CTDI Products

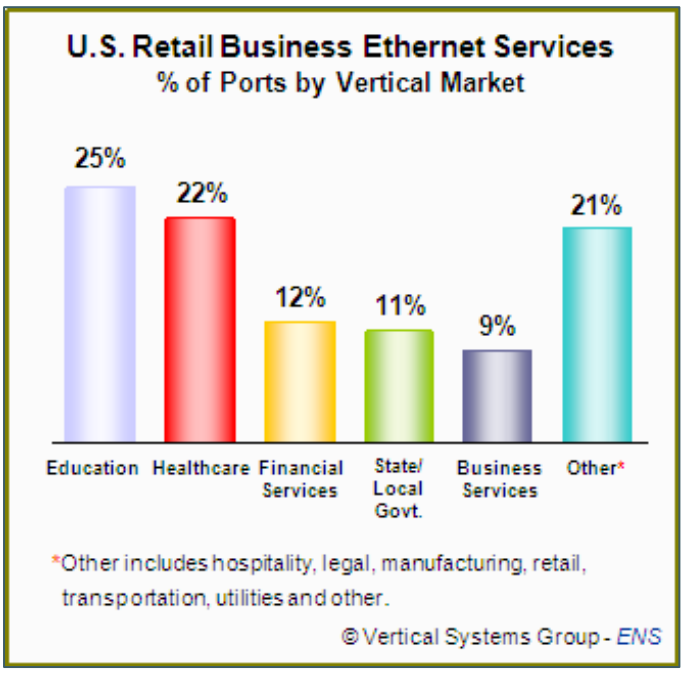
eMarc

White Paper

Table of Contents

Executive Summary

The 21st century has brought the telecommunications industry to a point of providing large amounts of end user demanded bandwidth. The 21st century saw this demand increase as a result of more intelligent end point devices being deployed. As the intelligence of the end point has increased, the end user is capable of having voice over IP, video/teleconferencing, constant internet access, and high speed data access at their desk. These services have required network service providers to discover more ways of allowing Ethernet access to become readily available.



With the ever increasing needs for greater desktop bandwidth, the challenge has been to provide this access while maintaining network integrity and network cost effectiveness. This represents a complex scenario, sometimes forcing the end user service provider to opt for a high-end solution in order meet desktop bandwidth demands. This document explores how, by utilizing existing WAN access circuits and devices and just considering minor changes to the network, Ethernet services can be provided to a large number of end users while simplifying its deployment.

The Value of Providing Ethernet Over WAN Services

Since the mid-nineties the costs of T-1/T-3 circuits have been declining making it easier for even smaller companies to acquire high speed network access. As companies look to implement cost savings, T-1/T-3 access is becoming a more desirable method for end user bandwidth requirements which have increased through the utilization of cost savings services such as Voice over IP and teleconferencing. As a result, the demand for Ethernet access, which requires high speed WAN access and additional hardware, has increased. As more hardware is required, the probability of outages increases, demanding more stringent requirements for managing an already complex network environment.

While several methods of network accesses have emerged during this current century, the availability and reliability of T-1/T-3 circuits remains a constant factor. Since major service providers' backbone networks rely heavily upon self-healing fiber networks, the last mile (T-1/T-3 circuits) benefits from this reliability. Service providers will have access to copper facilities needed to provide these T-1/T-3 circuits for many years to come. As direct fiber access and wireless internet connectivity becomes more available for those who can afford these methods, already deployed metallic layer 1 transport is more readily available. If these services are available, and cost effective devices to deliver Ethernet services become more available, the service provider will see the value in using this technology as an effective way to support Ethernet services delivered to the end user.

The Delivery Method Must Be Simple and Bandwidth Efficient

The general purpose of the T-1/T-3 access device is to provide a data access demarcation point between the service provider and the customer. It is at this demarcation point that protocol conversion to and from the customer network (Ethernet) and the provider network (TDM/HDLC) occurs. It is also a logical place to capture performance information of the data path for service level management as well as select applications (i.e.: VoIP, video, etc).

This delivery method must be presented in a simple yet efficient fashion in order to provide the end user with the highest degree of usable bandwidth. This delivery method should use standard multiplexing type protocols (i.e. MLPPP) so that the existing network is capable of having this transport integrated into the network in a seamless fashion. In most cases the bandwidth requirements for the Ethernet delivery can be anywhere from 1.5 MBS, 6 MBS, 12MPBS to 45 MBS. The design of the end user access device must be able to provide these increments of bandwidth on a common platform, making the implementation as simple as possible.

