MPLS from Core to Door

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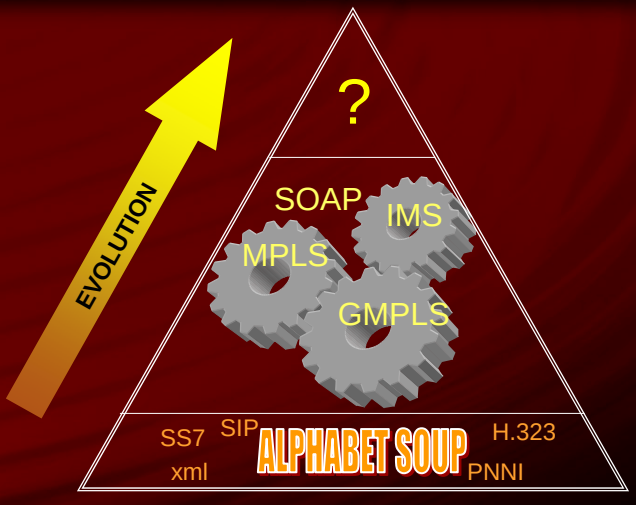
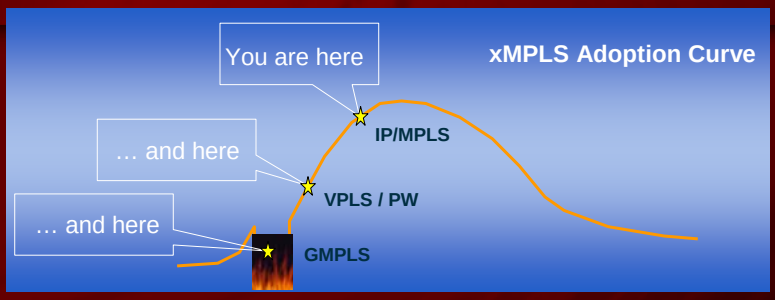
Network Transformation: Signaling & Control Convergence



Why Transformation?

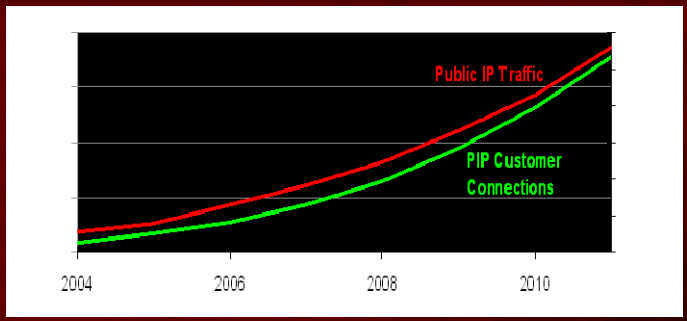
- **Significant savings for the Customer and Service Provider**
  - Reduces network elements
  - Eliminates provisioning across multiple networks and IT systems
  - Enables flow-through provisioning
  - Yields better performance
- **Packet delivery from "core to door"**
  - Simplifies our product portfolio
  - Provides a single service creation and service delivery environment
- **Bandwidth on demand: any speed, any time, anywhere!**
  - Empowers customers with better control, choice, and flexibility

Where Are We?



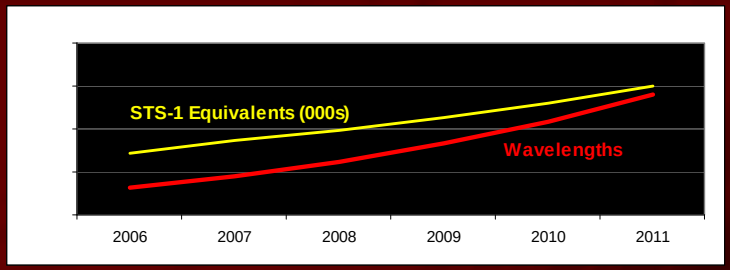
- **IP/MPLS:**
  - Core infrastructure deployed for private IP networks
  - Deployment into the Internet is underway
  - Value to Enterprise LAN is not yet proven
- **VPLS & Pseudo-wire:**
  - Adoption for specific applications
  - Limited large scale deployments
- **GMPLS:**
  - Stuck with early adopters
  - Still working the business case

