Requirements and Options for Layer-2 Packet Transport in 100G Next Generation Networks

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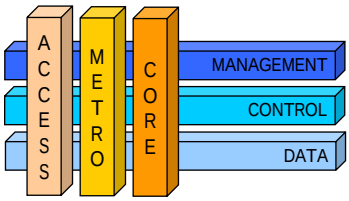
Changes in the Landscape of Communication Networks

- **Beginning of network convergence**
  - NGNs replace voice and data networks
  - Connection-oriented packet networks
  - First NGN services deployed
- **Complexity of data networks**
  - Hierarchical/logical network segmentation
  - Task-specific multi-layer networks (WDM→capacity, SONET/Ethernet→transport, ATM/MPLS→TE, IP/Ethernet→service)
- **NGN development drivers**
  - Traffic growth → Triple/Quadruple Play
  - Services quality → need for "virtual wires"
  - Low-cost technology → Ethernet
  - Decreasing revenue per bit → need for CAPEX / OPEX reduction



New technologies required enhancing data networks to suffice NGN requirements

New Concepts for L2 Packet Transport in 100GET

- **The two legs of 100GET**
  - 100 Gbit/s transmission physical layer
  - *New concepts for L2 packet transport*

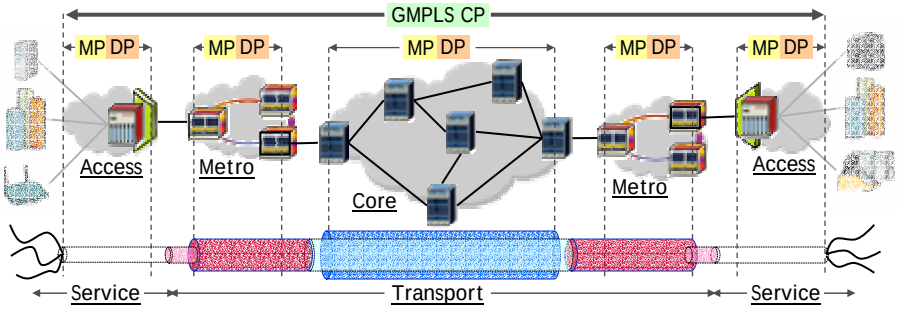
  } New flexible, efficient, reliable, and service-independent packet transport

- **Basic idea: shift packet transport to sub IP layers**
  - IP(L3) port costs **>>** L1/L2 port costs
  - Limited IP routing scalability
  - Here: focus on L2 transport concepts

  } Route at the edge, switch in the core!

- **Challenges of L2 packet transport**
  - Non-disruptive technology migration
  - Optimization of network resource utilization (CAPEX)
  - Simplification of end-to-end control & management (OPEX)
  - Securing of end-to-end service quality and reliability
- **Design options for L2 packet transport**
  - Consistent concepts across data, control, and management plane
  - Assessment by (cost-)efficiency, QoS-performance, scalability, and reliability

Vision of a 100G NGN Architecture



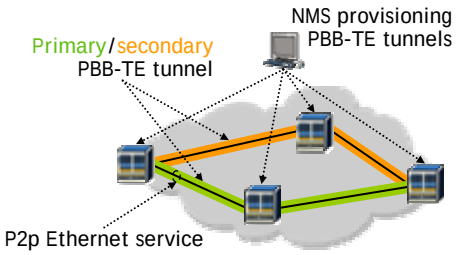
Management plane (MP)
- Flexible OAM functions for management of transport pipes
- Need for OPEX reduction
- CP extensions required
- Domain specific

Control plane (CP)
- GMPLS: defacto standard
- Support of a multitude of data plane technologies
- End-to-end signalling
- Domain independent

Data plane (DP)
- SONET/SDH to Ethernet migration
- Packet transport options
  - MPLS / Pseudowire
  - PBB-TE
  - T-MPLS / MPLS-TP NEW
- Domain specific

Provider Backbone Bridging – Traffic Engineering (PBB-TE aka. PBT)

- Technical idea
  - Point-to-point Ethernet tunneling
  - Provisioning only via NMS
  - MAC/VLAN forwarding
  - Subset of PBB (IEEE 802.1ah)
  - Introduction of TE functions, e.g.
    - MAC-in-MAC encapsulation
    - Connectivity check messages



Pros	Cons	Open issues
▪ Low-cost Ethernet support ▪ All Ethernet, i.e. native packet transport ▪ Scalable tunnel hierarchy (MAC/VID address encoding)	▪ No legacy support (ATM/FR, SONET/SDH, MPLS) ▪ Late in standardization and development ▪ Static provisioning only	▪ Multi-point support ▪ CP definition ▪ MP extensions ▪ Proof of (cost-)efficiency

PBB-TE hype is cooling down. Focus is shifting to lower tier & metro solutions.

Transport - MPLS (T-MPLS) & MPLS - Transport Profile (MPLS-TP)

- Technical idea (T-MPLS)
  - Optimization of MPLS for packet transport → T-MPLS = MPLS + OAM – IP complexity
  - Subset of MPLS (IETF RFC 3031)
    - Adoption of "strong" MPLS features (recovery mechanisms, …)
    - Omitting of OAM disrupting features (LSP merging, …)
  - Introduction of OAM management functions → FCAPS
- Displacement of T-MPLS by MPLS-TP
  - ITU / IETF consensus → Joint Working Team (JWT)
  - Probable acceptance by communications industry → non-disruptive migration

Pros	Cons	Open issues
▪ Mature MPLS base technology ▪ Support of Ethernet & legacy technologies ▪ Support of P2P, P2MP & MP2MP traffic ▪ Static (MP) & dynamic (CP) provisioning	▪ Coordination of 2 standards bodies	▪ CP adaptations / standardization ▪ MP extensions ▪ Internetworking architecture

MPLS-TP displacing T-MPLS will be first choice for higher tier & core solutions!

Some Technical Issues on Layer-2 Packet Transport in 100G NGN

- Network manageability
  - Which OAM functions are needed on the MP to save OPEX?
  - Which CP/signalling extensions are necessary to apply them to the DP?
- Network control
  - How should end-to-end paths be calculated?
  - Which information should/must be exchanged between network domains?
- Resource management
  - How should bandwidth pipes be dimensioned and multiplexed on Ethernet links?
  - How should they be aggregated into higher-level bandwidth pipes?
- Tunnel / LSP / Pseudowire performance
  - How should it be monitored?
  - How should it be enforced/guaranteed?

Conclusions

- Fundamental changes in communication networks due to NGN convergence
- Shift to connection-oriented packet transport on sub IP layers
- Requirements for L2 packet transport
  - (Cost-)Efficiency
  - Manageability
  - Service quality
  - Scalability
  - Reliability

  } New L2 transport mechanisms are needed to suffice these requirements
- Options for L2 packet transport
  - Management plane (MP): no options
    - New OAM functions required to improve manageability / reduce OPEX
  - Control plane (CP): single option
    - GMPLS defacto standard
    - Extension, adaptation, and standardization required for MP/DP support
  - Data plane (DP): mutliple options
    - MPLS/Pseudowire, PBB-TE, T-MPLS/MPLS-TP
    - Multi-technology DP expected