

Evolution of Symmetric DSL Technologies for Business Service Access Solutions.

February 2006, NexComm Systems, Inc.

Introductions

The recent economics around the globe is known to develop in direct proportional to the level of the Information & Communication Technology (ICT) infrastructure of each country. This paper includes discussion of various methods to structure the Next Generation Network at a snap and economically utilizing Ethernet based technologies, which has been and continues to be deployed rapidly.

The ultimate goal is to build networks utilizing the existing investments for legacy TDM service, and at the same time be able to correspond to the All-IP networks at the minimum cost. In order to keep it in the right track, it is a necessary hard mission to examine the network development road-maps from the advanced countries that have made a great effort to take the right direction in building infrastructures for Broadband Network Services.

Refer to the table 1 in the next page for the comparison between the Ethernet based Next Generation Network and the existing Sonet/SDH Network.

Feature	Sonet/SDH	Ethernet Transport
OAM	SDH OAM framework	<ul style="list-style-type: none"> ● IEEE 802.3ah ● ITU Y.17 ethoam PTP OAM ● IEEE 802.1ag e2e OAM ● MEF Service OAM & PM
Protection	UPSR, BLSR, SNCP, MSSP Ring, MSP 1+1, LCAS	MPLS, Fast Reroute, RPR, Link Aggregation
Traffic Engineering Hierarchy & Scalability	Sonet VT/STSS, SDH VCs	<ul style="list-style-type: none"> ● Q-in-Q (VLAN) ● MPLS Label Switched Paths(LSPs) ● Pseudowire (PWE3) ● Hierarchical VPLS (H-VPLS)
PDH, SDH Support	Inherent, deterministic	Circuit emulation over pseudowire
Multiprotocol Support	Escon, Ficon, Fibre Channel, etc. over GFP/VCAT	Multiple protocols over Pseudowire, mapped to Ethernet
Scaleability	Nearly limitless number of endpoints Transport/Interface rates to 40 Gbit/s	Control plane and data plane limits data rates to 10 Gbit/s today
SLA Support, QoS	Deterministic	Difficult end-to-end; exacerbated in any-to-any topologies
Interoperability	Interface well standardized, with proven intercarrier interworking	<ul style="list-style-type: none"> ● Many proprietary schemes today ● Standards looser than Sonet/SDH ● Demarcation devices new to market

(Source: Heavy Reading Webinar “Will Ethernet Devour Sonet/SDH?”)

Table 1.

As described above, the OAM, reliability, and other features once recognized as weaknesses of the current Ethernet Network have been greatly addressed so that the Ethernet network can be considered as substitutional technologies for traditional leased lines. Especially, the Ethernet Network is known to have many advantages in addition to economical efficiencies such as various QoS and interoperability when it is connected via Metro Ethernet to the IP/MPLS network of the network core.

This White Paper examines the alternatives of the best-suited investments for the desired broadband service networks of each country and its telecom operators.

Roles of the Legacy TDM network (Sonet/ SDH)

Sonet/SDH network, developed as the forthcoming of the worldwide communication mean along with the narrow-band PDH network over the last ages, has been growing as a powerful infrastructure that support low/mid speed data transmission and voice communications. In the

Evolution of Symmetric DSL Technologies for Business Service Access Solutions

phase of the development, the role of the legacy TDM network has been extended to transmit packets, IP data in other words, and various protocols have been developed. They specifically are Data over PSTN (64Kbps ~ 128Kbps), Frame Relay (mostly T1, E1, N x T1/E1), ATM (T1/E1/ DS3/ STM-1) and Leased Lines.

However, the network is required for expansion as the internet protocol has become more and more generalized, and services and applications demanding high bandwidth have become very common. So now Ethernet technology becomes the ultimate alternative solution that meets this explosive demand for higher bandwidth. For some countries that have not invested excessive investment in Frame Relay or ATM could take opportunity to leapfrog to the next generation network model by adapting Ethernet based Network and save tremendous investment cost in the network development phase.

