GMPLS-based Traffic Engineering in Multi-Region / Multi-Layer Service Network

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MPLS 2004

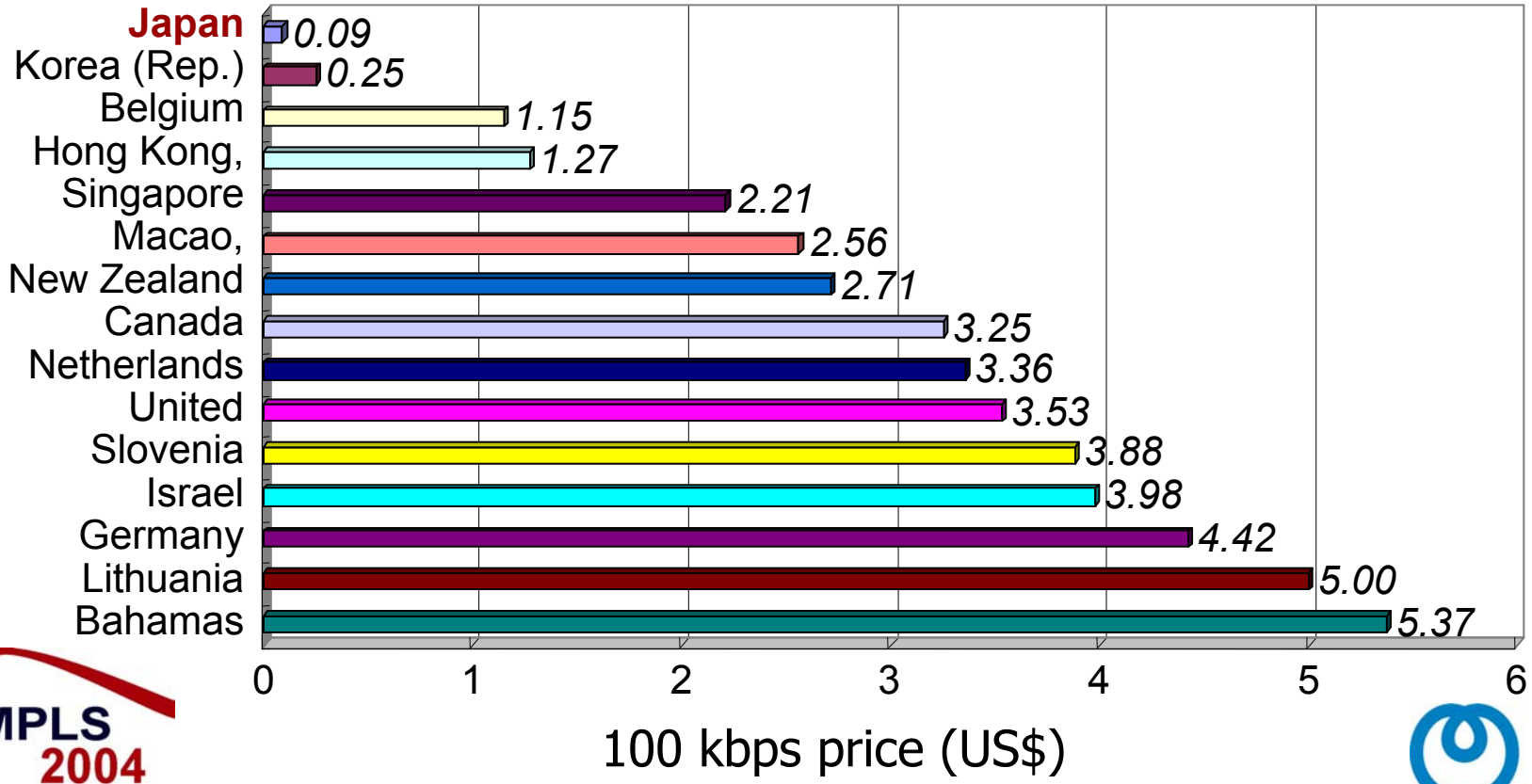
NTT

Outline

- IP optical network
- Multi-region traffic engineering
- Multi-layer service networks

