Converged Network
A Means to Accelerate Network Service Penetration

By
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Abstract

Convergence consolidates many disparate networks into a single network while supporting existing services and enabling new ones. The major benefits of a converged network to a service provider are lower capital cost, lower operational expense, enabling new services, increased revenue, and speedy provisioning. To reap the benefits brought about by converged network major service providers, inter-exchange carries, local exchange carriers and PTTs around the world have started converging their disparate networks into a single MPLS/IP packet based network.

This paper shows the importance of converged network to Ethiopia as a means to accelerate network service penetration across the country at a much lower cost than is possible otherwise. While the low telecommunications penetration rate poses a steep challenge for Ethiopia to catch up with the rest of the world, it also presents a great opportunity to leapfrog to a converged infrastructure, which enables service expansion at an expedited rate and at lower cost. Convergence is much more important to a country like Ethiopia, where the telecom penetration rate is very low, than to countries where telecom penetration is much higher.

This paper discusses what a converged network is and why it is important to Ethiopia. It also addresses IP/MPLS as the underlying technology that enables convergence, different wired and wireless access technologies, and migration issues – how the current services on disparate networks are transitioned to a converged network and how the current disparate network infrastructure can be reused in a converged network.

Introduction

Due to historical, technological, regulatory reasons and the tremendous growth in the late 1990s, today many service providers operate multiple networks each dedicated for a limited set of services. Most service providers have realized business benefits and importance of consolidating these disparate networks into a single converged network. Some have already embarked on a phased approach to a converged IP/MPLS network to reduce operational expenditure (OPEX), reduce capital expenditure (CAPEX) and increase revenue.

Convergence is the means to consolidate multiple networks – each network dedicated to supporting limited set of services – into a single network that is capable of supporting all existing services and enabling new ones, which would have been difficult if not impossible to conceive under legacy networks.

What it is convergence?

Convergence can be defined as an end-to-end service architecture where all networking applications – voice, video, data, and multimedia – are managed and delivered on a single IP based infrastructure.

Most service providers have multiple disparate networks each of which is dedicated to transport a few set of services:

- PSTN network: to provide POTS (Plain Old Telephone Service), dial-up access and fax service.
- Public Internet Network: dedicated for connecting users to the Internet.
- Data Network, which is typically based on Frame Relay and/or ATM technology and dedicated for Enterprise VPN service.
- Frame Relay or ATM network used to interconnect MSCs (Mobile Switching Centers) for mobile wireless access service.

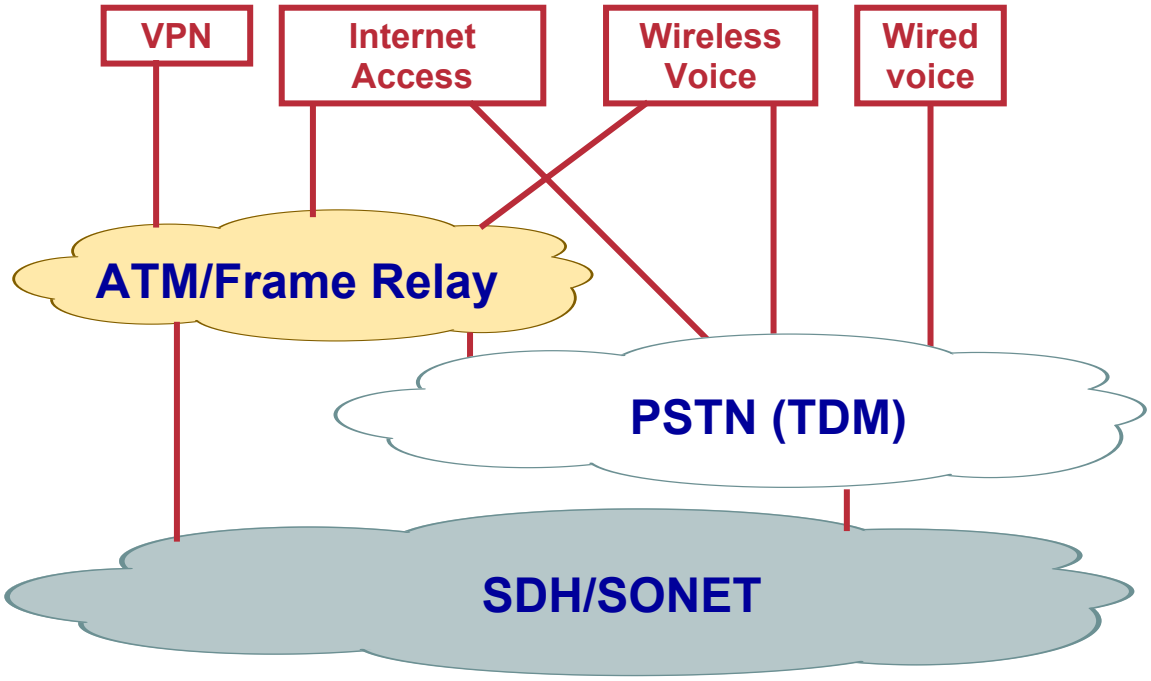

Figure 1. Example of legacy network

There are also different access mechanisms used for different purposes. For enterprise VPN service Frame Relay or ATM over fractional T1, full T1, E1, DS3, E3 or SONET/SDH are the most commonly used access mechanisms. For enterprise telephony service the most commonly used access mechanisms are T1, E1, DS3 or E3. For enterprise Internet access the most commonly used access mechanisms are Frame Relay, ATM or PPP over T1, E1, DS3 or E3, and metro Ethernet. For small businesses local loop, DSL over local loop, fractional T1/E1, and full T1/E1 are widely used. For

residential users the most widely used access mechanisms are local loop, DSL over local loop and Cable modem.

