aggregation of lower rate [usually electrical] streams in the DWDM platform. Secondly, a transport box per service still remains; each device with it's own set of protocols, element management and staffing, and support requirements for the network. The DWDM solution is still complex and expensive.

SONET multiplexers are often utilized to electrically aggregate low data rate services like 100 BT or OC-3 ATM into higher bandwidths, typically OC-48, for transport. Current technologies recently released are based on new mappings of circuit-switched payloads into SONET frames. These products, often referred to as SONET MSPP's [multi-service provisioning platforms], map traffic into different size circuit pipes based on multiples of SONET STS-1. Also available are numerous ATM and VP networks based on ATM over SONET technology. Good news is, this aggregation approach to transport simplifies the cable backbone, particularly in constant bit [CBR] services that fit neatly into standard SONET pipes. The bad news is, SONET MSPP's are less bandwidth efficient when transporting variable bit [VBR] IP based traffic and that's where all of your growth is projected to be.

A New Technology

There is a new aggregation technology that will increase transport bandwidth efficiency and utilization while still offering the desirable benefits of SONET's protection switching and ATM's QoS. This new technology Resilient Packet Ring [RPR] is currently an IEEE 802.17 working group with expectations to emerge as a worldwide standard in early 2002. RPR combines the best of SONET, Gigabit Ethernet, and DWDM technologies into a box that optimizes IP transport in the cable backbone.

Scientific-Atlanta and our technology partner Luminous Networks are active members of IEEE 802.17 and have submitted our version of RPR to the group called Resilient Packet Transport [RPT], for inclusion in the final standard.

RPT Technology Blocks

RPT technology is centered around four major innovations.

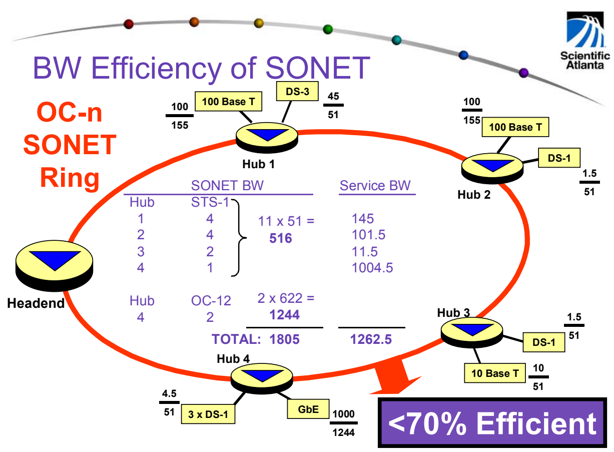
1. RPT utilities Gigabit Ethernet over Fiber, a packet-switched optical transport layer, optimized for efficient IP transport. This transport layer is similar to an Nx Gigabit Ethernet physical layer, with the addition of robust service mechanisms like performance monitoring, network synchronization, and control packets. RPT achieves SONET–level robustness at Gigabit Ethernet costs.

RPT's physical layer can be single wavelength or DWDM and is decoupled from the logical topology of the network.

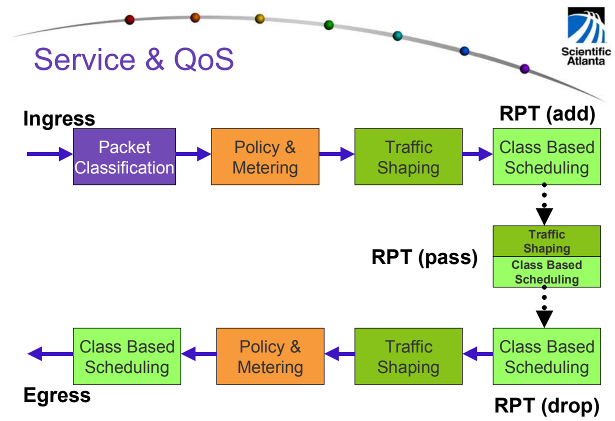
This enables the cable operator to configure point-to-point, rings, and mesh networks.

2. RPT enables full system redundancy and 50 ms span restoration switching. RPT also allows up to 200% of the ring bandwidth [work and protection] to be over provisioned with traffic when there is no span break. Typically, SONET requires the protection ring to be in reserve for protection switching events.

3. All traffic is statistically multiplexed in Layer 2 packets at point of ingress. This provides optimum efficiency in the transport of bursty IP traffic that otherwise would be limited by preconfigured SONET pipes. RPT yields a 30 to 50 percent increase in effective transport capacity over comparable circuit switched networks operating with similar nominal bandwidth links.



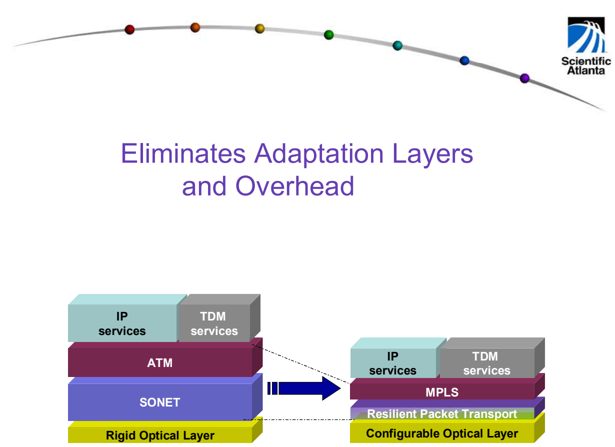
4. RPT provides extensive QoS support, including policing, shaping, class-based queuing, and flexible scheduling employing strict priorities and algorithms. RPT also supports minimum latency express paths for packets passing thru [but not dropping] at a hub. RPT overcomes the best effort IP QoS limitation found in Gigabit Ethernet to offer a strong alternative to ATM.