The devices that support this method of delivery must be feature rich and simple to operate, manage, and configure. Devices like the CTDI eMarc have the capability to address higher network speeds and newer protocols. In addition to working at higher speeds, these products incorporate all the features that enterprise users and service providers find popular today, such as Service Level Verification (SLV) and Service Level Management (SLM). The following is a high level view of end user expected features and compatibility:

- WAN protocols: PPP & Frame Relay
- Customer connections: T1 WAN, V.35, T1 & Ethernet LAN
- Capable of higher speeds and longevity
- Equipped with MLPPP & DS3 WAN with Ethernet LAN
- Integrated CSU/DSU capability
- In-band management
- Comprehensive SNMP management
- Simplified installation with automatic configuration
- Full SLV/SLM monitoring and reporting including VoIP management capabilities
- Report collection of statistics via standard SNMP protocol
- Configuration and software management via remote access methods
- Dial-in modem for VT100 management, software downloads, configuration up/downloads, and data pass through to serial port
- Serial port for terminal or external modem supporting, VT100 management, software downloads, configuration up/downloads, and data pass through from modem
- Software features enabled on individual devices through individual activation keys
- 120/220 VAC input Power
- Enclosure supporting stand alone configurations

- Homologation in a variety of countries in order for applications to be supported internationally
- In-service software upgrades (non-disruptive s/w downloads & dual image support)
- Support for NxT1/E1s, 4xT1E1 and 8xT1E1

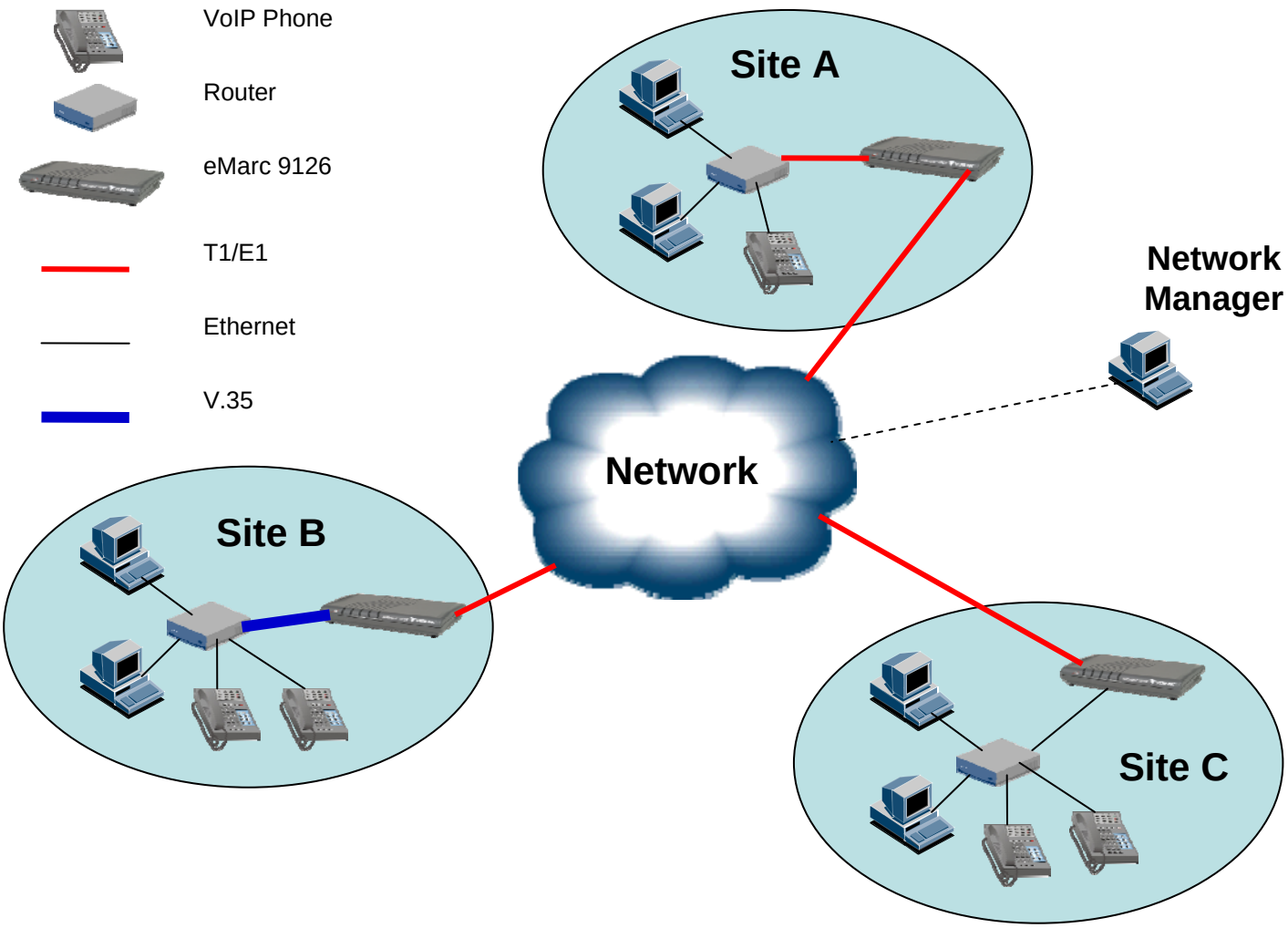
The list of expected features might seem long and complicated, but the product that is utilized must present these features in a fully integrated fashion so that the configuration of the product is very simple. The most efficient devices will incorporate a process for auto-configuration and easy installation.