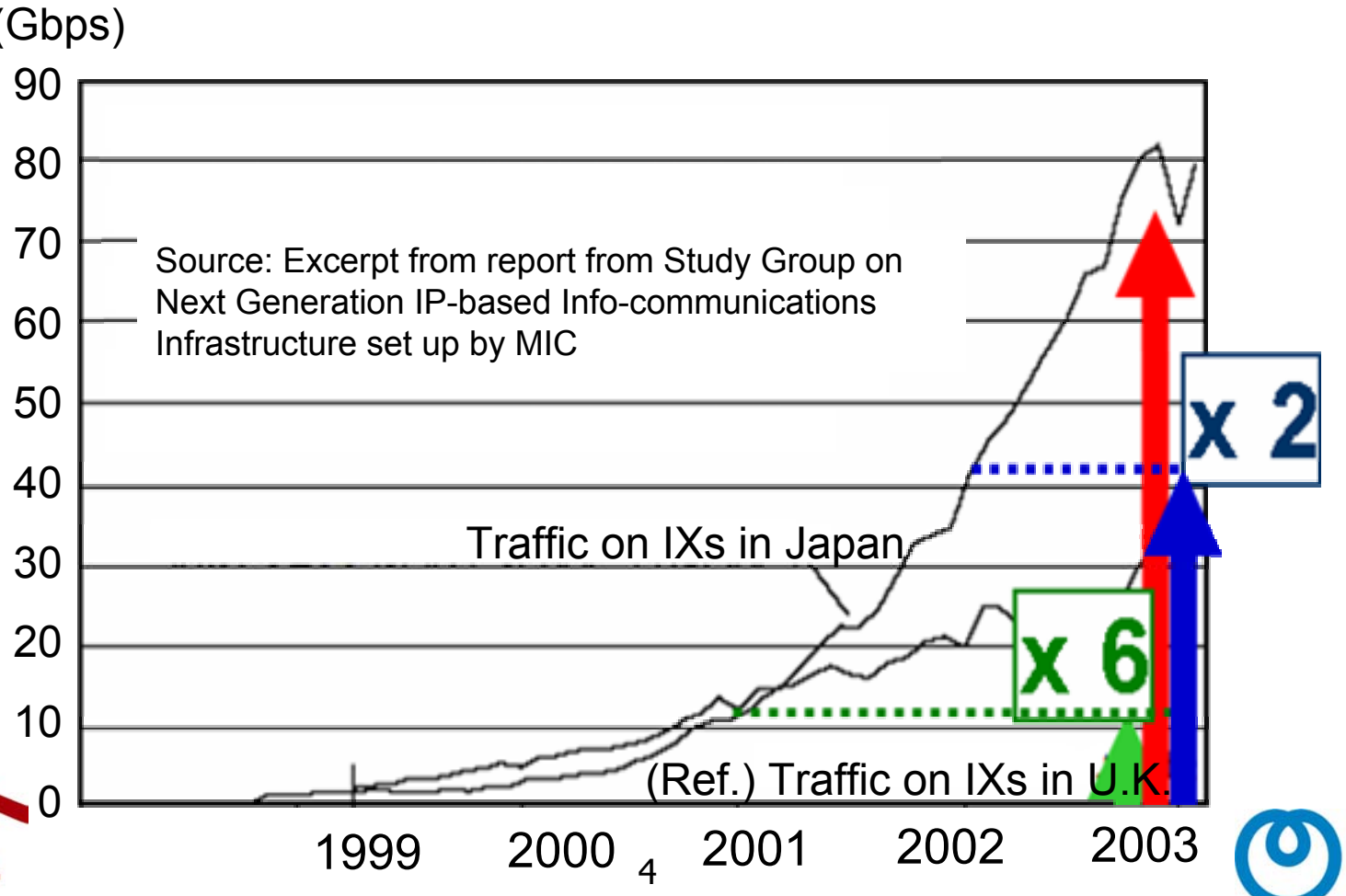
Broadband service price comparison

- Cheapest in the world thanks to fierce competition
- But, no ISPs can profit enough money to invest new tech.



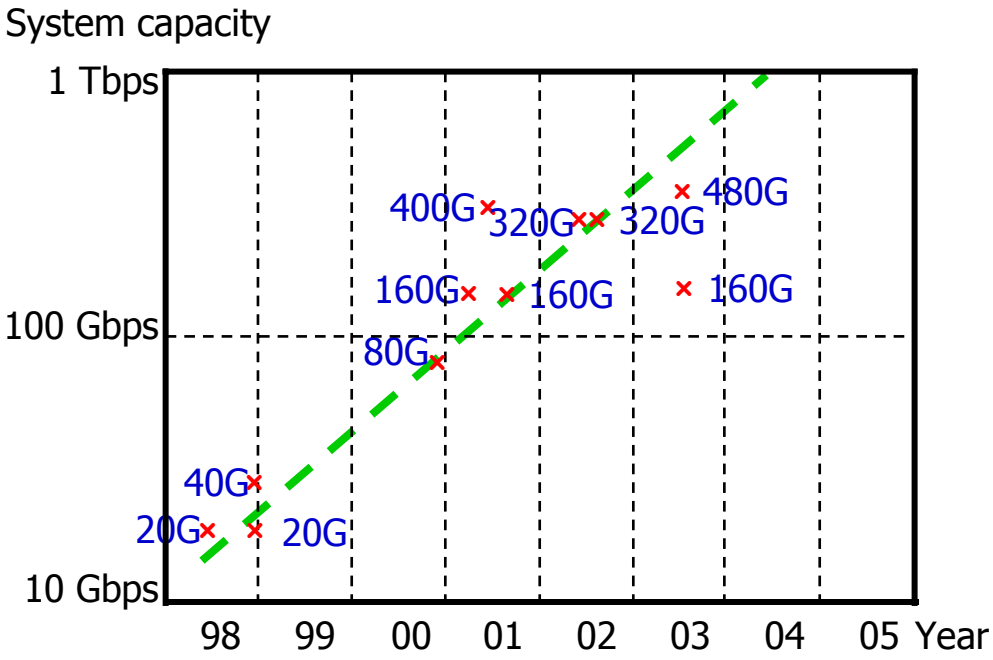
Traffic on IXs in Japan

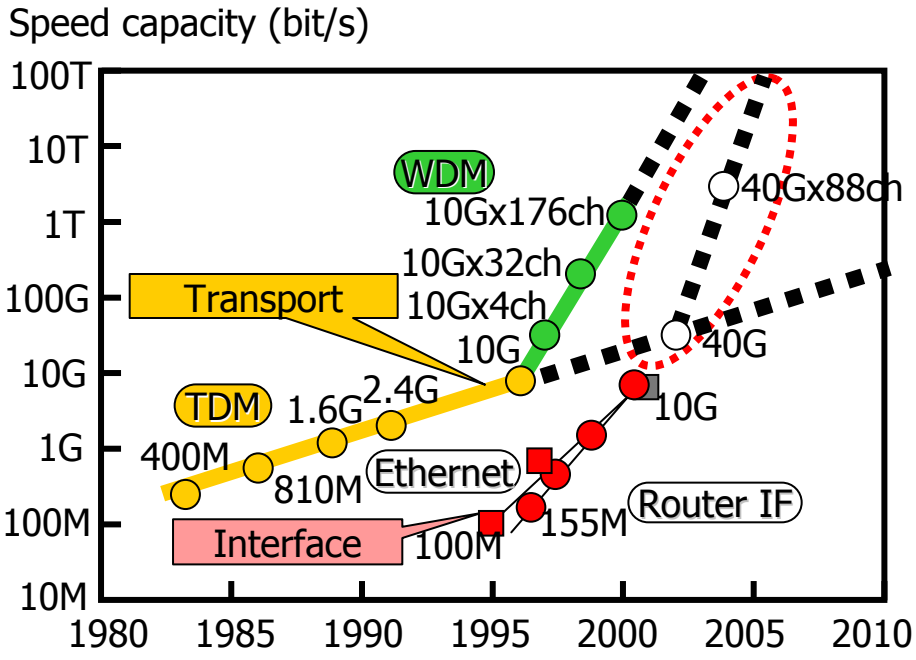
- The amount of traffic has been increasing rapidly