IP and Data Trends



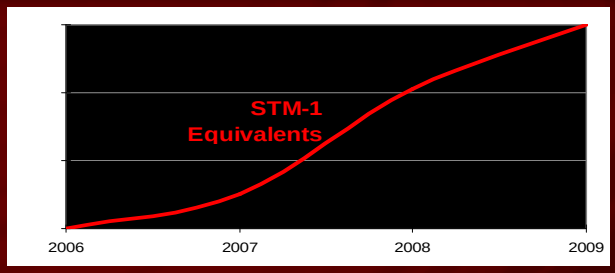
- **Acceleration of IP traffic growth:**
  - **MPLS / PIP customer connections have increased 230% over the past two years**
  - **Public IP traffic increased 136% over the past two years**

Domestic Transport Trends



- **Wavelength capacity dominates the demand for transport**
  - **65% growth in 2.5G and 10G wavelengths in 2006**
  - **Over 90% of transport requirements will be 10G wavelengths by 2011**

International Transport Trends



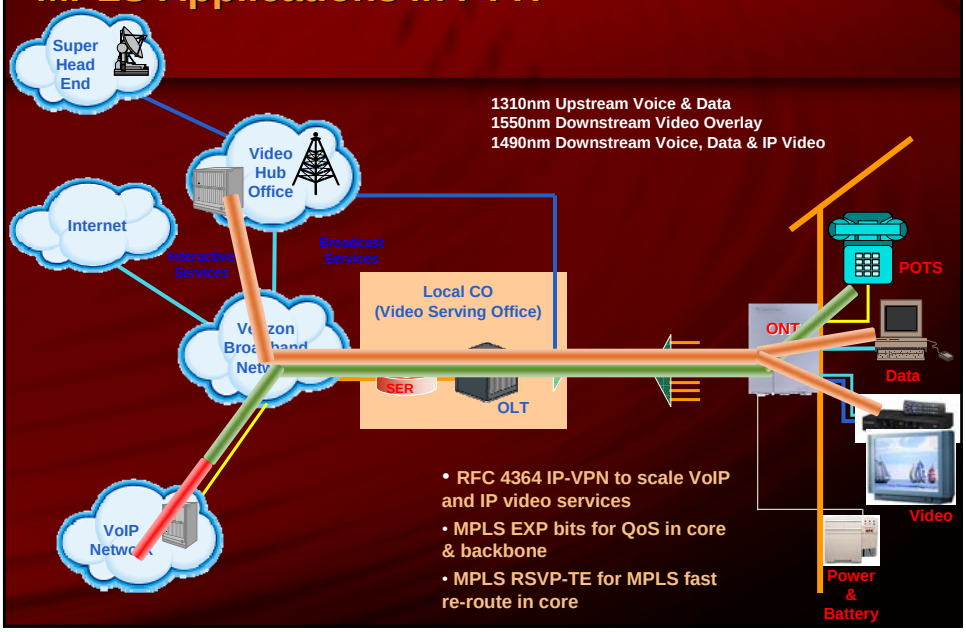
- **Tremendous growth in global transport requirements:**
  - **83% growth in 10G trans-Atlantic wavelengths in 2006**
  - **Asia-Pacific growth projected to continue at 30% annually for the next 10 years**

Summary of Drivers

- **Significant shift from legacy to IP-based services is driving network transformation**
  - Declining growth rates for TDM voice, Frame Relay, and ATM
  - Accelerating demand for IP / PIP / VoIP services
- **Major demand for bandwidth and bandwidth flexibility globally**
  - High growth of 10G requirements for customer and network build-out
  - Average port speed is increasing across all platforms
  - Move to optical from electrical services
- **Simplifies network, reduces cost to operate, and improves reliability**
  - Thousands of network elements removed, platforms eliminated
  - Touch points significantly reduced across all networks

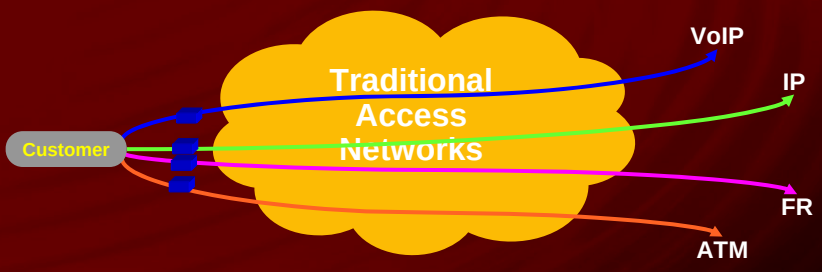
Role of MPLS in Broadband Residential Services