The process used to convert line protocol to Ethernet must be as close to "OSI layer 2" as possible so that the bandwidth is effectively and productively delivered. A protocol like MLPPP is efficient and is available in most router devices deployed today. A cost effective deployment results when using the service provider's router and a single access device at the end user location.

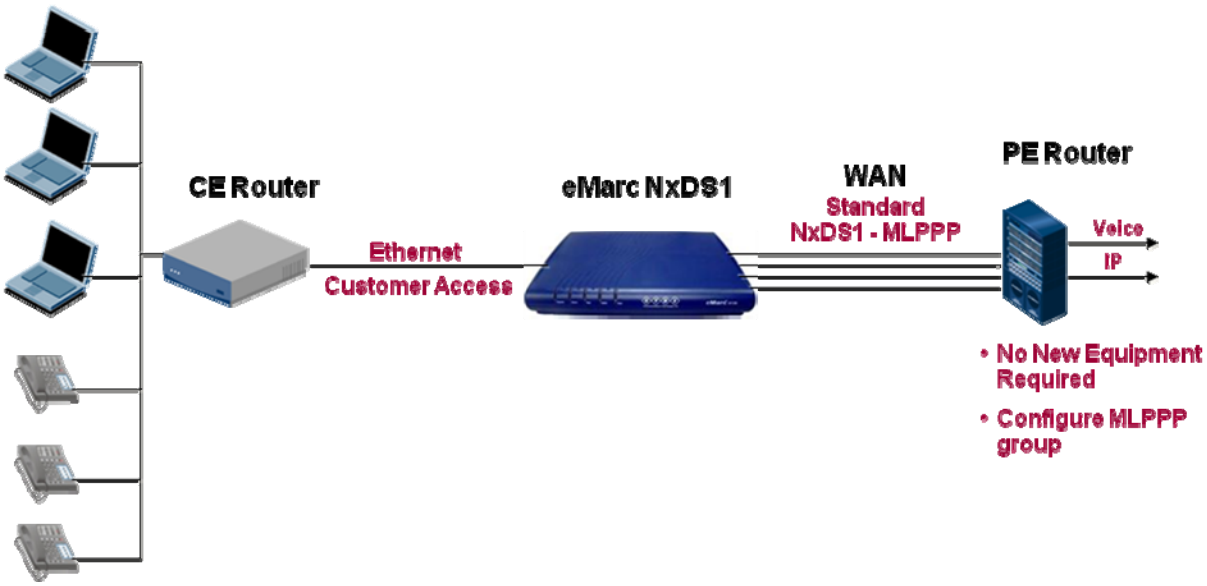
Not only does the delivery device need simple network management, it must be able to provide detailed statistics to both the end user and the service provider regarding performance of the circuits being used for the transport of the traffic. Even though the monitoring of the statistics needs to be protocol specific, the delivery method needs to be transparent to the protocols in order for the transport to make effective use of the bandwidth.