Trend of router throughput

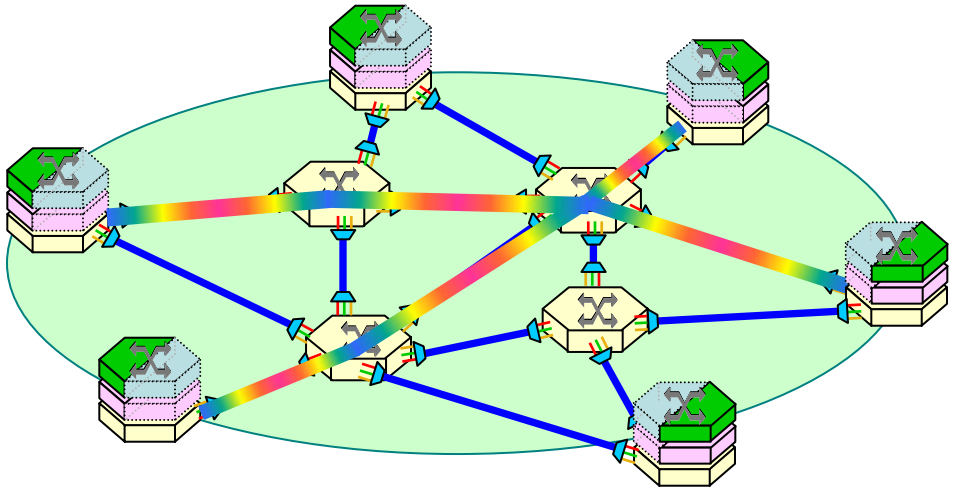
- Limitation of electrical processing beyond 40Gb/s

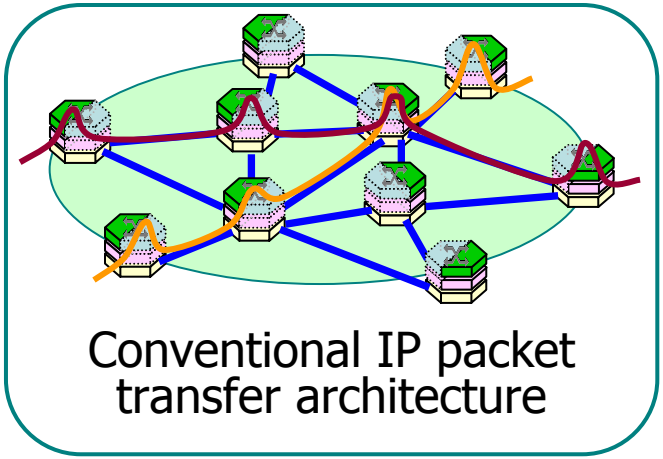




IP optical network architecture

- Direct optical path setup among edge nodes without electrical IP processing in transit nodes. (cut-through by optical path)