There are new emerging access mechanisms that promise higher bandwidth and further penetration of broadband service to residential and small business customers. Ethernet to the home (ETTH), Fiber to the curb (FTTC) and Broadband over power line (BPL) are among these.

For a speedy migration to a converged network, it is important that existing and emerging access mechanisms be efficiently converged.

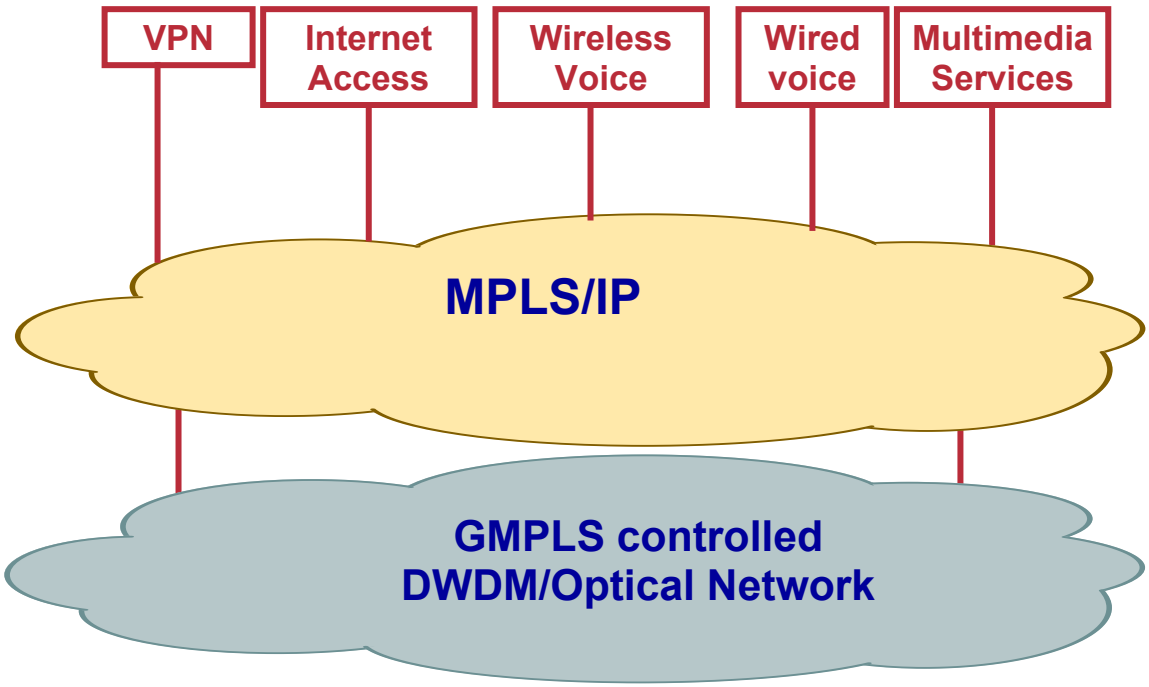

Figure 2. Converged network

MPLS

Multi Protocol Label Switching is a high-performance packet forwarding technology that integrates the performance and traffic management capabilities of data link layer (Layer 2) switching with the flexibility and control given by network-layer (Layer 3) routing, and the route-once, forward-many performance advantages of ATM and Frame Relay SVCs. MPLS technology is key to enabling efficient utilization of existing networks to meet growth demands and provide rapid fault correction of link and node failure. The technology also helps deliver highly scalable, differentiated end-to-end IP services with simpler configuration, management, and provisioning for both Internet providers and subscribers.

MPLS is an IETF standard that works on a route-once, forward-many-times model. MPLS architecture is defined in RFC 3031. Unlike IP routing, where a decision has to be made on the best of many possible ways to get to the destination with every packet,

MPLS uses a label switching method. In this method, the paths are set up in advance, and the switches/routers simply map the incoming label to the output label.

Packets are classified only when entering the MPLS network by the Label Edge Router (LER). The packet classification is encoded as a label. Inside the MPLS network, packets are forwarded by the Label Switch Routers (LSR) without having to be re-classified.

MPLS enables a number of services and features.