The product deployed must be capable of operating in many network and application environments. Using standards-based protocol ensures that anyone utilizing this product to deliver Ethernet traffic will not be forced to make major changes to the provider's network. Devices like the CTDI eMarc do not require major changes to the network deployment or network infrastructure.

CTDI eMarc Deployment Solutions



NxDS1 EoCu Application – No Custom Head-end Equipment



Current Ethernet Delivery Techniques

In the early 2000's it became apparent that the end user neighborhood was beginning to see not only the need for increased bandwidth, but for Ethernet delivery to the end user. Since the end points were becoming more intelligent, Ethernet at the end user location was now a highly desired element of the network design, resulting in the introduction of Carrier Ethernet which is highly effective and provides a sufficient amount of bandwidth. These methods do require that DSL pairs be bonded which places a burden on the service provider to ensure that the copper loops are properly conditioned to provide proper distances and reduce the effects of cross talk. The service provider is required to deploy a substantial amount of infrastructure based product in order to provide this service. Equipment from the service provider is required at both ends of the transport path in order for the transport of the user traffic to be accomplished in a transparent manner. Considering these factors, the cost of the service becomes higher than expected, limiting the number of customers who are able to deploy such a methodology.

Because the equipment is in addition to the other elements in the network, more interaction is required by the service provider in order to effectively deploy this service. Logic tells us, the more equipment in the traffic path, the higher potential for a network outage which can render a remote location helpless and in immediate need of restoration. Since Carrier Ethernet is a fairly new technology, it is important to insure the service provider is properly staffed to support the new elements in their network.

However, with a T-1/T-3 based transport system no new elements are required in the transport path and as a result, the service provider requires little to no additional training or staff. In the event of an outage in a T-1/T-3 based network, the existing troubleshooting techniques and test equipment is available to assist the service provider, as they were in the past, allowing for a rapid resolution to any network outage. Therefore, a T-1/T-3 based network transport method provides a cost effective, easy to deploy and manage approach to meeting the needs of end user neighborhoods.

Thoughts for the Service Provider

Deploying any new service requires an in-depth study of the effectiveness of that new service. As a service provider, you must first understand if there is a need for your subscribers to deploy Ethernet at their end user locations and define the appropriate price for the service they are requesting. The cost they are willing to pay must align with your ability to make a profit and properly provide the service.

As capital equipment investments are always a major concern, the utilization of a concept such as a protocol converter (CTDI eMarc) will minimize the investment that is required to implement this service. The CTDI eMarc utilizes MLPPP which can grow with your end user demands. As end user bandwidth requirements increase, the expansion of service only requires additional T-1s, minor changes to the serving router and additional WAN interfaces, if required. Since limited new equipment is required for the initial deployment and bandwidth upgrades, this process is easier to deploy and the lower the costs to the service provider will allow for overall lower costs to the subscriber.

If you are not currently providing Ethernet delivery services to your subscribers, a customer survey would be a good way to determine if your customers have a need and if there is a profitable market for you.

Thoughts for the End User

As a user of Ethernet services it is imperative that you acquire the correct service for your bandwidth needs, at same time insuring that you are getting best value for your investment. It doesn't matter if you buy the service from a provider or if you use your own enterprise backbone network; your requirements are the same. You need an efficient, cost effective delivery method.

Technology is always important because your investment will need to withstand the test of time. Your goal is to provide the desktop end points with the bandwidth required for today's applications and still have the ability to meet future requirements. Reliability, efficiency and low costs to implement will always be at the forefront of your strategy.

Network Management Considerations

So far within this document we have discussed the implementation of an Ethernet delivery over T-1/T-3 WAN media. The factors that we have dealt with relate to technology, cost, customer needs and implementation. As of yet we have not addressed the very important subject of network management. The approach that has been undertaken with CTDI's eMarc access device brings with it 35 years of telecommunication industry experience.

Accessing the device for management includes the capability of capturing data statistics, and must exist in both a locally attached mode and via several forms of remote access. The management of any device must include an intuitive user interface, like the menu driven structure of the CTDI eMarc. The ability to perform diagnostics and conduct rapid trouble shooting is also mandatory. The CTDI eMarc has built-in tools that provide these and many other functions. In addition to diagnostics, an intelligent access device must be able to display and report statistics through the entire OSI model. Here again the design of the CTDI eMarc incorporates an industrial standard. SNMP has been utilized as the method for reporting the statistics captured by the device. Therefore, any standard SNMP network manager will be able to be deployed, and /or utilized.