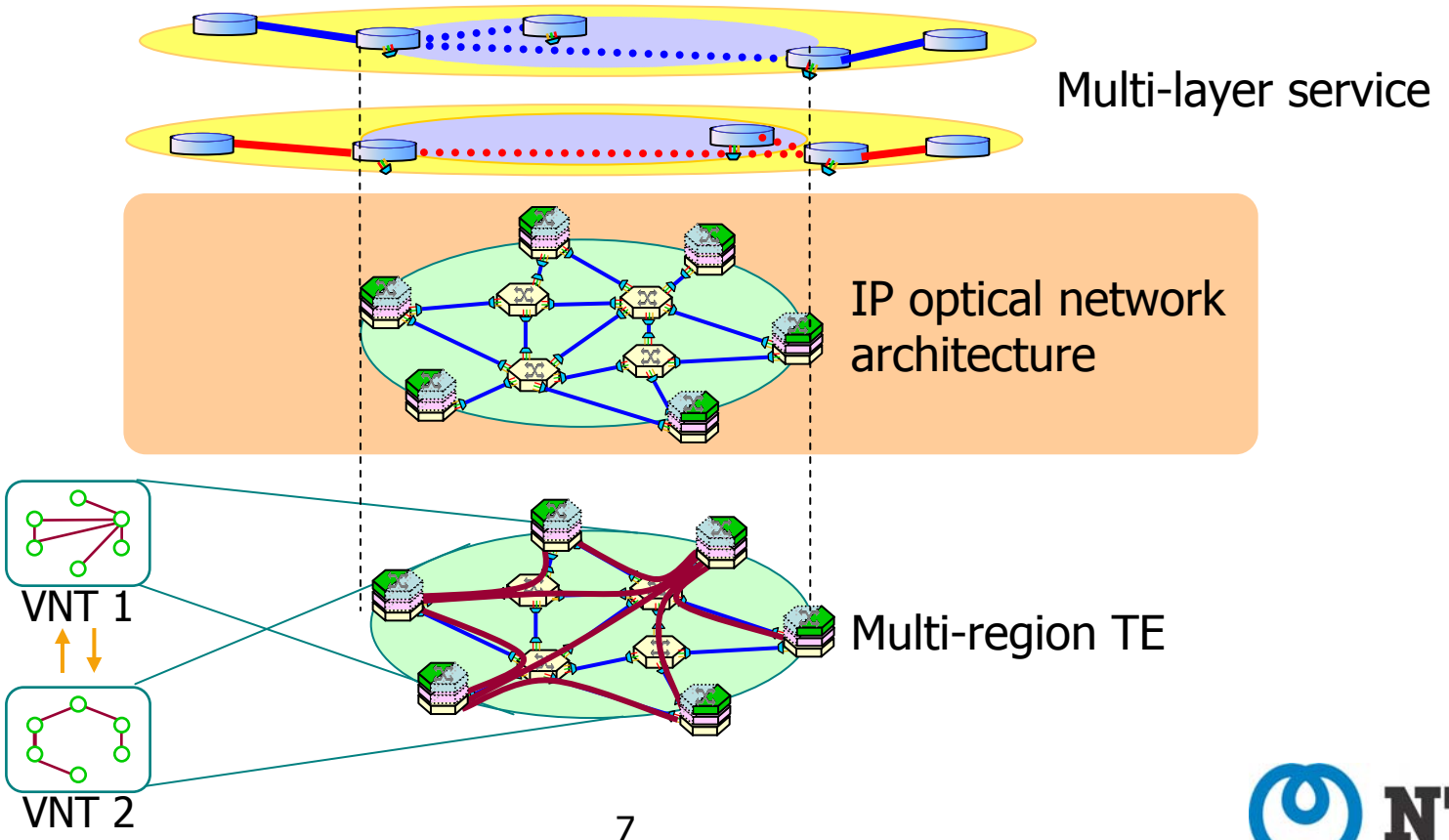




Conventional IP packet transfer architecture

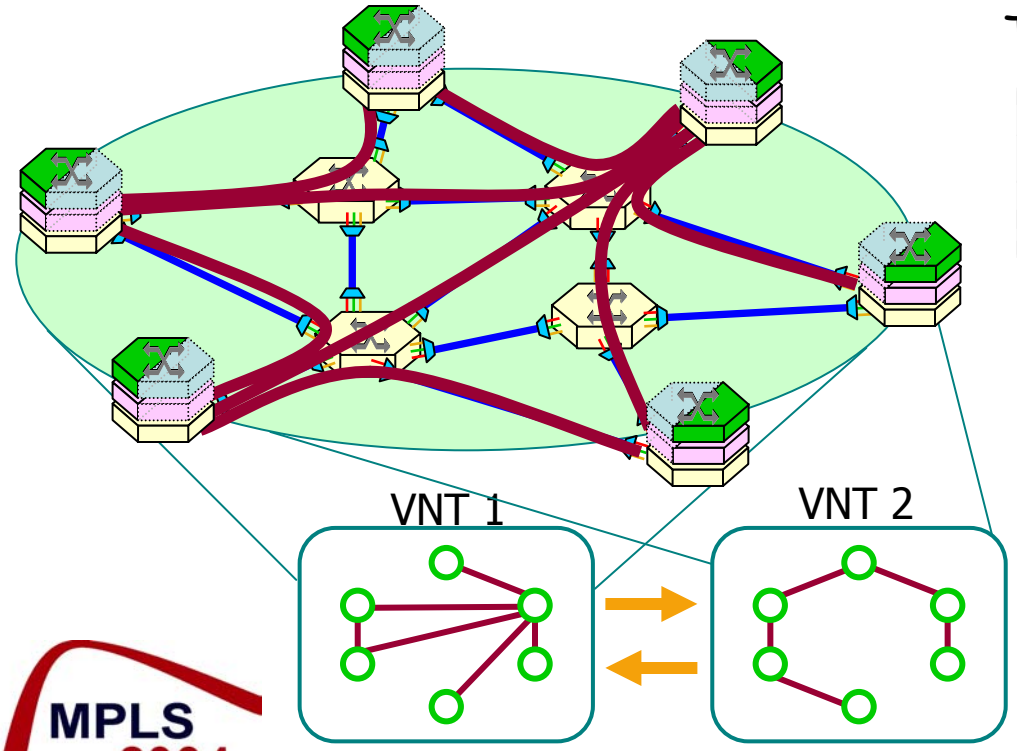
IP optical network architecture

- Multi-region traffic engineering
- Multi-layer service networks



Multi-region traffic engineering

- TE based on dynamic reconfiguration of VNT
  - Optical-layer provides VNT for packet-layer
  - VNT is re-configured by LSP setup/teardown.
    - Optical-LSP is routed over the fiber topology.



Traffic demand

$$\begin{pmatrix} r_{1,1} & r_{1,2} & \Lambda & r_{1,n} \\ r_{2,1} & r_{2,2} & \Lambda & r_{2,n} \\ M & M & O & M \\ r_{n,1} & r_{n,2} & \Lambda & r_{n,n} \end{pmatrix}$$

Current VNT

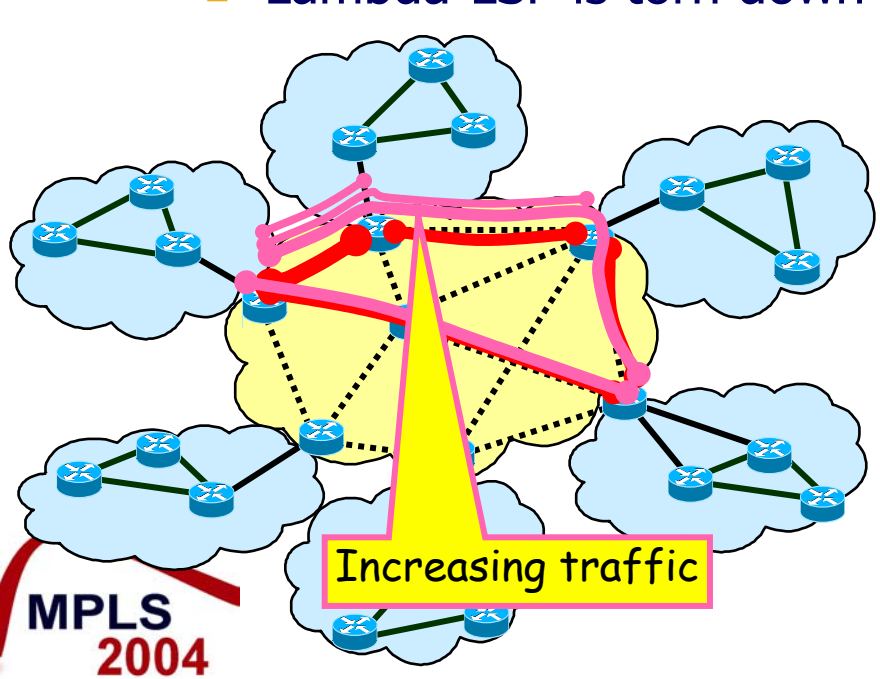
$$\begin{pmatrix} P_{1,1} & P_{1,2} & \Lambda & P_{1,n} \\ P_{2,1} & P_{2,2} & \Lambda & P_{2,n} \\ M & M & O & M \\ P_{n,1} & P_{n,2} & \Lambda & P_{n,n} \end{pmatrix}$$

