Turin Networks

iConnect™ MPLS/GMPLS for NG Converged Optical and Carrier Ethernet Networks

9 October 2007

MPLS JAPAN

MPLS/GMPLS and Converged Network

Transitioning
the **Optical Edge**™

MPLS Objectives for Ethernet and TDM Services over a SONET/SDH Transport Network

- Enable scalability for Ethernet Services over SONET/SDH infrastructure
- Provide fast reroute for Ethernet Service protection
- More efficient bandwidth usage over SONET/SDH network
- Enable TDM service to be carried in conjunction with the packet network
- Simplify Service Operations versus provisioning a router
- Provide “Point and Click, End to End” provisioning
- Allow Carriers to build on SONET/SDH resiliency and provide Carrier Ethernet Service SLAs with QoS

GMPLS Background

- **Used by SONET/SDH MSPP to automate provisioning**
- **Each network element running GMPLS supports:**
  - OSPF-TE routing
  - RSVP-TE signaling
  - Label distribution through RSVP
- **GMPLS is a superset of MPLS**
  - In IP MPLS, data and management packets mixed in same bit stream.
  - TDM GMPLS establishes bidirectional LSPs
- **MPLS and GMPLS are peers**

Bridging the MPLS and GMPLS domain

- **Ethernet cards in MSPPs can be adapted to exchange the necessary routing information to allow MPLS and GMPLS domains to communicate**
- **These Ethernet cards will be responsible for:**
  - Establishing an OSPF neighbor relationship
  - Exchanging IP routing information
  - Receiving and sending RSVP requests
  - Switching MPLS labels
- **The adapted Ethernet cards are simply a client interface into the existing GMPLS control plane**

Converged Services Infrastructure

- **What problem are you trying to solve?**
  - All Services over a Common Network Infrastructure
  - All services over an Ethernet Transport Network
- **Network needs to support Ethernet services and TDM services**
  - Different ways to implement – each having pros and cons

Different approaches to take depending upon which problem you want to solve

Converged Transport Technology Choices

- **IEEE 802.1ad (Provider Bridges / QinQ)**
- **IEEE 802.1ah (Provider Backbone Bridges)**
  - Provider Backbone Transport (PBT)
- **Ethernet over SONET/SDH**
- **Ethernet over MPLS (Pseudo wires)**

Converged Transport Technology Choices - Ethernet Transport

- **IEEE 802.1ad (Provider Bridges / QinQ)**
  - Most commonly implemented Ethernet service delivery technology
  - S-VLAN ID (S-VID) used to identify 4095 services
  - Uses customer's MAC address for forwarding
  - RSTP or MSTP for protection/restoration
- **IEEE 802.1ah (Provider Backbone Bridges)**
  - I-SID used to identify 16M services
  - B-VLAN ID (B-VID) used to identify backbone tunnel
  - RSTP or MSTP for protection/restoration
- **Provider Backbone Transport (PBT)**
  - Backbone tunnels (working and protected) identified via globally unique 60 bit B-VID+Destination MAC address
    - Can use GMPLS to pre-provision protected tunnel
  - Disables Ethernet control plane (BPDUs)
  - Can use GMPLS (g-LSPs) as control plane for simplified tunnel provisioning
    - RSVP-TE for CAC for deterministic QoS and BW management

Converged Transport Technology Choices - SONET/SDH Transport

- **Uses 802.1ad (S-VID) or 802.1ah (I-SID) for service identification**
- **Uses VCAT and LCAS for bandwidth on demand**
  - Dynamic resizing of SONET/SDH VC containers
- **Can use RSTP/MSTP or SONET/SDH APS for protection**
  - Can use GMPLS to pre-provision or calculate protected path/tunnel
- **Uses GMPLS (g-LSPs) as control plane for simplified end-to-end path/tunnel provisioning**
  - RSVP-TE for CAC for Ethernet packet services for deterministic QoS and BW management
  - Simultaneously supports TDM services

MSPPs today support Switched Ethernet and EPL Services over SONET/SDH
GMPLS provides the common control plane for Ethernet and TDM services