As a consequence, it will be a wise choice to invest in Ethernet Network while taking the most out of the Sonet/SDH network that have already been invested. Particularly, it is very advisable to minimize the excessive investment in Sonet/SDH network to expand PSTN voice services, which have been leveraged by mobile telephone services in some countries. Instead, investing in the future platforms, which is ideal for converged services with voice and multi-media data.

Desirable Network Investment Scenario

It is necessary to give it a second thought when determining the candidates in need of urgent investments in order to approach the subject more efficiently.

A. Service Provider's view point

- High speed Internet business for the common; Internet, Gaming, VOD etc.
- Communication services for SMB's or Enterprises; Internet, LAN extension, VoIP etc.

B. Government sector's view point

- Delivering broadband service over each classed school; e-learning, school management etc.
- Delivering broadband service over each Government office; e-government, data exchange, etc.
- Securing communication infrastructure for national welfare: health care, Internet café (free), municipal wireless mesh networks and etc.

It is interpreted that the investment systems can differ according to the purposes described in A and B above. The access network investment for the purpose A will be legacy ADSL, and

Evolution of Symmetric DSL Technologies for Business Service Access Solutions

moving on to FTTC + VDSL or FTTH afterwards. For enterprises, optical fiber backboned network using Symmetric DSL or Metro Ethernet in an Access network will be the most viable solutions. For the purpose B, investment for the Symmetric DSL utilizing fixed phone line and point-to-point WiMAX when there is not availability of the phone line will be alternatives. Optical fiber can also come into consideration afterwards. Refer to the below figure 1. regarding the access technologies for the business subscribers:

DSL(EoCu*)	Optical Ethernet	WiMAX
<ul style="list-style-type: none"> • Uses existing copper lines • Intelligent CPE can address upstream congestion control • New IP/Ethernet DSLAMs allow more cost effective Ethernet aggregation 	<ul style="list-style-type: none"> • Last mile equipment perceived to be costly • Aggregation is over Cost-effective Ethernet • Requires a fiber strand per user • Future proof upgrade to GE 	<ul style="list-style-type: none"> • Last mile equipment perceived to be costly for the initial investment • Aggregation is over cost-effective Ethernet • Requires no wireline infrastructure • Easy addition of new users

- DSL(EoCu) is the best choice for delivering business grade VoIP and Multi-media and data services without last mile changes or additional investment.
- *EoCu: Ethernet over Copper

Figure 1

As described above, it is clear that DSL technology is the most efficient and economic technology. Advisable investment for each class of network is as below:

- A. Core Network: IP/MPLS network over Ethernet Optical Transport Network (EOTN)
 - Utilization of Ethernet over DWDM or Ethernet over Sonet/SDH in substitute for EOTN.
- B. Edge or Regional Network: Metro Ethernet network is the most suitable.
- C. Access Network: various access solutions mentioned above.

Evolution of Symmetric DSL Technologies for Business Service Access Solutions

Symmetric DSL infrastructure for SMB, Government offices and public sectors

At the present time, utilization of symmetric DSL technology, which realizes provision of broadband service with less investment, is advised for those in the countries with reasonable fixed phone line infrastructure is already built. Especially Ethernet based SDSL (or SHDSL) is able to make economic and full featured broadband services when working with Metro Ethernet network as a higher level network (Edge network).

Most of the present and future network services and its features can be actualized utilizing the Ethernet OAM standardized by the ITU-T G.991.2. For instance:

- ①. Providing Internet Access services with various functions via economic and simple SHDSL Business Gateway for Enterprises, compared to CSU/DSU and CPE Routers.
- ②. Providing optimal Access Network for E-Line and E-LAN service of Metro Ethernet.
- ③. Provision of QoS (Layer 1/2/3) for VoIP, Multi-media conference.
- ④. Enabling Managed service using smart demarcation functions of the Business Gateway.
(e.g, network security service, tiered services etc)

Refer to the below diagram 1. describing the service model mentioned above:

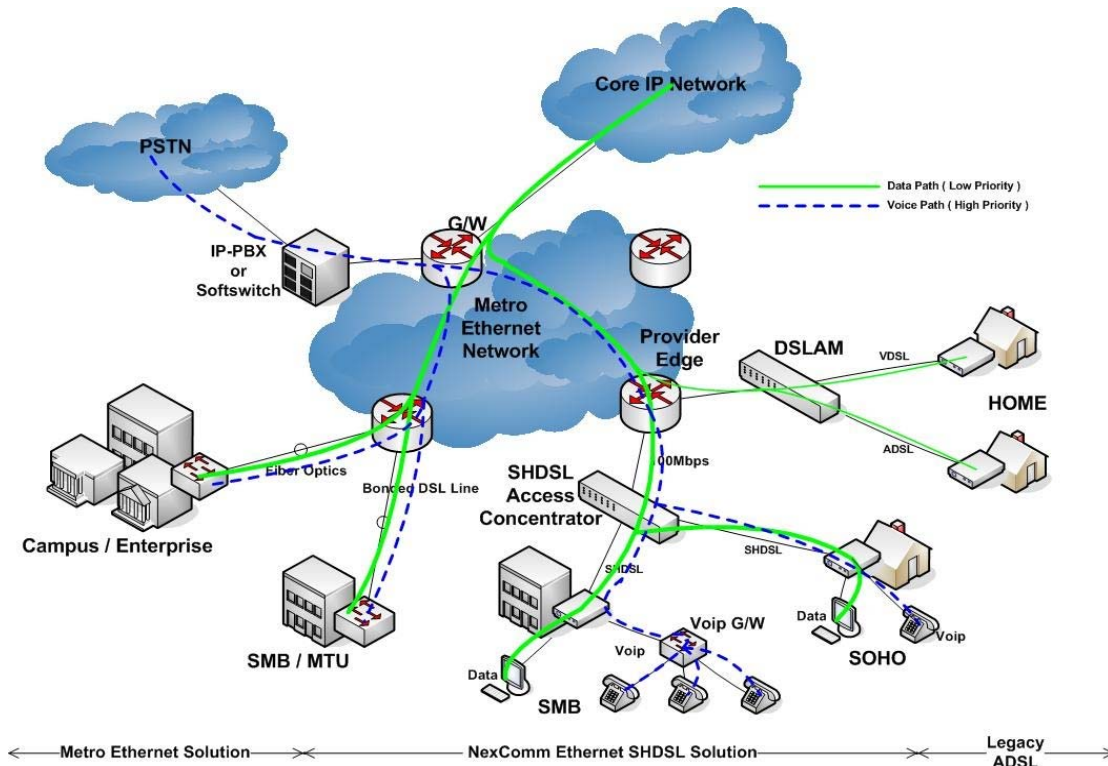


Diagram 1.

As shown above, most of all of the enterprises and institutional facilities like schools can come

Evolution of Symmetric DSL Technologies for Business Service Access Solutions

into the broadband service domain only with Metro Ethernet equipments and Ethernet based SHDSL, and realizes provision of services such as Internet access, VoIP and etc.

What's interesting is the fact that SHDSL is naturally adapting the service system blended with the devices consisting Metro Ethernet, and service providers are able to constitute service networks with most economical efficiency according to clients' needs.

Shown in the above diagram, regional Ethernet Network can be utilized to provide services in the fields as below:

- 1) Regional networking including VoIP service of Local councils
 - schools, government offices, healthcare centers
- 2) Large enterprise campus networking with VoIP.
- 3) Military campus broadband networking
- 4) Regional network for railway system, highway system and etc.

Such as the above Access Network will be the best alternative investment, since it enables to manage end to end QoS service in tight connection with investment in IP/MPLS of the Core network afterwards. Below diagram 2. describes the futuristic Broad-band Network.