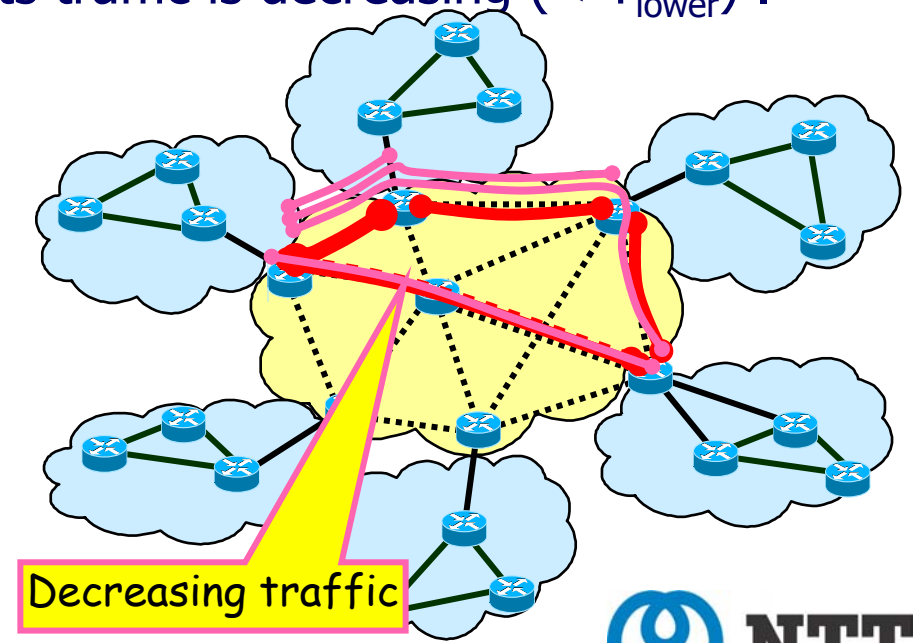
New VNT

$$\begin{pmatrix} P_{1,1} & P_{1,2} & \Lambda & P_{1,n} \\ P_{2,1} & P_{2,2} & \Lambda & P_{2,n} \\ M & M & O & M \\ P_{n,1} & P_{n,2} & \Lambda & P_{n,n} \end{pmatrix}$$

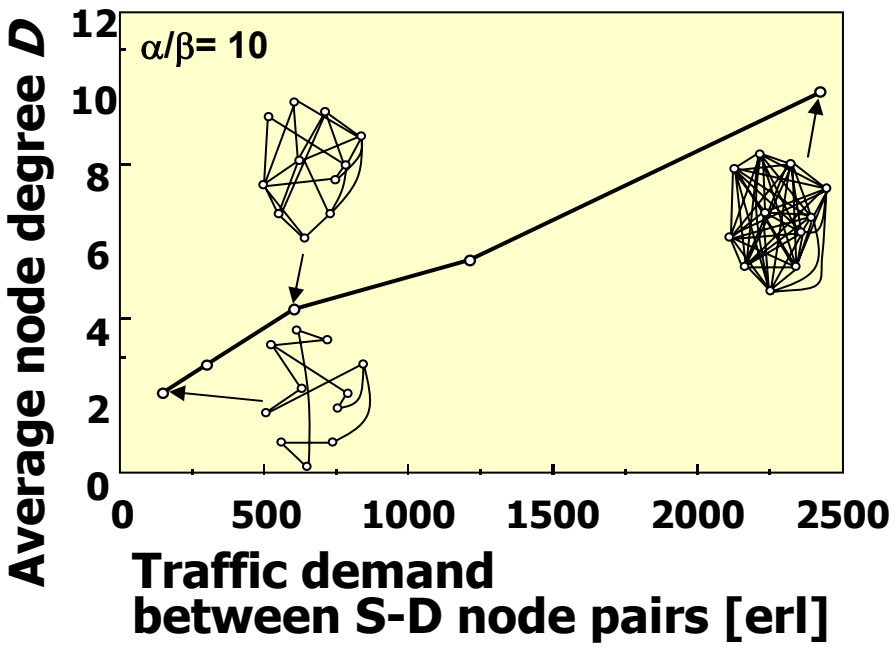
Heuristic VNT calculation algorithm

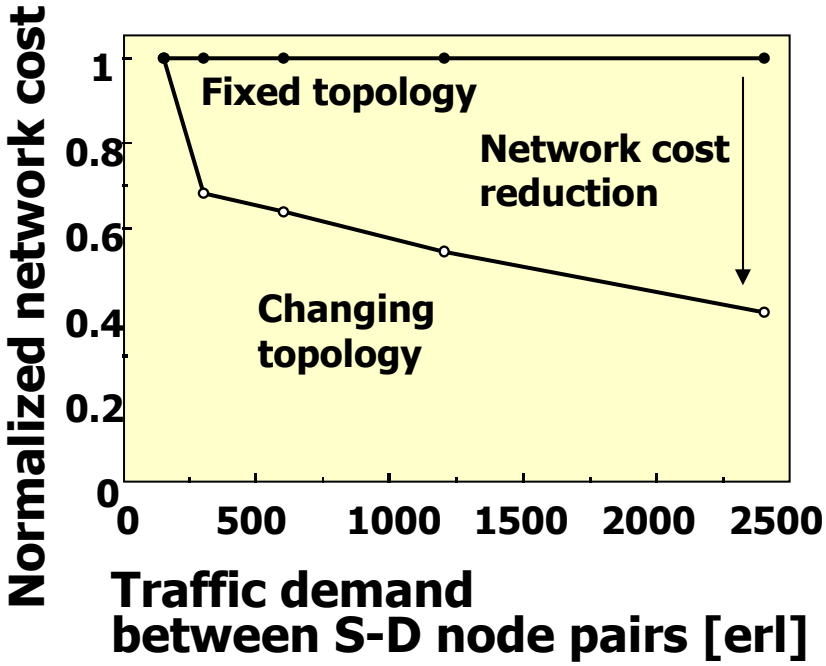
- LSP setup for increasing traffic
  - New lambda-LSP is set up so that multi-hop packet LSPs over the congested lambda-LSP (> T_{upper}) can get routed.
- LSP teardown for decreasing traffic
  - Lambda-LSP is torn down if its traffic is decreasing (< T_{lower}) .





