QoS in GMPLS based IP/DWDM Metro Networks

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Outline

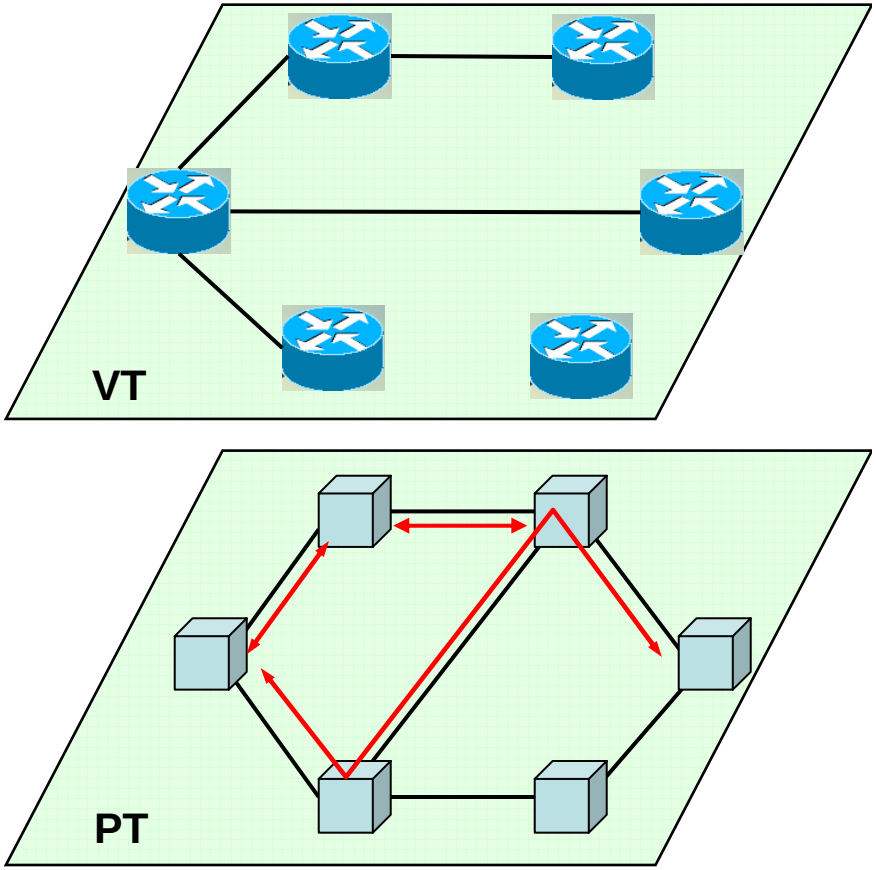
- Evolution
- IP over optical networks
- GMPLS QoS problem in optical networks
- Proposed scheme for integrated QoS control
- Simulation study
- Conclusions and future works

Evolution

- Traffic dominated by IP services
  - DSL, cable modem, Ethernet passive optical networks
  - Unpredictable
- New network infrastructure is needed
  - Multi service to increase ROI
  - Self-adaptivity to replace the traditional overprovisioning
- Migration from SONET/SDH rings to DWDM mesh networks
  - Lower CAPEX
  - OPEX reduced by the GMPLS distributed control plane and MTE paradigm
  - Tight IP/DWDM layers integration

