Moving to High-Speed Frame Relay Services

Frame Relay has been the enterprise WAN of choice since the early 1990s. According to Vertical Systems Group, there were approximately 35,000 U.S. enterprises using Frame Relay services, compared to 1,637 using ATM services in 2000. Frame Relay offers a simple solution for point-to-point connectivity with Quality of Service (QoS) guarantees. Service providers also benefit from easy performance monitoring and Service Level Agreement (SLA) management. Currently, Frame Relay services are offered at a maximum port speed of DS-3 (45 Mbps). In addition, the maximum trunk speed in a Frame Relay core network, if ATM technology is used, is OC-48/STM-16 (2.5 Gbps) as shown in Figure 1. Very High Speed (10 Gbps) Frame Relay ports are not available in today’s market. Although high-speed access (beyond DS-3) can be obtained through ATM technology, Frame Relay is more cost-efficient and easier to manage.

Tellabs has created a complete solution for enabling High Speed Frame Relay services. This solution is based on the advanced Tellabs Multi-service Operating System (Tellabs OS) software, which offers a high-speed, multi-service IP network solution with unlimited scalability.

Frame Relay Networks Today

Today’s Frame Relay services are offered at a maximum port speed of DS-3 (45 Mbps). Service providers’ customers use Frame Relay access devices, such as a router with Frame Relay ports, on their premises to offer Frame Relay wide area connectivity. In many service providers’ backbones, ATM technology has been adopted to deliver network traffic at high speeds. This network architecture requires Frame-to-ATM network interworking at the edge. Currently, an ATM backbone can offer a maximum port speed of OC-48/STM-16.

As data traffic continues to grow exponentially, there are several issues that limit network expansion:

- **Insufficient Port Speed** – As previously mentioned, the maximum access port speed today is DS-3. If ATM technology is used in the core, the maximum trunk speed is OC-48/STM-16. Solutions for OC-192/STM-64 (10 Gbps) and beyond are not available yet.

- **Fragmentation** – Currently, Frame Relay fragmentation has a high performance. However, as port speeds increase in the future, existing technology may not keep up with the performance required for high-speed processing. ASIC-based solutions are more reliable at supporting high-speed Frame Relay fragmentation.

- **PVC Scalability** – Frame Relay service provides Layer 2 connectivity between edge routers or Frame Relay switches. However, when edge access devices are interconnected over Frame Relay PVCs, scalability will be an issue. An example is given in Figure 2.

![Figure 1: Maximum Trunk Speed Using ATM Technology](image-url)
In this example, four customer sites need to be connected by a carrier’s Frame Relay services. Therefore, every site needs to subscribe to three PVCs, with each PVC going to every other site. As a result, six PVCs are required. In general, to interconnect n customer sites, a total of n*(n-1)/2 PVCs are required. Therefore, the number of PVCs grows exponentially as the number of customer sites increase. This PVC scalability problem limits the size of an IP-over-Frame Relay network.

Tellabs OS-Powered High-Speed Frame Relay Networks

Tellabs OS-powered core networks provide a complete solution for High Speed Frame Relay access and backbone capacity expansion. The Tellabs ASIC-based solution delivers the performance and QoS required for frame processing at OC-192/STM-64 speed. Moreover, Tellabs OS-powered core networks enable various value-added applications, such as IP-enabled Frame Relay, on top of existing Frame Relay networks. Tellabs OS provides the power to build a flexible network infrastructure and create advanced services that can accelerate business growth. Tellabs OS-powered Multi-service Switch Routers provide Frame Relay support at various port speeds, including DS-3, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16 and OC-192/STM-64. This flexibility provides immediate relief for ATM core networks running out of capacity.

How does the Tellabs OS software advance multi-service support and offer a breakthrough in port speed? Unlike ATM-centric core network architectures, Tellabs OS uses packet-over-SONET as its primary trunking technology. This technology provides the most reliable transport and the most flexible bandwidth management for a core network. Tellabs OS controls a set of custom-designed ASICs that convert bandwidth into intelligent service transport. In the core network, the forwarding path is signaled by Tellabs OS using the latest MPLS technology. When Frame Relay traffic from end users reach Tellabs OS-powered Multi-service Switch Routers in an access CO, the incoming PVC is mapped onto a Label Switching Path (LSP) that provides edge-to-edge connectivity with QoS guarantees (see Figure 3). At the receiving edge, the LSP is mapped to the destined PVC to complete end-to-end connectivity. While delivering the same QoS support, the Tellabs OS-powered technology in the core is completely transparent to the Frame Relay PVCs at the edge. The Tellabs OS Frame Relay-over-MPLS solution is based on the well-recognized Layer 2 services-over-MPLS standard, offering excellent interoperability with other equipment that conforms to the same standard.
A More Efficient Frame-based Core
Given the inefficiency of using ATM cells in the core to transport frames, the advantages of using native frames (or packets) in the core are clear. Without a computation-intensive ATM SAR process at the edge, the core switch can now scale and process tens of millions of packets per second.