Effect of dynamic VNT reconfiguration



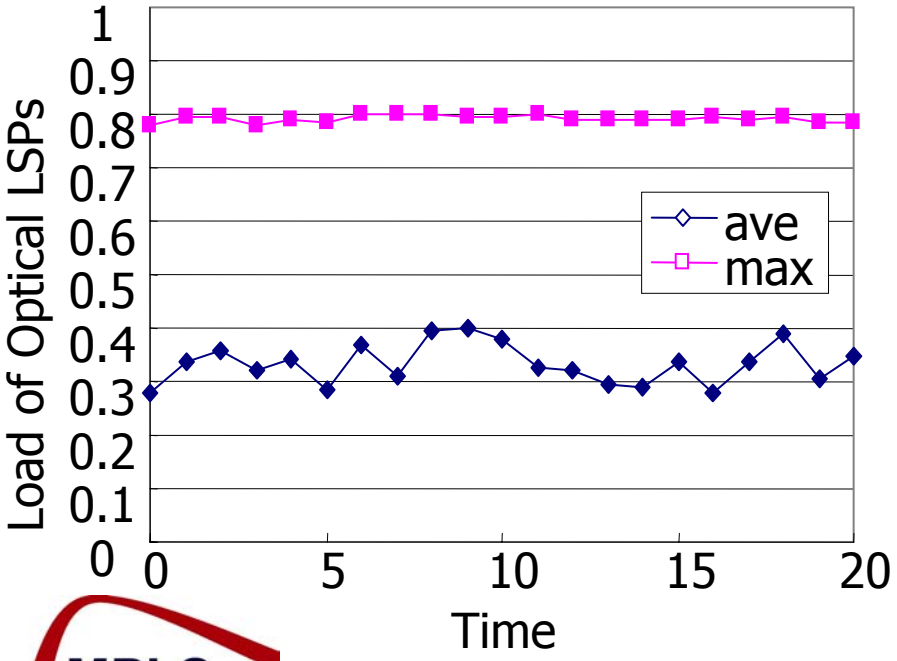


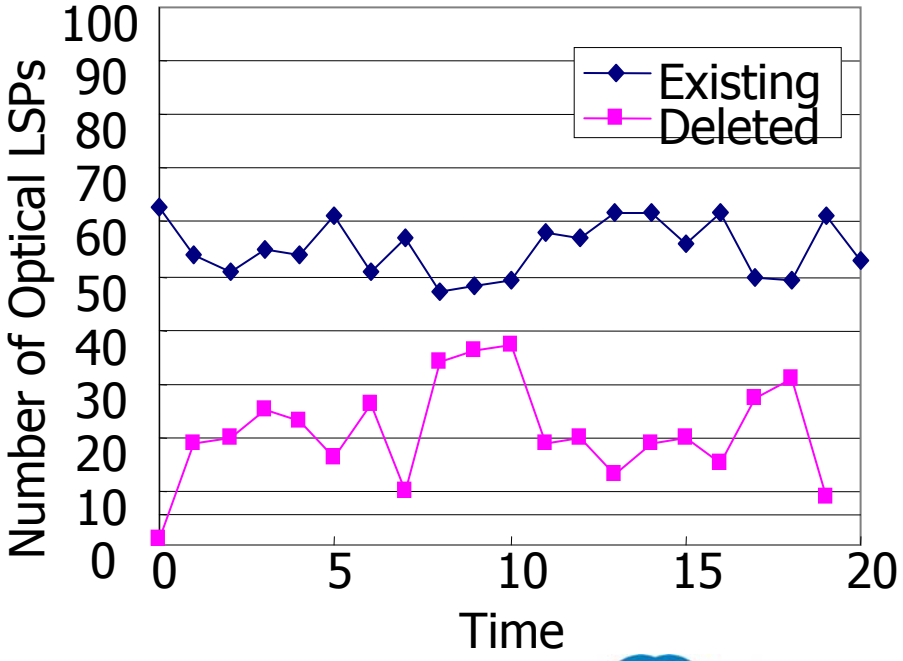
Topology : LATA network model
Lambda path cap. : 2.5 Gb/s

t(i,j) : fixed uniform
Cost : proportional to # of ports (E and O)

Simulation example

- Assumption
  - Traffic demand rij is assumed to be uniformly distributed in the range (r0, r1)=(0,0.3)
- Observation
  - Maximum load of Optical LPSs is well controlled by establishing and releasing Optical LSPs. (Tupper=0.8)