The CTDI eMarc is able to look at various functions at the different levels. The following is a high level overview of the different areas in which the CTDI eMarc will look at statistics:

- **As an Individual Stand Alone Device**

  At the "Stand Alone Device" level, an SLM device measures performance based solely on traffic passing through its interfaces. No interaction is required with other devices in the network. Performance can be tracked at Layer 1, Layer 2 and Layer 3, towards both Router and Network. Layer 3 performance is of special interest.

- **In-band Management Connectivity & Circuit Up Status**

  In-band Management Connectivity is required for ongoing data collection. The exact method of management access will typically match the Carrier's existing infrastructure. The device should track circuit availability results over time.

- **Data Throughput – Tx & Rx Traffic for Each Circuit**

  Measures the amount of data passed for each circuit over a defined window of time.

- **Data Congestion – Tx Traffic Congestion for Each Circuit**

  How this limit is exceeded can be quantified either by the amount of data, the amount of seconds the limit was being exceeded, or the number of packets.

- **Throughput by Class of Service – Tx & Rx Traffic for Each COS and Circuit**
  The amount of data passed for each COS and each circuit over a defined window of time.

- **Throughput by Application – Tx & Rx Traffic for Each Application and Circuit**
  The amount of data passed for each application within each circuit over a defined window of time.

- **IP Communications Throughput – Tx & Rx Traffic for Each IP Address**
  Continuous counters reflecting the amount of data sent and received by every IP Address passing data through the device. Traditionally, the top 10 communicators are categorized and reported over 15 minute windows.

- **Burst Analysis – Tx & Rx Traffic for Each Level of Circuit Utilization**
  The burst behavior of total traffic passing on the physical access link can be represented using various schemes.

- **Availability - Path Up Status**
  Verifies that the path is available, based on ICMP pings, and tracks the results over time.

- **Latency by Class of Service – Round Trip Latency for Each COS for Each Path**
  The round trip latency is measured using ICMP pings periodically sent on every path and COS which has been defined. The result is accumulated for the minimum, maximum, and average over the defined window of time. A report of Jitter Range is also created using the difference between the minimum and maximum values.

- **Throughput by Class of Service – Tx & Rx Traffic for Each COS and Path**
  The amount of data passed for each COS and each Path over a defined window of time.

- **Throughput by Application - Tx & Rx Traffic for Each Application and Path**
  The amount of data passed for each application and each Path over a defined window of time.

- **Data Delivery Analysis – Traffic Loss for each COS and Path**
  The amount of data passed for each COS and each path over a defined window of time. Traffic Loss is also measured based on information which is exchanged over the path between the devices.

The above list is only representative of the statistics available from the CTDI eMarc, it also needs to be mentioned that an access device must also be able to measure the user traffic that is being sent over the path. The following is an explanation of how the CTDI eMarc monitors and measures Voice over IP traffic that is in the data stream. The following VoIP statistics are collected and reported:

- Jitter: measured in both mS and RTP time units
- Call scoring: measured in both R-factor (G.107) and MOS
- Burstiness and burst density
- Gap density and duration (gap is the period between bursts)
- Settings for QOS/Precedence (IP TOS field etc.)
- Compression Technologies being used:
  - G.711 (no compression)
  - G.729 (8 kbps)
  - G.723 (6.3kbps, 5.3 kbps)
- Two categories of each statistic are recorded and reported
  - Per call
  - Aggregate for the link

In summary, it is mandatory that the access device used to deliver any Ethernet service to an end user be equipped with standard and sufficient management tools to insure the proper delivery of the end user's traffic at an acceptable performance level.

Conclusion

After considering the access methods available today for delivering Ethernet to the end user location it is clear to see that using a multiplexing type device over T-1/T-3 circuits is an effective and rapid approach to providing the end user with greater bandwidth requirements. With fast bandwidth available and lower costs to the provider and end user, it is obvious why you would chose a solution based on T-1/T-3 circuits using MLPPP.

For additional information on the CTDI eMarc, as well as our entire portfolio of products, please contact:
CTDI Product Sales
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www.ctdi.com