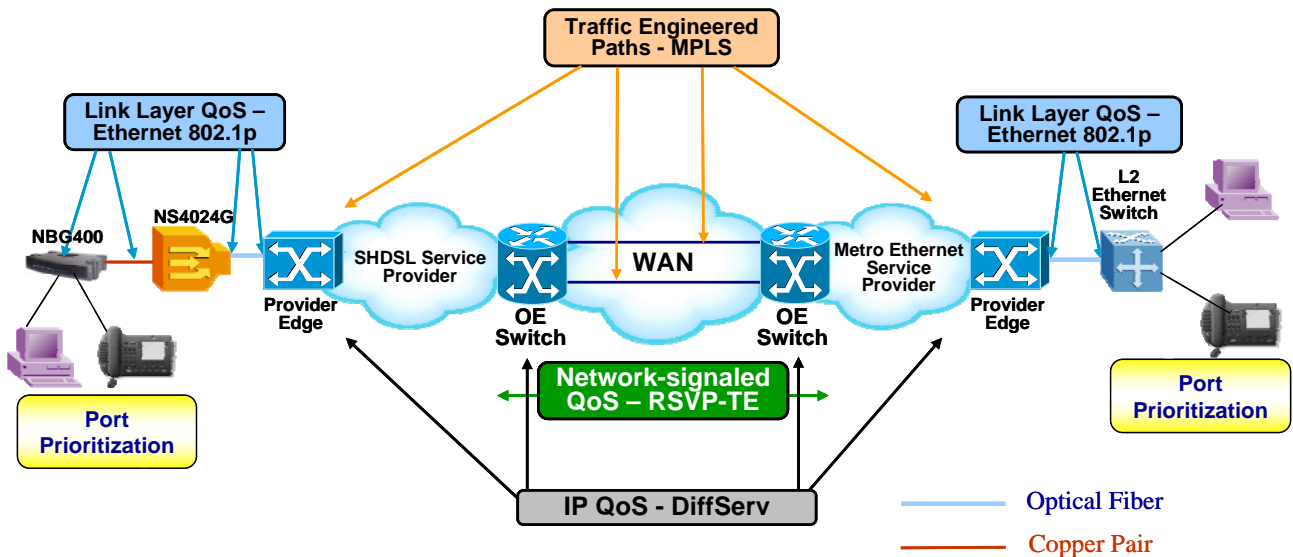


Diagram 2.

As you can see the above diagram, the Ethernet based SHDSL access solution is a perfect service platform with the Ethernet core network and can provides the End-to-End QoS service. Occasionally, MPLS network of the Core will lead the actual broadband network as being evolved to Ethernet Optical Transport Network (EOTN) according to the advancement of networks.

Symmetric DSL Technologies

There are various technologies of Symmetric DSL, including HDSL (High bit rate DSL), FDSL (Single Pair HDSL), SDSL (Single Pair, 2B1Q based) for legacy TDM transmission. However, the global standard has become the HDSL (Two Pair solution, ITU-T G.991.1) using 2B1Q and SHDSL (ITU-T G.991.2 Annex A/B) using a single pair. Annex F/G with faster transmission speed and added Multi Pair Bonding technology was introduced recently.

Bandwidth capacities of SHDSL (Annex A/B) providing symmetric bandwidth for downstream and upstream, full duplex, are as below

- 2.3Mbps using one pair(two wires) of copper cable.
- 4.6Mbps using two pair (four wires) of copper cables.

Symmetric DSL solution based on this technology comes in three categories such as ATM based, legacy TDM based and the most recent Ethernet based solution.