Service Types and Requirements

A look at the services and converged infrastructure performance requirements

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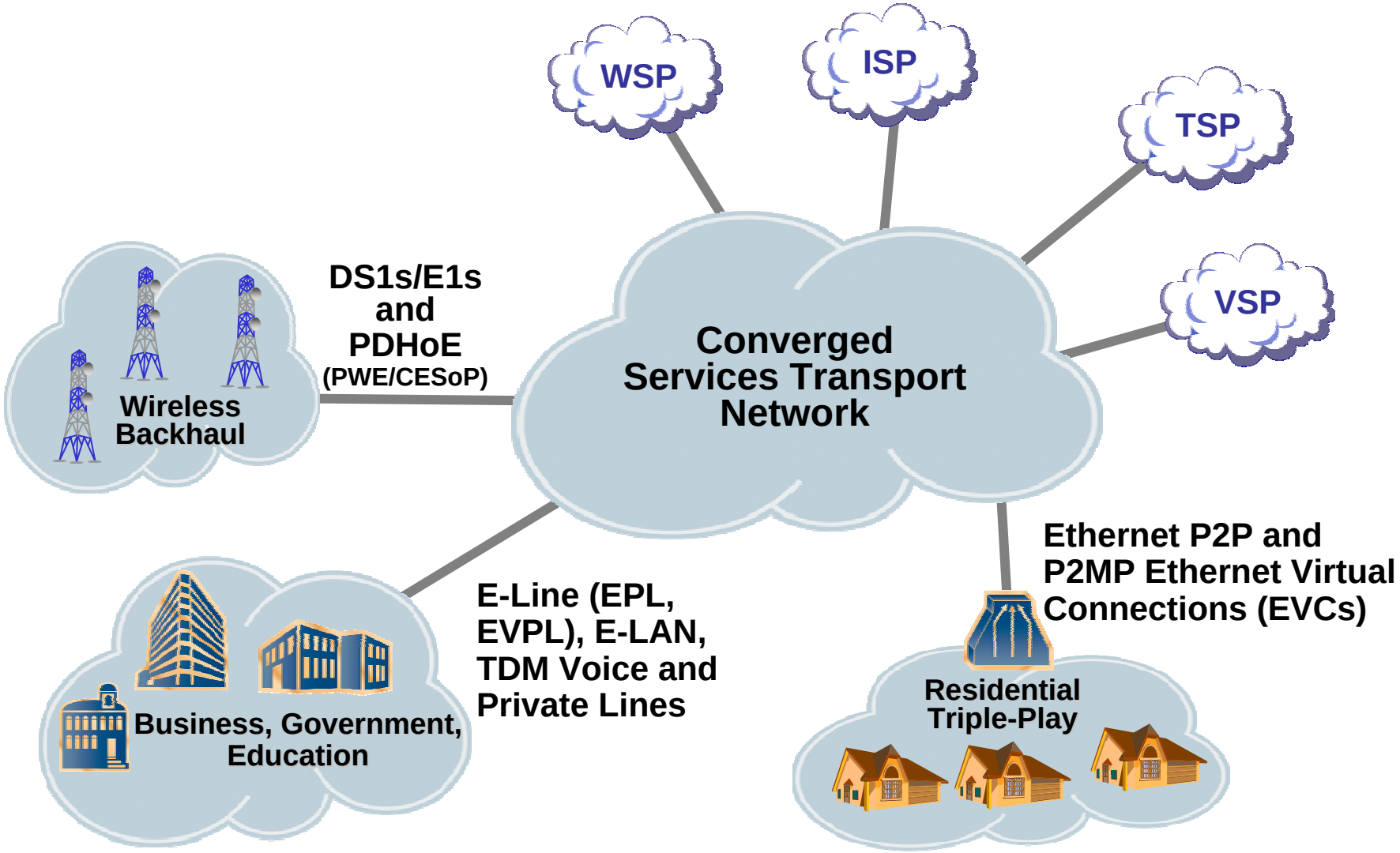
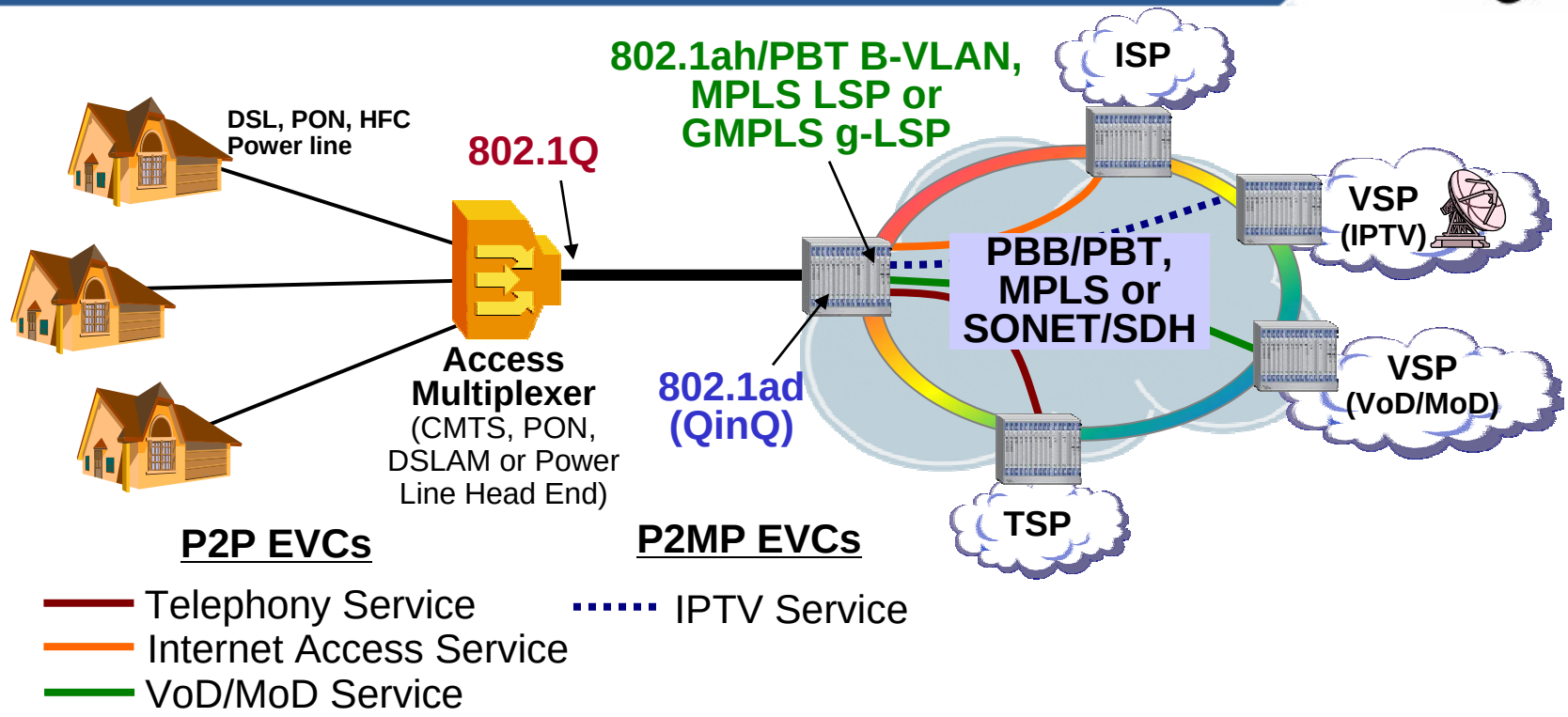
Converged Services Transport