- **Traffic engineering** is enabled through MPLS mechanisms that allow traffic to be directed through a specific path, based on constraints given, resulting in more efficient use of total network resources.
- **Guaranteed bandwidth** is a value-added enhancement to traditional traffic-engineering mechanisms. MPLS lets service providers deliver guaranteed pipes and bandwidth allocations. There is both a redundancy/resilience aspect as well as the "true" QoS aspects.
- **Fast reroute (FRR)** reduces failover times to the 50ms range. Such fast recovery prevents end-user applications from timing out and also prevents loss of data. It's extremely important for providing the kind of SLA's that IP telephony needs in order to work optimally.
- **MPLS based Layer 3 VPNs** greatly simplify service deployment compared to traditional IP VPNs. As the number of routes and customers increases, MPLS VPNs easily scale, while providing the same level of privacy as Layer 2 technologies. In addition, they can transport non-unique IP addresses. The customers inter-site routing is managed by the service provider.
- **MPLS based Layer 2 VPNs:** Service provider devices forward customer packets based on Layer 2 information such as Frame Relay DLCI, ATM VPI/VCI, and Ethernet VLAN tag or mac address. The SP is not involved in customer IP routing. This service is equivalent to Frame Relay or ATM VPN service. The major difference is that MPLS L2VPN allows multiple customer connection types including Ethernet, Frame Relay, ATM, and PPP.
- **MPLS Quality-of-service (QoS)** capabilities have 2 aspects: QoS mapping of incoming packets to the correct Label Switched Path (LSP), and maintenance of QoS guarantees through that path.

Why converged network?

- Consolidation: Operation is more cost effective when there is only a single network.
- New services: Availability of compelling IP applications delivered anywhere, anytime. New services are important since it gives the service provider competitive advantage and brings about new streams of revenue.
- Extending the scope of SP services. Convergence enables service providers to extend their scope into new areas such as: managed CPE, managed LAN and managed IP Telephony service offerings.

- Ubiquitous transport mechanism: IP has become the dominant network protocol and applications are designed to be transported over an IP network.
- Reduce CAPEX and OPEX. Single converged network to deploy and operate coupled with intelligent networking enabled by IP reduces both CAPEX and OPEX.
- Common interface to customers
- Automated service provisioning
- Fewer and standards based technologies
    - Easy to train man power
    - Long life cycle
    - Eliminates dependence on single vendor
    - Products that are based on standards based technology are typically much less expensive than those that are based on proprietary technology.

New Enhanced Services

- **Unified messaging**—voice, fax, and e-mail integration on a single, Unix- and IP–based message repository
- **IP–enhanced services**—features not possible with legacy, narrowband Class-5 equipment, such as feature mobility, CD–quality voice, PC phone calls, and IP terminal support
- **Enhanced Class features**—features that enhance productivity and performance such as selective call waiting, group ring, and find-me, follow-me
- **Subscriber control tools**—Web- and Palm-based applications and e-mail plug-ins for self-provisioning and management of call and messaging features, and related usage/billing information

Requirements for a converged network

A converged network needs to exhibit excellent resiliency to network component failures, speedy recovery from failures, very high availability, and excellent manageability. Network scalability and resiliency must be better than any of the legacy networks to ensure that customer experience is improved. It should also have different layers of security protections against malicious and unintentional attacks. A converged network needs to support different levels of QoS so that services with widely varying levels of requirements – in terms of latency, jitter, throughput and guaranteed bandwidth – can be accommodated on a single network. It should also be highly scalable. It is also important that a converged network support IP Multicasting and IPv6 protocols since some new and future services would require them.

The case of Ethiopia

In this paper we would try to argue that convergence is very important for Ethiopia and other countries in similar situation. As explained in the foregoing sections, the main reason that service providers embrace convergence is that it enables them to reduce

operational and capital expenditure. For Ethiopia and other countries in similar situation which have far lower budget for telecom services compared to more developed counties, convergence becomes even much more important and urgent.

Here are some of the advantages of adopting convergence for Ethiopia and other countries in similar situation:

- Single network and single standards based networking technology – IP/MPLS – implies not only reduced capital and operational expenses but accelerates technology adoption by focusing the knowledge transfer on IP/MPLS.
- Enables broader choice of access technologies. More importantly, it allows the use of the inexpensive Ethernet based broadband access technologies.
- Service providers do not have to provision multiple access mechanisms and infrastructure to the customers.
- Enables cost effective virtual private networking service to enterprise and small business customers.

Ethiopian Institutions need to embrace Information and Communication Technology (ICT) in order to serve well and compete effectively in a global village with a global economy of the 21st century. This adoption of ICT creates a huge demand for various applications and services such as:

- Support for converged services: Data, Voice, Video and Multimedia
- The need for time independent low cost Internet access
- Support for low cost telephone services (VOIP, IP Telephony)
- Cost effective virtual private networking (VPN)
- The need for high speed Internet connectivity
- Scalable, reliable and secure networks

In summary there is a tremendous need for a network that can support broad range of services for lower costs *and* better functionality.

For Ethiopia moving to a converged networking infrastructure is the greatest opportunity to leapfrog from a very low telecom penetration rate and basic services to a higher penetration rate and rich services, which would in turn increase productivity and fuel economic activity.