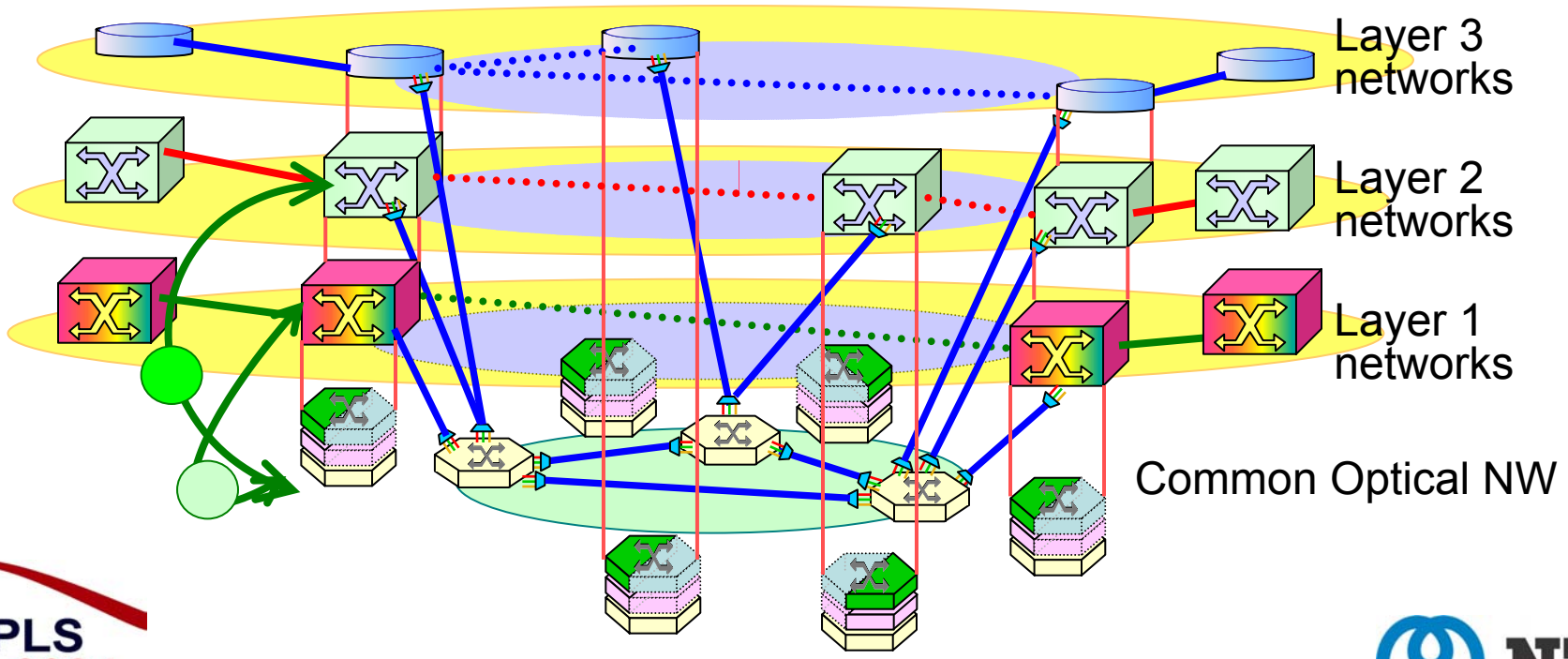


Multi-region network (MRN)

- IETF drafts
  - "Generalized MPLS Architecture for Multi-Region Networks" <draft-vigoureux-shiomoto-ccamp-gmpls-mrn-04.txt>,2/2004
  - "Requirements for GMPLS-based multi-region network," <draft-shiomoto-ccamp-gmpls-mrn-reqs-00.txt>, 10/2004
  - "Generalized MPLS Architecture for Multi-Region Networks," <draft-dimitri-ccamp-gmpls-mrn-extensions-00.txt>, 10/2004
- Running code demonstration
  - Please visit the PIL (Photonic Internet Lab) booth @MPLS2004 (Booth No.: 300).

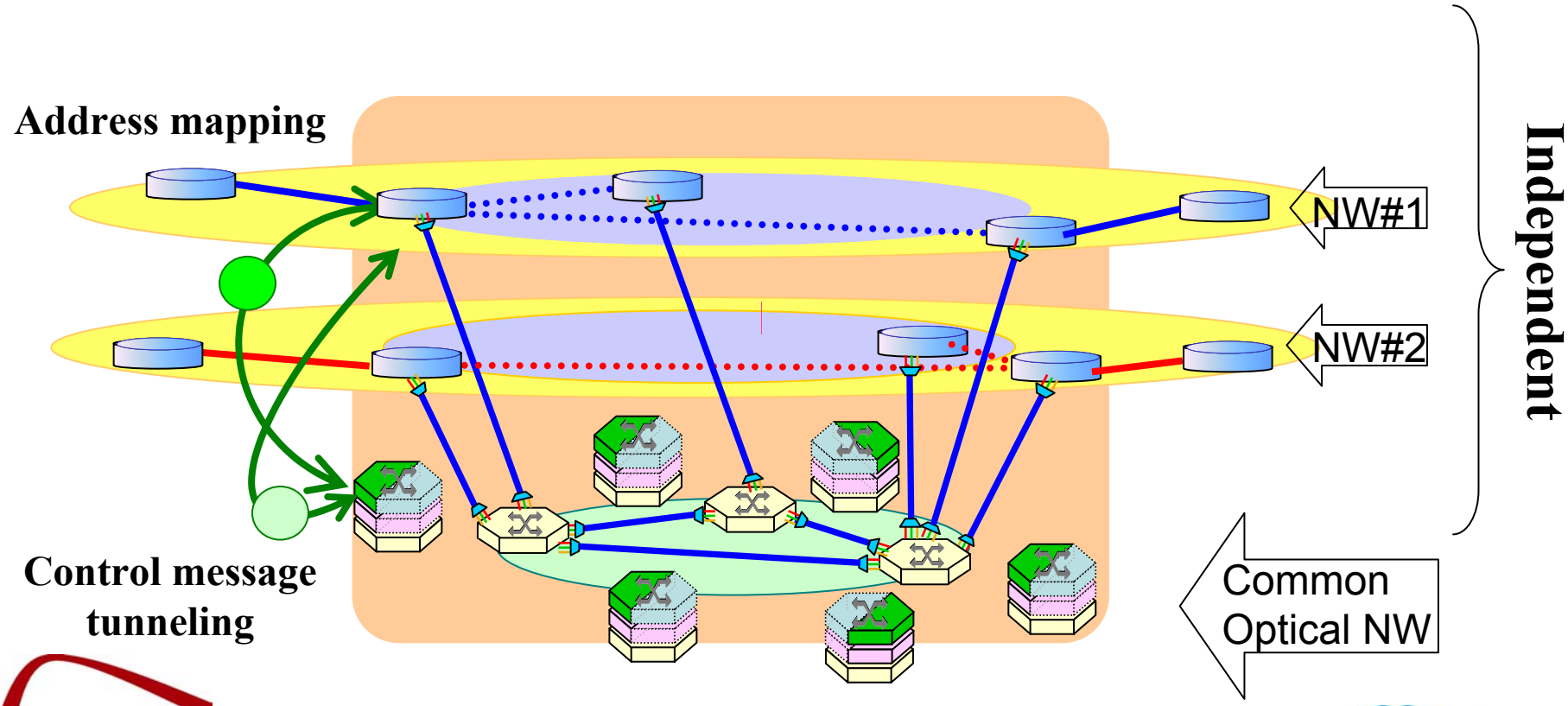
Multi-layer service network

- Accommodate Multiple different layer network service, different type of service, in different control technologies (i.e., address spaces)
- Dynamic optical path control enabling advanced service realization