Triple Play Service Transport Options



- **802.1Q VLAN ID can identify subscriber or service**
- **If typical customer subscribes to 3 to 5 services**
  - 802.1Q VLAN ID would support ~800 subscribers per Access Mux

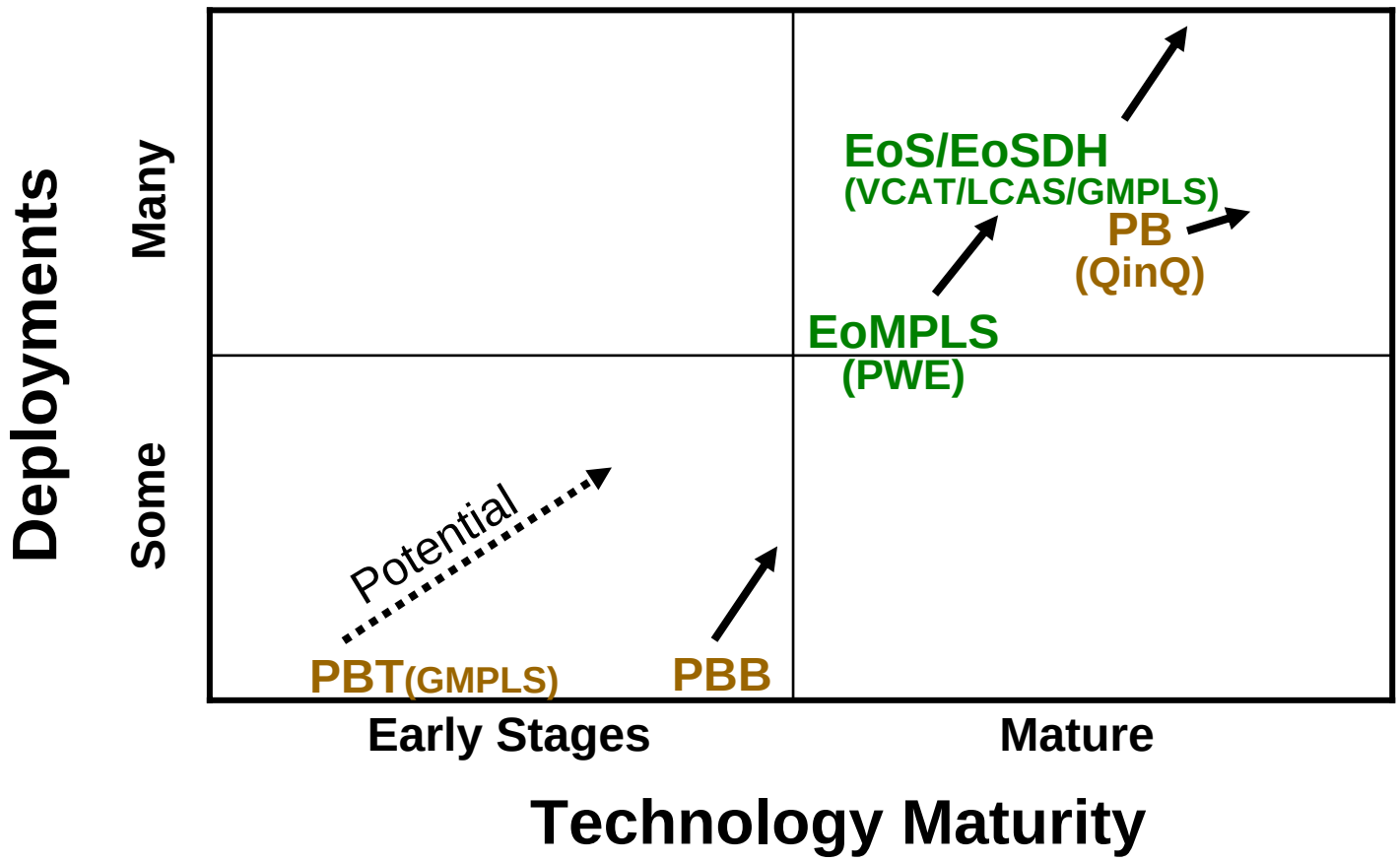
Services to support over Converged Transport Network – Business, Govt. and Education Services