High-Speed Frame Relay Access Ports for Generating More Revenue
At the access, the Tellabs OS-powered Multi-service Switch Routers provide Frame Relay support at various port speeds (i.e., DS-3, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16 and OC-192/STM-64) that are much higher than the access rates being offered today. Therefore, the higher the access speed, the greater the service provider’s Frame Relay revenue.

High-Speed Frame Relay Trunking Ports for Reducing Operational Costs
In the backbone, Tellabs OS-powered core networks break the capacity bottleneck in ATM trunks, providing a four times capacity expansion through OC-192/STM-64. The Tellabs® 8860 Multi-service Switch Router, equipped with high-speed OC-192 ports and a 160 Gbps high capacity switch fabric, provides a high-density switch platform that increases the capacity in the Frame Relay core. Aggregating traffic on an OC-192/STM-64 core rather than on a large number of OC-48/STM-16 trunks significantly reduces the complexity and operational cost of Frame Relay services.

Fast Label Swapping in the Core
To provide connectivity for edge PVCs, a two-layer label stack is used. An example of how Frame Relay traffic is delivered across the Tellabs OS-powered MPLS core is illustrated in Figure 4. A customer at Site A needs PVC connectivity to Site C and Site D. The service provider then provisions two Frame Relay PVCs (with DLCI = 101 and 102) to Site A, one PVC (with DLCI = 201) to Site C and one PVC (with DLCI = 202) to Site D. To connect these PVCs across the Tellabs OS/MPLS core, two LSPs—each with two labels — are provisioned. The first label, called the VC label, is used to identify edge-to-edge circuits. In this example, VC label 1 is assigned to connect PVC 101 and 201, and VC label 2 is assigned to connect PVC 102 and 202. The VC labels only have visibility at the receiving edge and are not involved in any forwarding in the core. The second label, called the tunnel label, is responsible for fast switching in the core, getting all packets to their destinations. During the intermediate hops, a tunnel label swapping is used to cross-connect LSP segments. This fast-label swapping enables high-speed processing and transmission in the core, compared to a hop-by-hop routing table lookup for IP.

Figure 4: Delivery of Frame Relay Traffic with Tellabs' Solution

Tunnel LSPs also provide additional features for easy flow management in the core. By bundling numerous VC LSPs onto a few tunnel LSPs in the core, service providers simplify their network management through MPLS scalability. In addition, if a link failure occurs, a fast re-route for all VC LSPs can be achieved by simply re-directing the tunnel LSPs on the failed port to another active port.
High Performance ASIC-based Frame Relay Fragmentation

As end users now utilize large frames to increase link efficiency, Frame Relay fragmentation becomes very important at the edge of the core network. This fragmentation prevents incoming large frames from being dropped at the edge due to an MTU mismatch. As shown in Figure 5, dividing a large frame into several small frames at a very high speed is a computation-intensive process. One solution to achieve this is based on advanced ASIC design. The Tellabs OS-powered Multi-service Switch Router is built on a set of ASICs that enable wire-speed Frame Relay fragmentation.

QoS Support

One of the most important benefits of Frame Relay services is QoS guarantees. Frame Relay services offer various service classes through priority PVCs. To meet Frame Relay QoS requirements, the Tellabs OS-powered Multi-service Switch Router controls a rich set of QoS metrics such as delay, jitter and loss rate. Each traffic flow can be differentiated and managed on Tellabs per-flow traffic management platforms. Service providers can easily control their traffic management functions built into Tellabs' ASICs to optimize network utilization and SLA offerings by using the system's per-flow policing, congestion management, traffic shaping, optimal scheduling and priority queuing features. QoS support in the Tellabs OS-powered Multi-service Switch Routers delivers Frame Relay service guarantees across the network.

Easy OAM&P with IP-enabled Frame Relay

IP-enabled Frame Relay services based on Tellabs OS provides a great solution for improving scalability in today's Frame Relay networks (see Figure 6). Tellabs OS simply re-invents Frame Relay — from providing point-to-point virtual channels to offering any-to-any connectivity. A customer site now needs only one PVC for QoS-enabled access to a service provider's Frame Relay network. At the access CO, the Tellabs OS-powered Multi-service Switch Router will look at Layer 3 destination information in each frame. The frame is then forwarded to the corresponding MPLS-controlled LSP to reach its destination. IP-enabled Frame Relay networks provide a neat and highly scalable framework that simplifies end users' network management tasks. It also simplifies Operation, Administration, Maintenance, and Provisioning (OAM&P) for service providers, reducing operational costs in the core.

Figure 5: Frame Relay Fragmentation is a computation-intensive process

Figure 6: Tellabs OS reinvents Frame Relay
Summary
Moving to high-speed Frame Relay service presents a strong revenue growth opportunity for service providers. The Tellabs OS-powered Multi-service Switch Router offers the processing power, advanced features, simplified management and definite QoS support needed in this high speed evolution. Tellabs is ready to help service providers build their next-generation high-speed Frame Relay networks.

For more information on Tellabs Multi-service Switch Routers, please visit tellabs.com.