IP over DWDM mesh networks

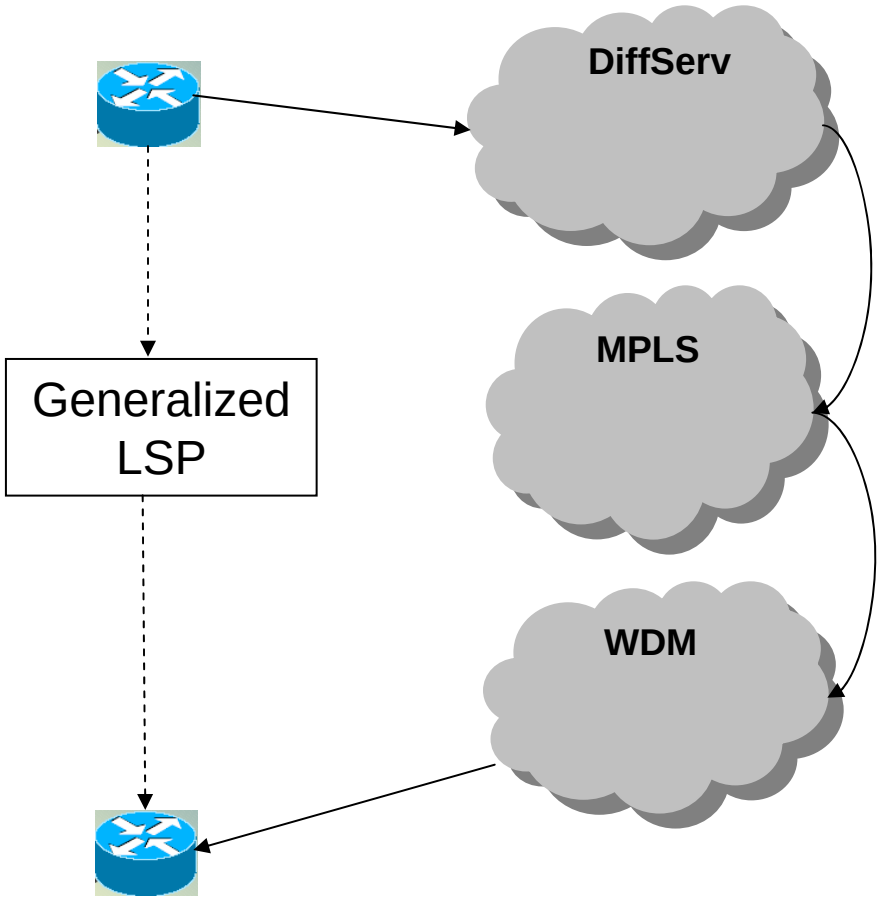
- DWDM technology
  - Users traffic multiplexed on different wavelengths
  - Fibers reach Terahertz of capacities
- Physical optical topology
  - Optical Add/Drop Multiplexers (OADMs) wavelength add/drop/bypass
  - Optical Cross Connects (OXCs)
  - Lightpaths
- Logical (virtual) IP topology
  - IP electronic routers
  - Set of lightpaths
- Multilayer Traffic Engineering
  - IP load balancing in the IP layer
  - Lightpath establishment when high load
  - Dynamic virtual topology reconfiguration



Generalized MPLS control plane

- MPLS for unloading IP routers
  - Label switching replaces traditional routing
- From MPLS to GMPLS
  - Packet, TDM, Wavelength, Fiber
  - Wavelength replaces the notion of label
- IP/DWDM integration
  - Nodes with two switching technologies
  - Network with Unique Traffic Engineering Database (TED)
  - Better resource utilization
- DiffServ at IP/MPLS layer
  - Classes of Service in IP
  - Different LSPs for different CoS
- DiffServ at optical layer
  - Virtual topology differentiation