- **Ethernet Private Line and Ethernet Internet Access**
  - "Pipe service" most commonly implemented over SONET/SDH
- **Ethernet VPNs**
  - E-Line (EVPL) and E-LAN (VPLS, TLS)
  - Can implement over Ethernet, MPLS and SONET/SDH
- **Legacy services over Ethernet**
  - PBX PRI Trunks
  - T1/E1 Private Lines
  - Require PDHoE to implement over Ethernet or MPLS
  - Transported unaltered over SONET/SDH

Multiservice Transport Network Service Management Requirements

- **Fault Isolation**
  - Need to determine if the fault is in the Ethernet Service Layer or Transport Layer
  - Need to be able to troubleshoot:
    - Ethernet Service, end to end (Service Continuity Check)
    - End-to-end path and local interconnections
- **QoS Performance Monitoring (PM)**
  - Need to measure/report at service level and transport level:
    - Delay, Delay Variation and Loss
    - Goodput and Throughput
  - Required for Service Level Objectives specified in SLA

Converged Services Transport Technology
"Magic Quadrant"



iConnect™ Network

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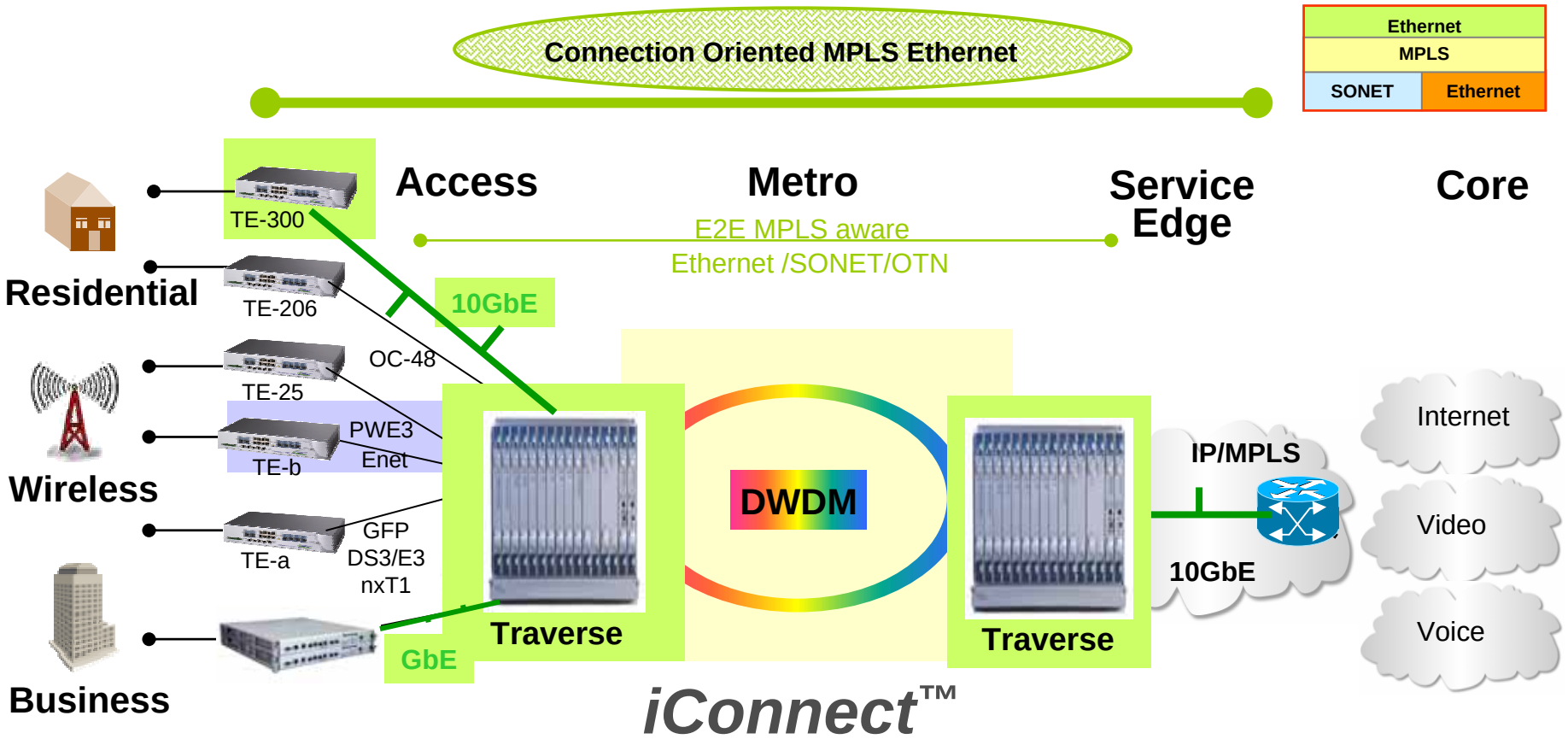
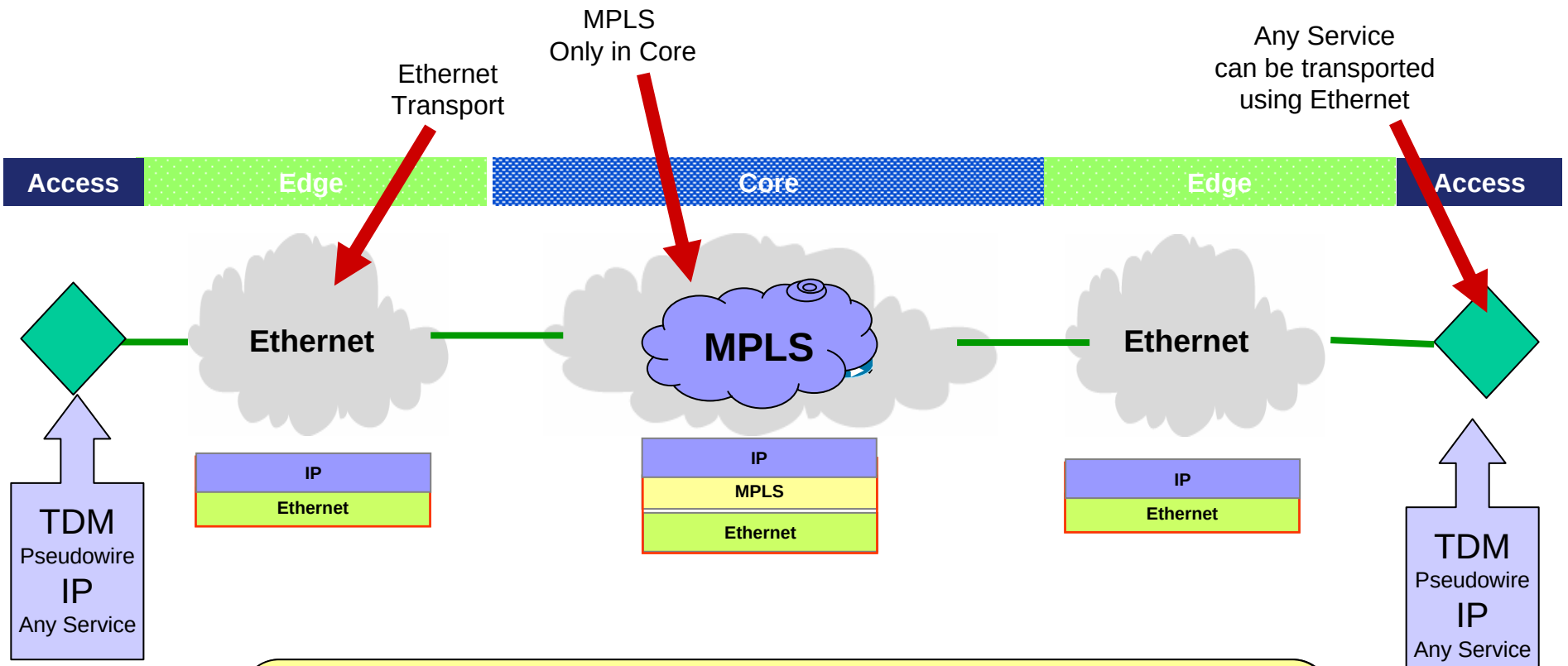
Turin Optimized Service Delivery Architecture