MPLS Applications in FTTP



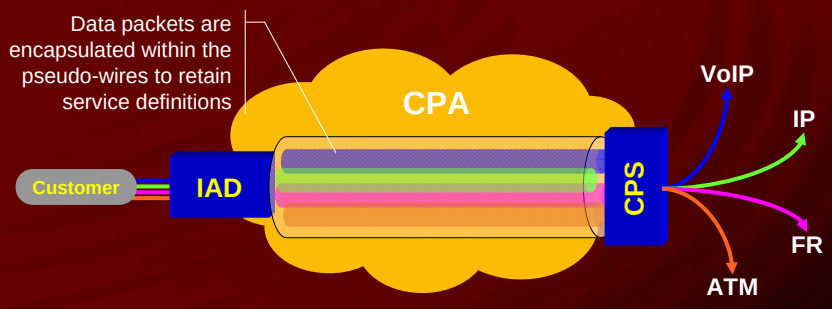
Role of MPLS in Business Access Networks

Traditional Access Architecture



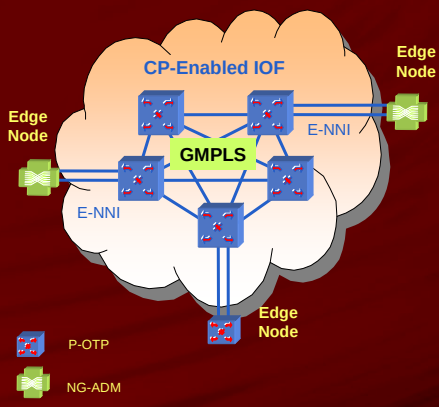
- Individual access circuits for each service
- Multiple network interface devices on customer premise

Converged Packet Architecture



- **Pseudo-wires provide framework to logically separate services (e.g., Frame Relay, ATM, TDM, Ethernet).**
- **CPA uses pseudo-wires to converge multiple services onto a single access facility.**

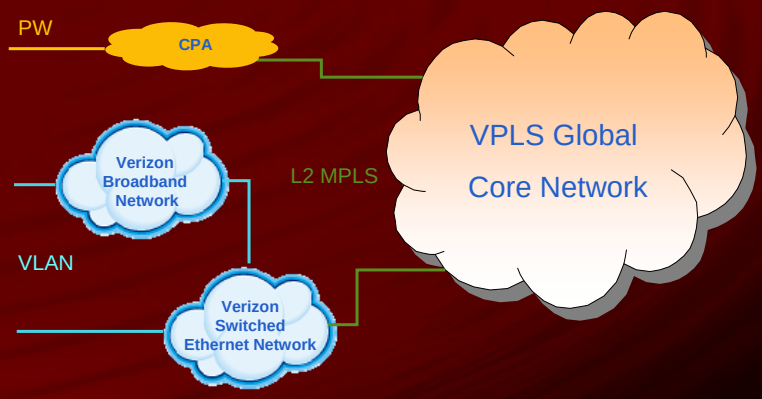
Mesh + Optical Control Plane: Bandwidth Dial-Tone



- **Lower Cost:**
  - Higher fiber utilization at equivalent resiliency
  - Simplified circuit design and provisioning.
  - Common operational treatment for DS-3, OC-n and EPL 'circuits'.
- **New Revenue Opportunities:**
  - 'Just-in-Time' service activation
  - GFP and VCAT provide service adaptation for Ethernet
  - Supports DS3, OC-n, GbE private line
  - STS-1 granularity for OC-n and Ethernet private line
  - Unprotected and control plane 1+1 protected, non-revertive
  - Full link diversity with best effort node diversity
- **Customer Portal for self-service**

Role of MPLS in Core Networks

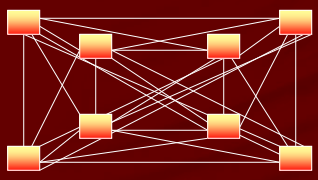
VPLS Core Network



- VPLS provides interconnectivity between L2 access networks
- MPLS L2 VPNs provide context for services and customer separation

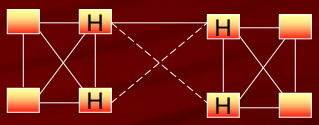
VPLS Scaling Issues

Current VPLS



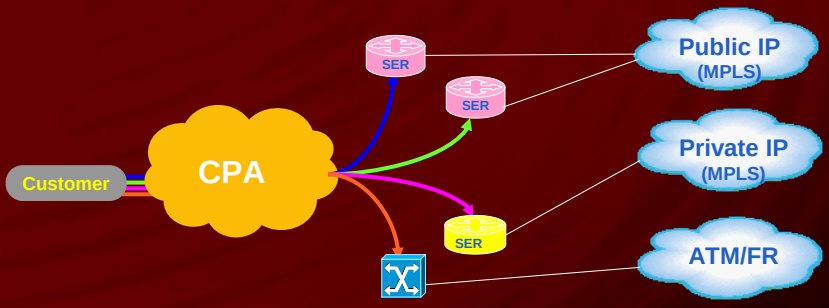
- *N* PEs → O(N^2) LSPs and VPLS PWs
- Packet replication increases as PWs increase
- As demand grows, scalability issues need to be addressed

