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SONET versus STP Ethernet Switch Rings

SONET has compelling advantages over STP and RSTP Ethernet switch rings when mixing voice, serial data and ethernet data.

Overhead

Is anything gained when sending both TDM and IP data over ethernet? At first glance, one would answer "yes". TDM requires fixed channels, and these fixed channels may not always have any data in them. The unused bandwidth can be considered wasted if there is an idle TDM channel carrying no data while an ethernet channel is, at the same instance, overloaded due to a burst of ethernet/IP data activity.

TDM (voice and serial data, typically), uses just a tiny fraction of a SONET link, typically, leaving plenty of bandwidth for ethernet. Further, overhead added to TDM data to transport it over ethernet eats up any bandwidth utilization advantages. Sending T1 data over ethernet requires overhead that about doubles the size of the transported data packets.

Deterministic versus statistical burstiness – i.e., time delays

SONET is a TDM protocol, where the data stream is a constant rate, time divided into channels of various sizes. Each channel is a fixed amount of bandwidth. The time it takes to move data from one end to the other is constant. For example, a T1, running at 1.544 Mbps, is always guaranteed to take the same amount of time to get from end to end through a SONET network, typically a millisecond or two. No buffering is required.

Ethernet is a packet protocol, where the delivery time from end to end is not constant. Delivery time is a function of how busy the single channel might be due to how many packets of what size are vying for the single channel. This is termed "non-deterministic". A packet may take a fraction of a millisecond, a few milliseconds, or many milliseconds, depending upon what other data is also using the channel. Data from many sources must be buffered and sent down the ethernet link when time is available. For example, if a T1 is sent over an ethernet link, the T1 data is split into packets, typically UDP.

NextGen SONET Addresses the fixed channel issue

Next generation SONET has added the concept of Virtual Concatenation (VC) and LCAS (Link Capacity Adjustment Scheme).

Virtual Concatenation allows channels to be built up to optimum sizes, arbitrary in regard to the SONET backbone, but specific to the end point requirements. For example, bandwidth can be assigned to a T1 channel in a VT1.5 increment, which is T1 in size. It is not necessary to assign an entire 51 Mbit STS-1 to one or a few T1's.

LCAS adds dynamic load balancing and bandwidth on demand to SONET. If an ethernet channel is very busy, another not, LCAS seamlessly adds more bandwidth to the busier link.

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Next Generation SONET, when bridging ethernet packets, also allows users to define QOS (Quality of Service) applications that need low propagation delay, such as voice and video. Voice over TDM is the best choice for low propagation delay, but for VOIP applications, Next Generation SONET addresses the delay issue by adding QOS capability.

Voice echo issues, a consequence of packet delays

When running standard PCM voice over links with delays that are above 50 milliseconds, echoes become noticeable by the user. Over 50 milliseconds is where humans begin to detect the echoes, which can be irritating. Echoes are caused by impedance mismatch, the analog signal feedback through the 2-wire to 4-wire conversions between the local 2-wire phone line connections and the T1 transmission equipment.

Echo can be reduced by adjusting the transmit and receive level difference. Typically, the transmit levels are a higher than the receive levels, by 3 to 9 dB. The greater the differences between transmit and receive levels, the more the echoes are suppressed.

Echoes can also be suppressed by using echo suppressors, which are not typical on customer owned T1 transmission equipment.

Digital compressed voice devices usually have some echo suppression built to compensate for the transmission delays typical of compressed voice links. The echo suppression is done at the digital level.

Complexity, a consequence of TDM over ethernet/IP

When TDM is transported over ethernet, the complexity is greatly increased. For example, a typical TDM over IP devices requires a second level of TDM cross connect mapping. The TDM channel banks require cross connect mapping. A device that carries TDM over IP must also be mapped for the correct number of DS-0 channels to be transported. The TDM over IP devices must also be programmed with IP addresses, gateway, subnet mask, TDM packet sizes, jitter buffer sizes. The jitter buffer sizes may be appropriate initially, but become inadequate as the ethernet network becomes busier.

There is further complexity in configuring RSTP. Comparing RSTP configuration to configuring a SONET ring, a SONET ring has a more simple, straight forward configuration. For someone who has extensive router and switch expertise and little or no SONET expertise, it SONET may at first seem daunting, but it has far fewer concepts and nuances than Ethernet/TCPIP/UDP, routing, etc.

Long Term System Tweaking

A ring made with ethernet switches employing spanning tree will likely need more management over time than a SONET ring. As more devices are added and the load increases on an ethernet network, settings that were correct for TDM voice and for serial data circuits will change. Voice over IP requires jitter buffers and low propagation time to control echo. As loads change on an ethernet network, voice settings that one time worked may no long work without making configuration changes.

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Ring recovery time

A SONET ring will switch to the backup path in about 50 milliseconds. RSTP (Rapid Spanning Tree Protocol) takes 3 to 6 seconds to establish a new path in the event of a link failure, and STP (Spanning Tree Protocol) takes 30 to 60 seconds to establish a new path when recovering from a link failure.

Resilient Packet Ring is an 802.17 specification for Metro Area Networks. RPR is designed to switch as quickly as SONET rings, 50 ms. RPR is a layer 2 protocol than can overlay onto a SONET network or be considered an alternative to a SONET network.