QoS in GMPLS IP/WDM networks

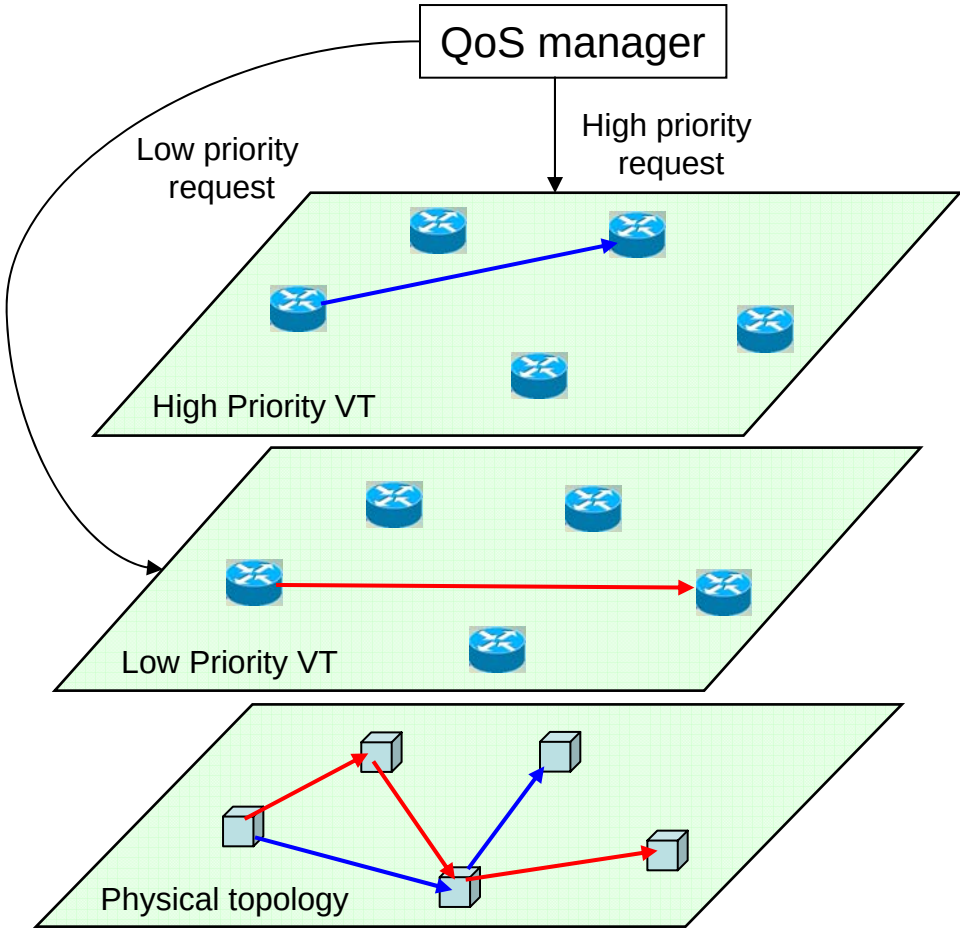


- IP traffic divided in CoS
  - Expedited Forwarding (EF)
  - Assured Forwarding (AF)
  - Best Effort (BE)
- Different LSPs for different CoS
  - EXP-inferred LSP (E-LSP)
  - Label-inferred LSP (L-LSP)
- Traffic re-aggregated in WDM

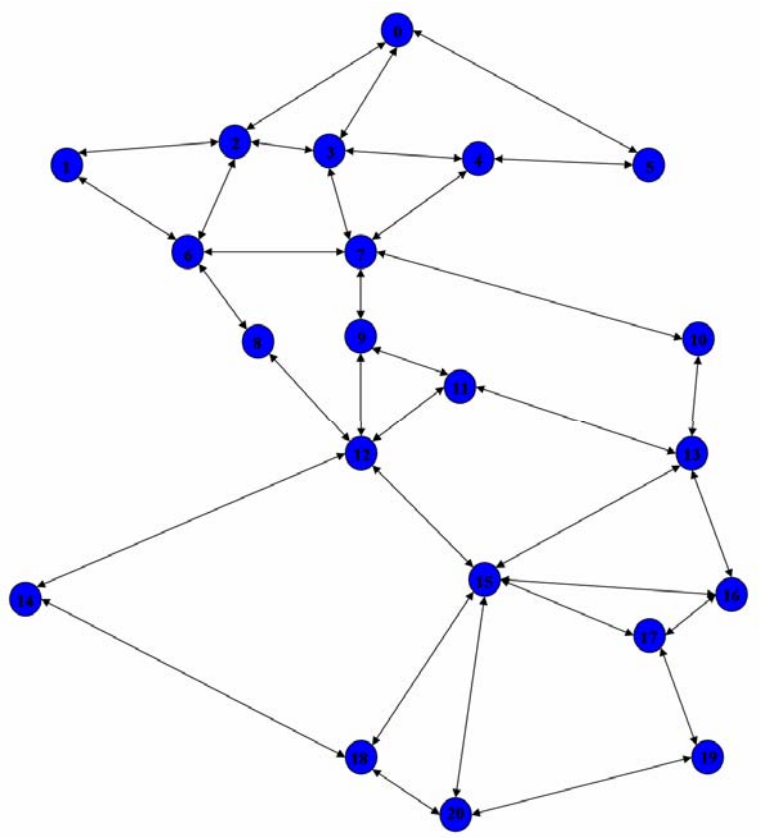
Multilayer Differentiation needed

Virtual topology differentiation

- First differentiation based on lightpath quality
  - Bit Error Rate (BER), delay, jitter
  - Protection
- Several virtual topologies
  - OLSPs are advertised as an FA with a certain grade of quality
  - Set of FAs with the same quality form an independent VT
- Different strategies for different virtual topologies
  - Routing/grooming policies
  - Reconfiguration frequency, rerouting, etc.