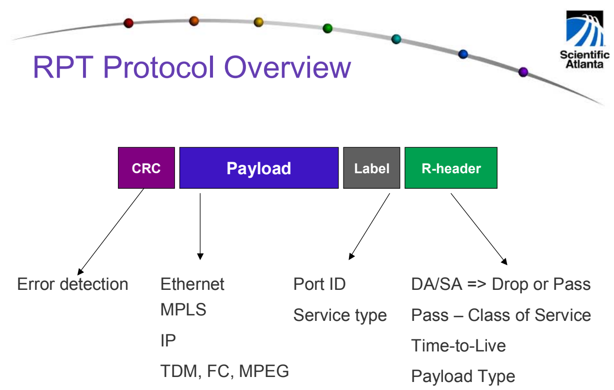
Implementation Benefits of RPT

In implementation, RPT will allow the cable operator to effectively deploy new services, simplify network design, and reduce operation expenditures.

RPT eliminates adaptation to connection-oriented protocols [like SONET and ATM] and recovers some lost overhead. These layers are replaced by a thinner and more flexible RPT and MPLS stack capable of transporting IP services, TDM voice circuits, and video.



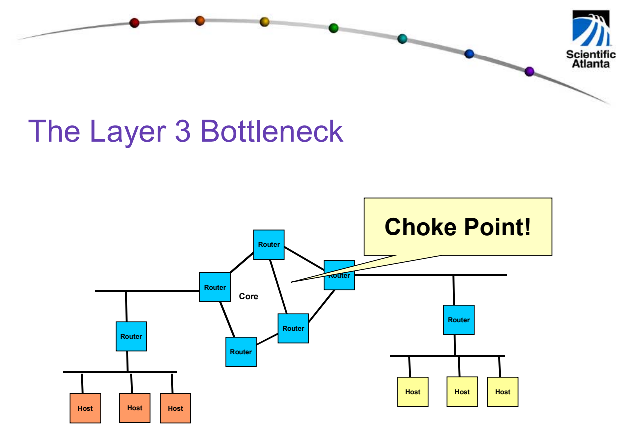
The RPT packet includes a 6 bytes RPT header and 4 bytes MPLS and contains all the necessary information to move the packet through the network. This is a very small tax relative to SONET and ATM for similar functionality.



Central to RPT is the ability to enable switching and transport at the packet level. Packet level processing yields infinite granularity and maximizes transport bandwidth efficiency. Eliminating the need to map bandwidth into preconfigured circuits that are always the wrong size. RPT enables the provisioning of more services to more customers over the same cable backbone network. Transport bandwidth may be provisioned in exacting amounts with flexible burst capability.

RPT technology transports video, data, and voice payloads using MPLS [multi-protocol label switching] techniques. The video payload consists of MPEG data originating from either a QAM IF or DVB-ASI interface. The data payload is IP and originates from 10/100 BT, 100 BFX, GigE, or OC-n POS interfaces. The voice payload consists of T-1 or E-1 frames. RPT supports TDM voice by establishing network synchronization to an external Stratum clock (BITS, T-1). This allows transport of toll quality voice services originating from TDM equipment.

In conventional router networks, bottlenecks can occur when L-3 packet traffic exceeds the capacity of the router to efficiently "open" each packet, read the destination address, etc., and forward to the next router. Today's solution requires the cable operator to upgrade to a higher capacity router.



RPT eliminates the layer three bottleneck and expense by operating in Layer 2-1/2 and using the RPT header for pack destination information. As each packet traverses network, the RPT header determines if the packet should be dropped or passed. RPT enabled boxes will likely reduce network dependence on high capacity routers.

RPT should better position the cable operator or its CLEC partner to sell differentiated services to end users [often B2B customers] through Service Level Agreements [SLAs]. A SLA is a contract between the operator and the user/subscriber setting expectations and pricing for transport services while establishing penalties for non-compliance. These end-to-end service guarantees include latency, bandwidth, and packet loss. For a successful business, SLAs require all traffic to be trackable, verifiable, and billable.

RPT enables this high-end service capability through the implementation of QoS and network management. Key to RPT's implementation of QoS is the preclassification of each [voice, video, data] packet as it ingresses the ring. Classification is based on "diffserve" code, source/

destination address, port, MPLS tag, or application or a combination of the above. RPT offers eight QoS classes from express forwarding [EF] for time sensitive services like video or toll voice, ranging to best effort [BE]. Once a preclassified packet enters the ring, software algorithms manage traffic congestion and properly balance add/drop/pass traffic at each node.

RPT's Network Management Control is standards compliant and includes the ability to control the provisioning of guaranteed services and implement SLA's. Point and click provisioning for bandwidth management, cross-connects, class of service, and accounting management facilitate the cable operators ability to deliver, monitor, verify, and bill for differentiated IP services.

Summary

It is forecasted the growth and pattern of traffic in the cable operator's backbone network will migrate towards IP data. However, the MSO must also reliably and efficiently transport analog/digital video, and TDM voice services over this same network. RPT technology offers a packet level alternative that is efficient for all types of transport traffic, and allows the true economic benefits of a single platform transport solution to be realized.