H-VPLS



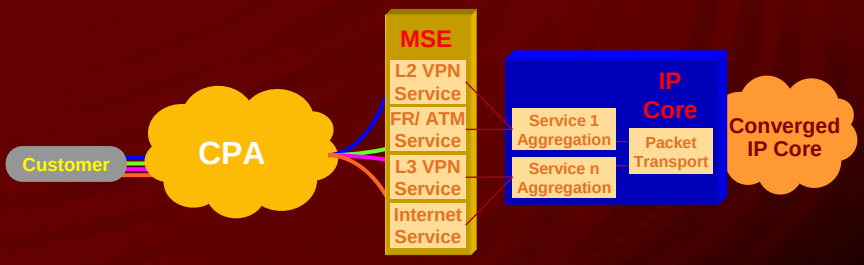
- LSPs and VPLS PWs are decreased at VPLS PEs
- Packet replication decreased

Current Core Networks



- **Multiple, service specific edge routers and switches**
- **Service isolation makes service inter-working costly**

Converged IP/MPLS

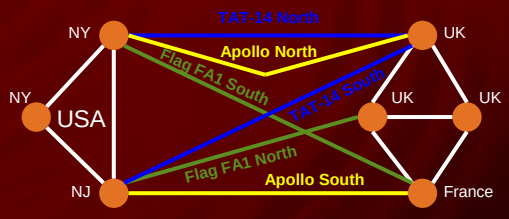


- Logical Routers provide secure distinct router domains within one physical router.
- IP/MPLS provides L2 and L3 VPN services across the converged IP core (e.g., VPLS used to provide Ethernet transport services, RFC 4364 used to provide L3 IP-VPN)
- Multi-Services Edge router provides common IP edge for all IP-enabled services

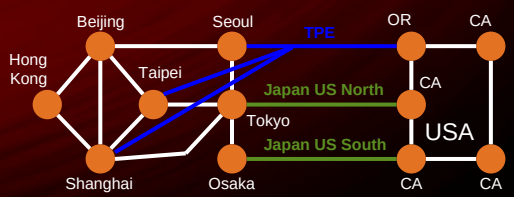
Optical Control Plane Enabled Mesh

- **New Cable Systems**
  - TPE (China, Korea, Taiwan)
  - Other regional expansions
- **Additional Mesh Diversity**
  - 7-way in the Atlantic in 2007
- **Europe Deployment**
  - ULH in 2008-2011
  - Mesh network in 2009-2011

Atlantic Mesh



Asia-Pacific Mesh



Next Steps in the Transformation

IP/MPLS Inter-Carrier Peering

Key applications or services that the MPLS-ICI is intended to support:

- Inter-Provider BGP/MPLS IPVPN: Extension of IPVPN services across domains
- Inter-Provider MPLS Pseudowires (PWs): Extension of L2/L1 circuits across domains
- Data trunks: Efficient long-haul packet transport over traffic-engineered MPLS tunnels.

Technical aspects that require specification across the inter-carrier interface:

- Mechanisms for MPLS label-switched path (LSP) establishment
- Signaling and routing protocols: MP-BGP, LDP, RSVP-TE, path computation
- Resiliency: Rerouting around failed inter-carrier interface points
- QoS, traffic management, and admission control
- OAM functions for fault detection and correction
- Security

GMPLS / Optical Control Plane

Completion of Standards development:

- Harmonization of IETF, ITU and OIF approaches
- LMI

Operational support of optical control plane:

- Integration of OSS with control plane for service activation and service assurance of the bear path AND the control plane

Inter-carrier interface:

- E-NNI peering requires development of business interface specifications
- Inter-domain peering to non-optical control plane domains

Conclusions

- **Evolve to converged IP / MPLS cores supporting L2 & L3 services**
  - Consolidate edge and backbone functions via logical routing
- **Converge legacy networks**
  - Consolidate and VoIP-enable all traditional voice networks
  - Migrate over time Frame Relay and ATM Services to common IP/MPLS Core
- **Transform access from TDM to packet using pseudowire over converged access loop**
- **Leverage MPLS VPNs for segregation of triple play services**
- **Exploit optical control plane for added resiliency, efficiency and bandwidth allocation flexibility**