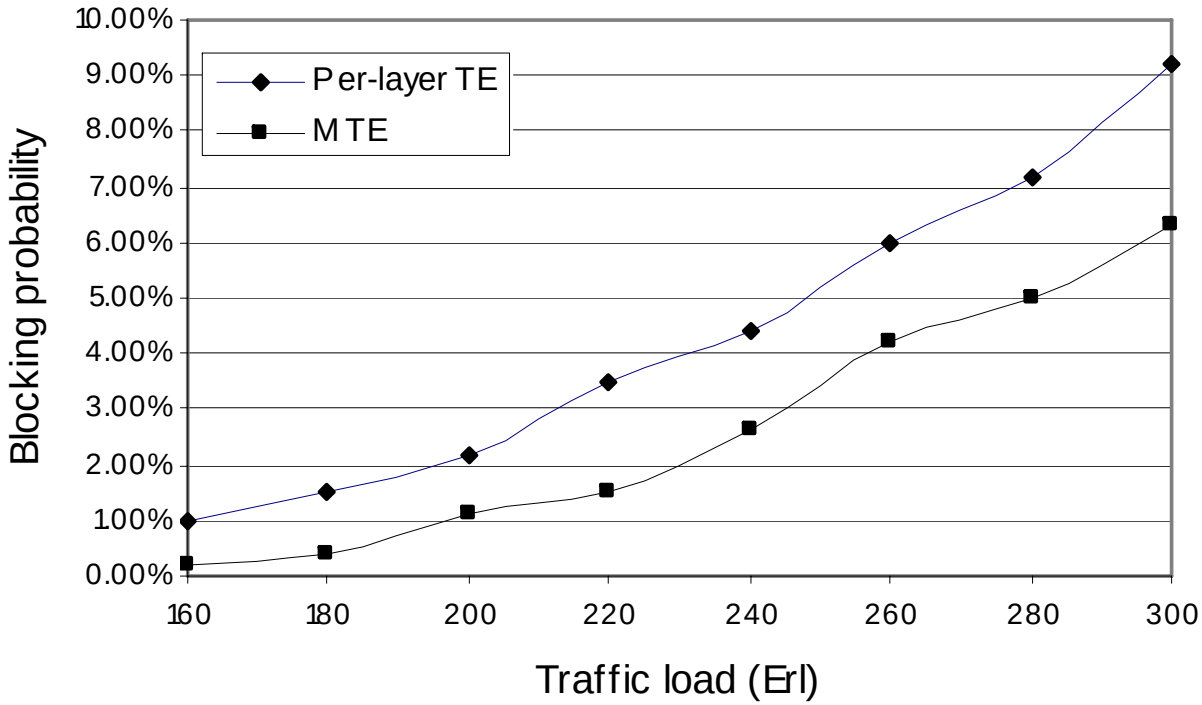


Simulation study

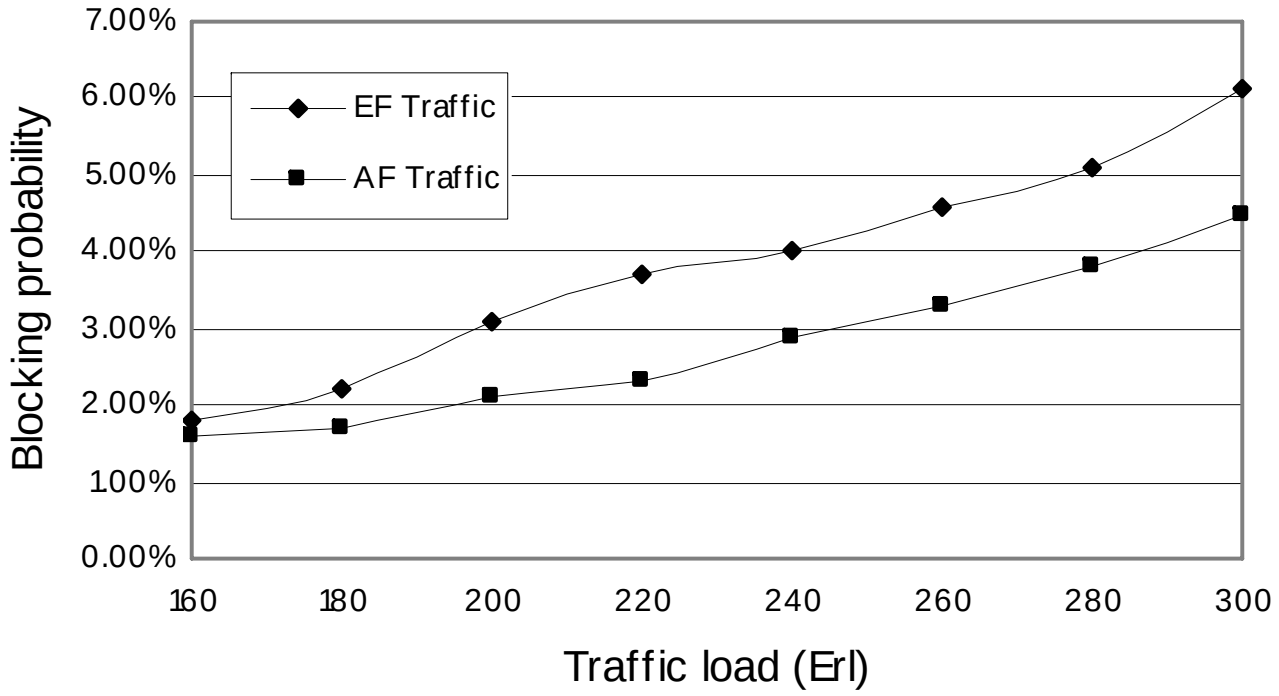


- 21 nodes, 36 fibers
- 12 wavelengths from OC-1 to OC-192
- 10^6 connection requests according to Poisson distribution
- 40% EF and 60% AF traffic
- Capacity uniformly distributed
- Sources-destinations uniformly distributed
- OMNET++ simulation tool