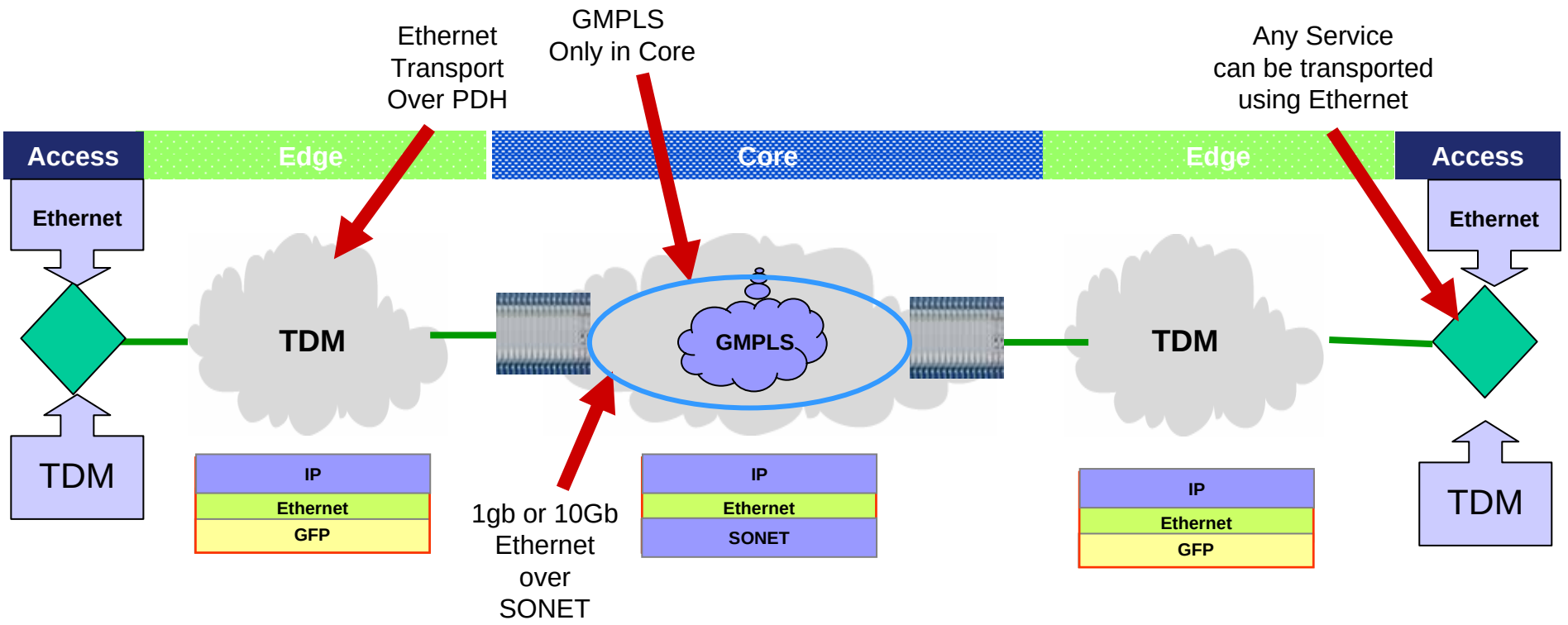
- **Seamless delivery of Ethernet End-to-End Services**
- **Guaranteed Ethernet SLA Service delivery quality**
- **Access over any media, coexistence of SONET and Optical Ethernet.**