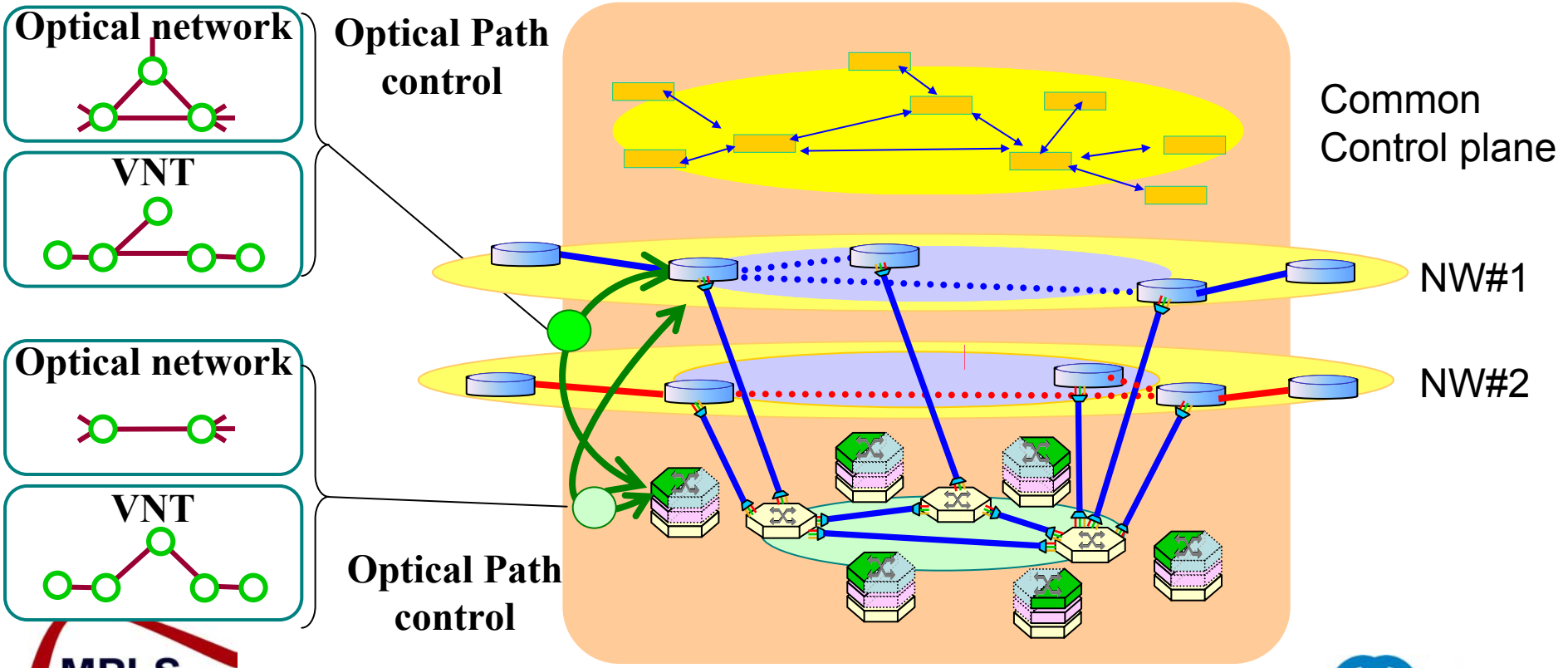
Accommodate Multiple service-networks

- Accommodate multiple service-networks utilizing independent control technologies and address spaces



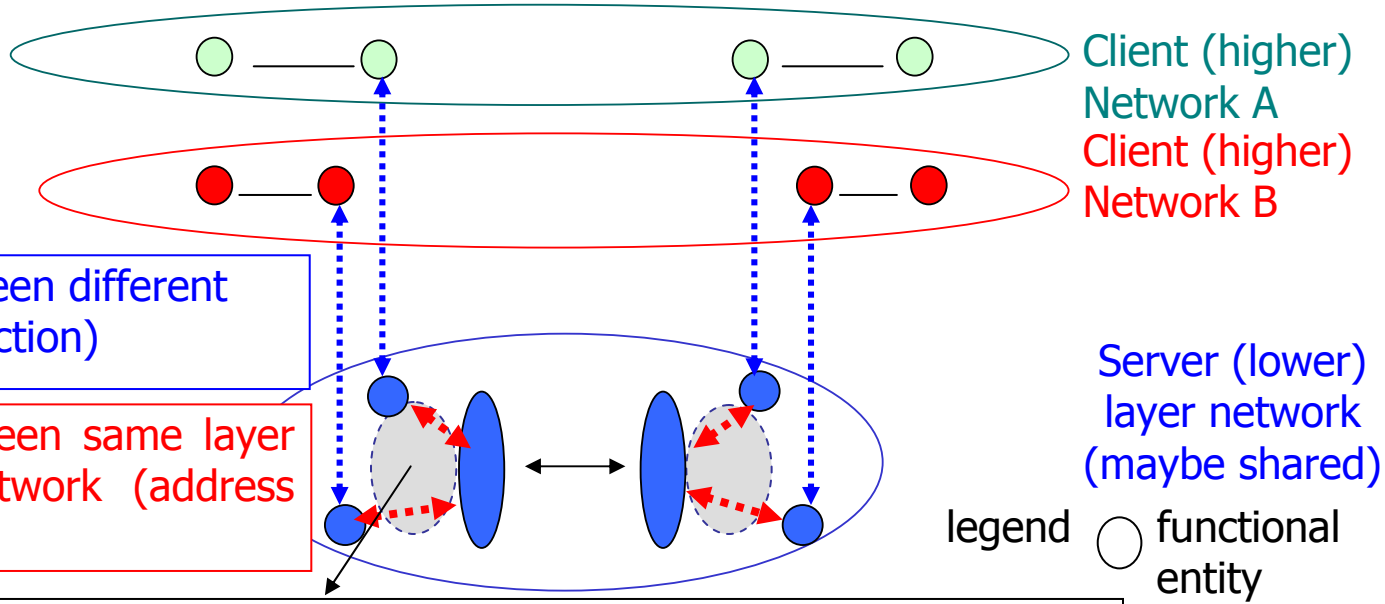
Autonomous optical path control

- Autonomous optical path control according to different conditions in each service network



Functional model
Multi layer service network

- ITU-T has agreed on a new recommendation called Y.2011. There is a section to conceptually include the multi layer network architecture.
- This is a natural extension of GMPLS multi region network concept.



Server layer function provides independent control of multiple parameters including address spaces, control parameters, policies and other algorithms for different client layer networks.

Summary

- IP Optical network architecture
- Multi-region traffic engineering
  - VNT is reconfigured using GMPLS protocols.
  - Information in IP and optical is consolidated into a single TED using GMPLS protocols.
  - VNT calculation (traffic demand & current VNT)
- Multi-layer service networks
  - Different service network is overlayed over GMPLS-based MRN
  - Address space separation & Autonomous optical path control


Thanks!