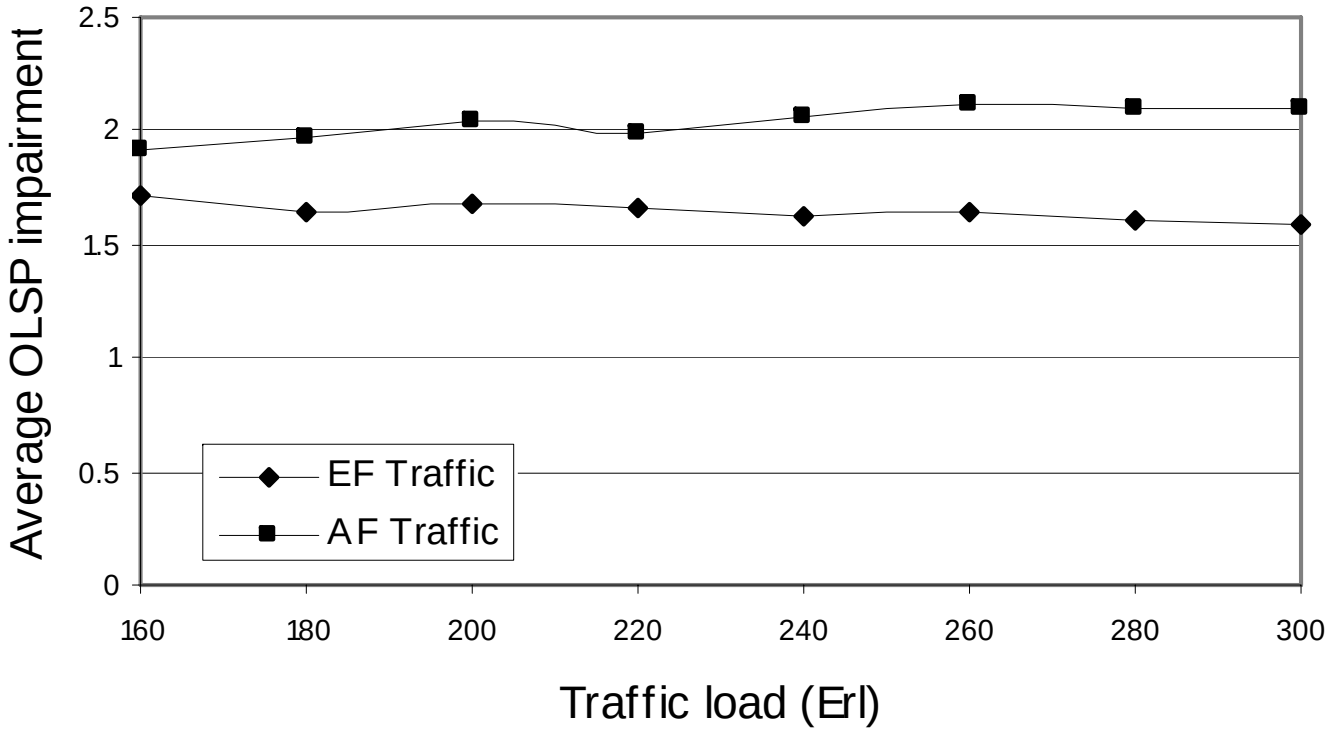
Benefits of integrated IP/DWDM



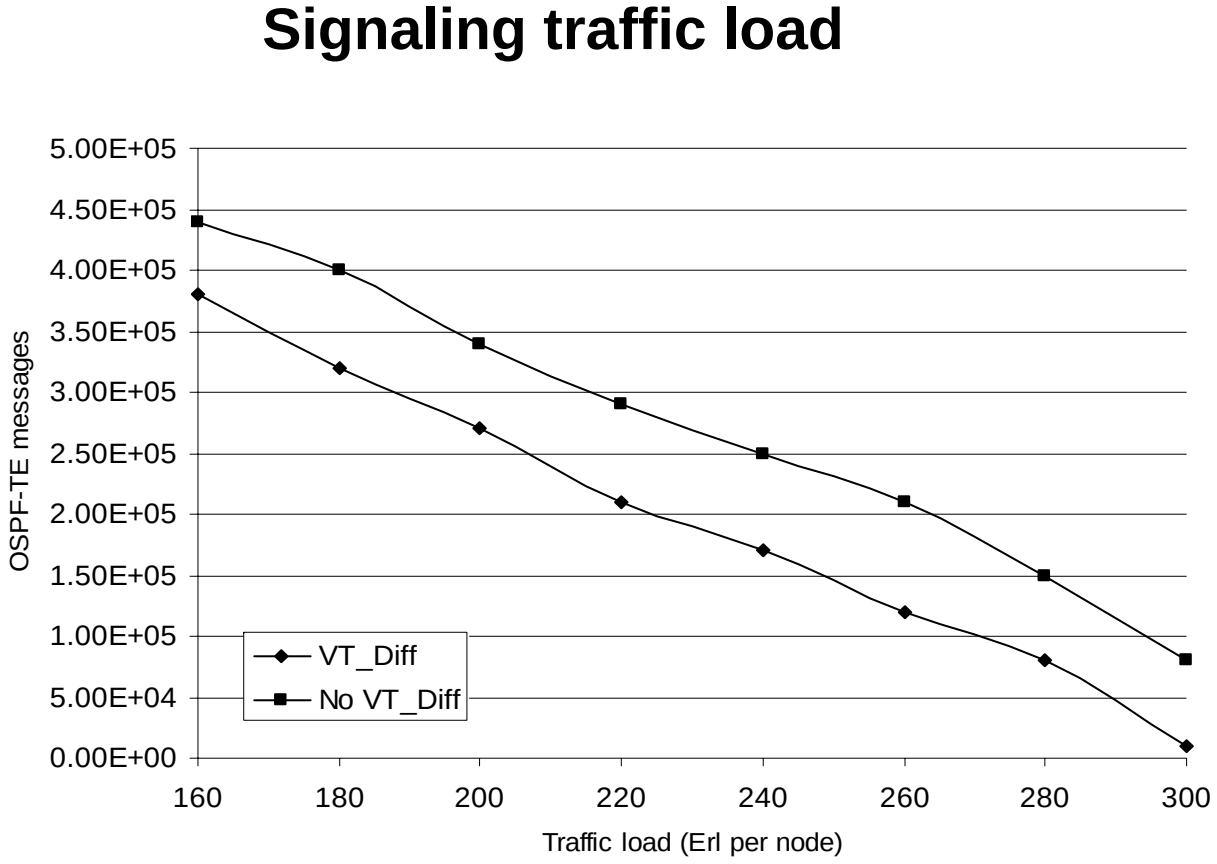
Multilayer DiffServ



Multilayer DiffServ (2)



Signaling traffic



Conclusions

- GMPLS IP/DWDM networks solution for new generation networks
  - Low CAPEX and OPEX
  - Better blocking probability and resource usage
- DiffServ in GMPLS needed to support QoS
  - Higher RoI
- Scheme for QoS IP/WDM GMPLS networks
  - LSPs differentiation in MPLS domain
  - OLSPs differentiation
- Improvements
  - Qos traffic for high priority
  - Performance when integrated domains

Thank you for your attention!

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