- 1) ATM based equipment: Most of DSLAM and CPE vendor at present time supply this equipment so called IP DSLAM that has Ethernet interfaces to backhaul and User side as well. The challenge of this kind of ATM based solution is that since it is designed to make easily applicable to the existing ATM based solution tremendously rolled out so far, it still uses ATM protocol over DSL line. ATM Cells are terminated at both ends of CPE and COE. This scenario can raise a lot of disadvantages when providing Ethernet service to Enterprise users because of this inefficiency.
- 2) Legacy TDM over SHDSL Solution: This solution has been used to replace and install more T1/E1 leased lines that have been rolled out in the largest number.
- 3) Ethernet Based Solution: To address the shortcomings of the above mentioned solution and to leverage forthcoming Ethernet Service model, DSL solutions to which Ethernet based DSL technologies and Ethernet backplane are applied have been introduced recently. For the present, together with Metro Ethernet and Optical Fiber solution, Ethernet based SDHSL solution should be the best-suited solution for SMB service platform. The Ethernet solution falling under these platform has been evolving keeping pace with international standards including ITU-T G.991.2 and IEEE802.3ah.

Comparison of various SHDSL technologies

As mentioned in the previous section, SHDSL technology is put to practical use in a various way according to the area it is applied. There are three important application types including 2Base-

Evolution of Symmetric DSL Technologies for Business Service Access Solutions

TL technology. Please not the comparison table as below.

	TDM application	ATM application	Ethernet application (2BaseTL)
T1/ E1	Inherent	Circuit Emulation	TDMoIP ?
Line Coding	2B1Q/ TC-PAM16	TC-PAM 16	TC-PAM 16
Loop Bonding	NA	IMA	iMUX (Proprietary)
Resiliency	No	Poor	Yes
OAM	TDM OAM	ATM OAM	IEEE802.3ah OAM
Voice, Data convergence	Exclusive (voice or data)	Using PVC's	VLAN and IEEE802.1p
Multiple QoS	No	Only with ATM	Yes
Ethernet CoS	No	Restricted	Yes
LAN Emulation	No	Yes (but difficult)	Yes (E-LAN)

Table 2.

Evolution Roadmap of Symmetric DSL Technologies

A. Convergence of Voice and Data

As the limitation of VoIP service, which is provided by using IP DSLAM rolled out in the past, has been emerged, the industry starts to consider VoIP as one of the premium services based on QoS and SLA. For the method to enable this VoIP service, they took an approach of converting ATM QoS scheme to IP QoS or Ethernet Layer 2 CoS feature with existing IP DSLAM. However, this method has fundamental drawbacks of inefficiency when converting and remapping QoS marked ATM cells to the according IP packets or Ethernet frames. So Ethernet solution based on QoS and CoS (Class of Service) function came across as strong alternatives. This solution, so called Next Generation Network, is comprised with IP/MPLS, Metro Ethernet, fiber optic access, SHDSL and VDLS access solution. It seems that the future network takes full advantage of the existing DSL solution based on ADLS2+ or VDSL and try new value added services in the residential market. But for the business market Fiber and Ethernet based SHDSL solution will be the main investment to be made

B. Rollout of IP/MPLS and realization of End to End QoS

Up until now many challenges of Metro Ethernet network comparing to the Sonet/SDH network has been addressed significantly for the criteria such as security, reliability, and supportability of legacy TDM service. The challenges coped with are as follows;

Evolution of Symmetric DSL Technologies for Business Service Access Solutions

- ①. Network Reliabilities: Fast rerouting of IP/MPLS, RPR of Metro Ethernet
- ②. Network Securities: Layer 3 and Ethernet VPN (E-Line, E-LAN), Safety against DOS etc.
- ③. TDM supports: Pseudo wire emulation, end to end (PWE3) of IP/MPLS, TDM over IP (TDMoIP)
- ④. Class of Service (CoS): Until now Metro Ethernet camp has defined and offered 8 levels of CoS. This kind of CoS delivers necessary service according to the access method

Conclusions

Ethernet Network will be continuously developed in a same way with the other Network that has been developed and evolved so far. Taking it for granted that the network is evolved as mentioned in the above sections, a variety of Ethernet access network solution supporting QoS/CoS should give a longevity that compensates its investment independent of core/metro network change to come.

For more information please contact;

John Han: Director of Business Development/ NexComm Systems, Inc.

john@nexcomm.co.kr

+82-31-781-1862 x 240