Mobility Network Evolution Target
Any to Any Service with Ethernet Transport



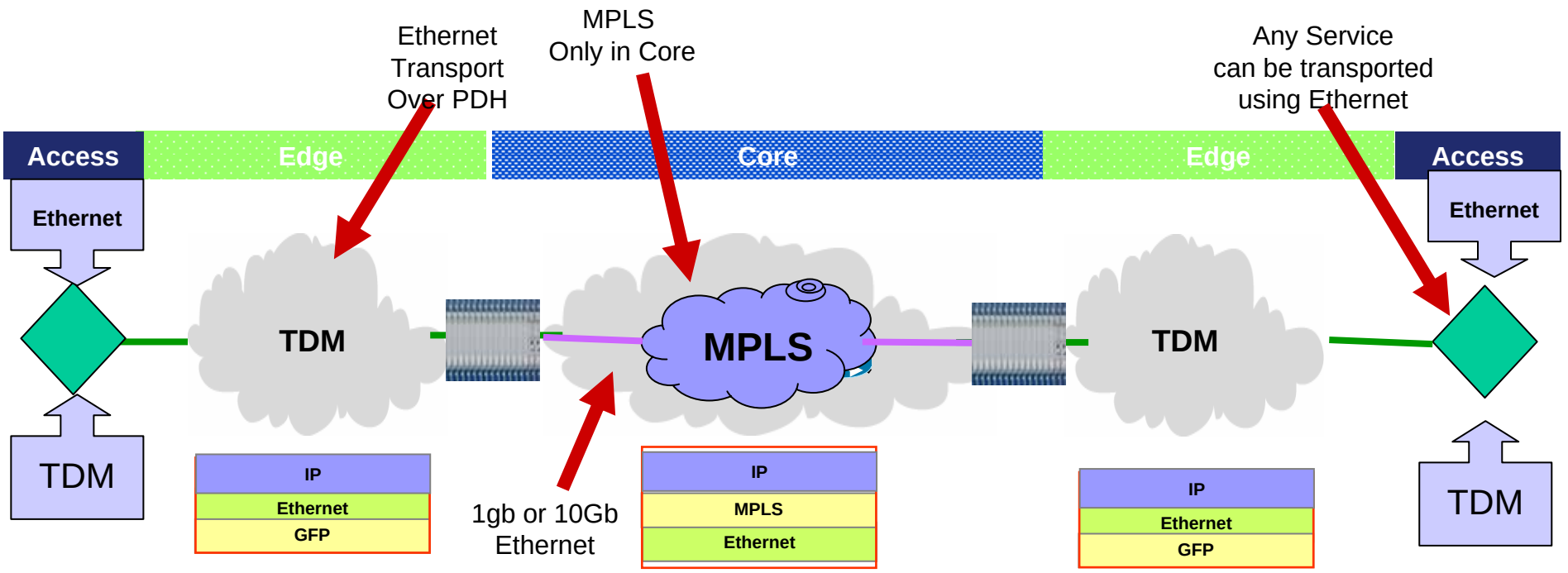
- **All Transport is over Ethernet**
- **Takes advantage and benefits of MPLS with reduced cost**
- **Simplifies operational complexities**
- **Allows legacy services currently deployed to be managed and transported on same transport network.**

Mobility Network Evolution 2007 with Turin Traverse



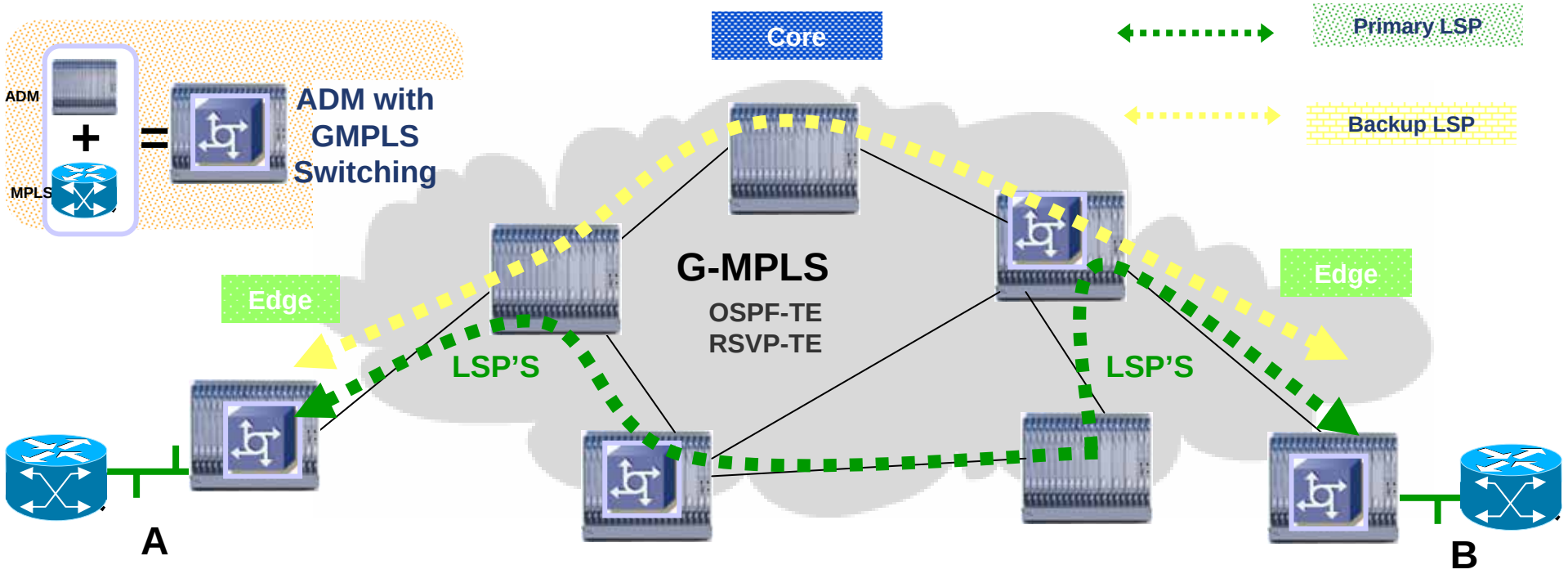
- **Ethernet transported EoPDH at Access**
- **Ethernet transported Ethernet over SONET at Edge**
- **TDM Transported TDM/SONET**
- **GMPLS based path protection**

Mobility Network Evolution 2009 with Turin Traverse



- **TDM Pseudo-wire aggregation on the Edge**
- **MPLS routing and protection in the core for all service**

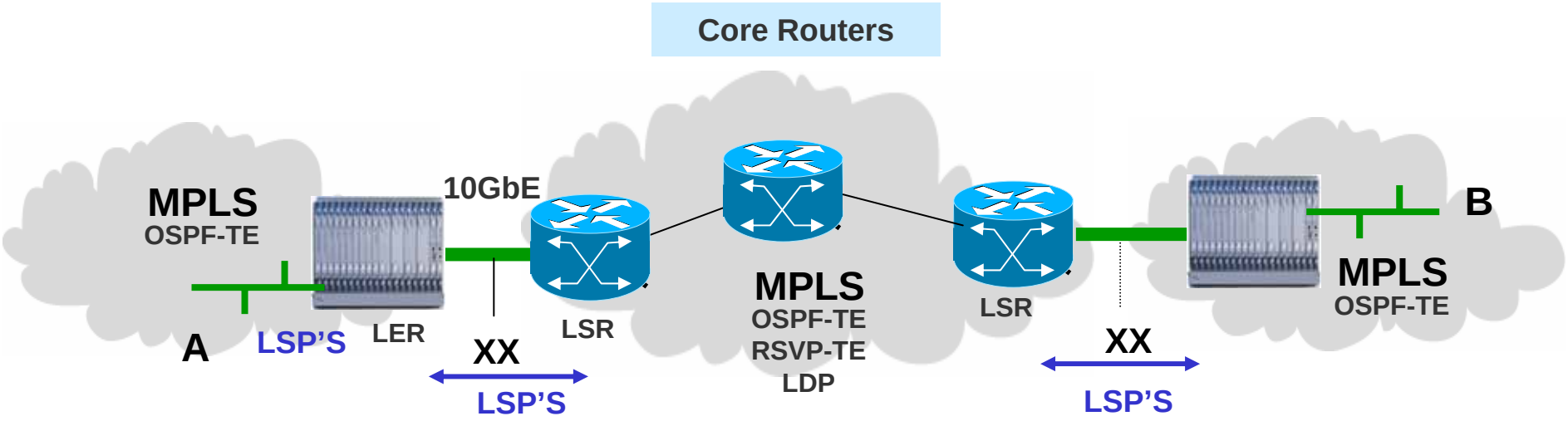
Mobility Network Evolution
End-to-End Ethernet using GMPLS (2008)



GMPLS

- Delivers End-to-End **Ethernet over TDM/Lambda**
- Support **Path Restoration**, more flexible use of BW.
- Support sub 50mS protection switching without dependency on SONET protection (EPL & EVPL)
- Support Provider Backbone Bridge and PBB-TE

Mobility Network Evolution
End-to-End Ethernet - MPLS (beyond 2008)



MPLS

- Delivers Ethernet over MPLS
- Opens the Traverse Routing to external Routers.
- Provides E2E over the Core Routers
- Traverse can be used as an LER (Edge Router for services)
- Provides Fast Re-Route

Conclusion

- Turin solution builds on existing GMPLS based control plane
- Several Technology Choices for converged services infrastructure
- Hitless addition/removal of optical BW using VCAT/LCAS
- Selective upgrades to mesh network along spans that are heavily used
- Allows TDM/Ethernet/MPLS/PBT switching to co-exist on the same network element
- MPLS encapsulation of Ethernet (EoMPLS) and pseudo-wires
- Fast-reroute based protection of the RSVP tunnels
- Enable an evolutionary change from TDM to packet switched networks (pay as you grow)
- Unified control plane model leverages the best of TDM/packet worlds to provide optimal solutions

Summary – Why Turin?

Versatile, Next-Generation Product Offerings

- Rapid delivery of new packet-based services for the lowest cost
- Supports future product extensions through a continuous stream of new service modules

Large and Diverse Customer Base

- Tier-1 such as Verizon, Alltel, NTT and Cable & Wireless as well as numerous ILECs, CLECS, Utilities, Wireless carriers, and MSOs
- Drives broad feature set while fostering an emphasis on product resilience

Focus on Customers

- Large enough to be considered a industry leader, small enough to care about our customers