Traffic Engineering & Network Planning Tool for MPLS Networks

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Outline

- MPLS in core networks
- Rationale for MPLS traffic engineering
- VS routing scheme for MPLS path selection
- Technical merits of Virtual Space routing
- Vegayan MPLS-TE & NP solution
- MPLS TE Tool implementation
- Sample MPLS network case
- Conclusions

Traditional Technologies in Core Networks

- ATM or Frame Relay network: Optimized for voice transport
  - Advantages: connection oriented, reliable, supports QoS
  - Disadvantages: limited scalability and flexibility, high overhead
- IP network: Optimized for data (packet) transport
  - Advantages: excellent scalability and flexibility, efficient, common application platform, supports several data services
  - Disadvantages: connectionless, best-effort, no performance guarantees
- Networks supported over TDM or SONET/SDH platform
- SONET/SDH network: Statically provisioned, reliable (SLA support)

MPLS Technology for Core Networks

- Very costly to keep separate voice, video, and data networks
- Bridging the gap between IP (data) and ATM (voice) networks
  - → MPLS network to support voice, video, and data services
- Individual label-switched paths with QoS guarantees for aggregate flows
  - – Explicit routed LSPs with specific resource reservation
- Evolutionary path for IP and ATM infrastructure → Reduced CAPEX
- Single operation and management plane → Reduced OPEX
- Additional services over existing networks → Increased ROI
  - – Enable layer 2 and layer 3 virtual private networks (VPNs)

Emerging Broadband Applications

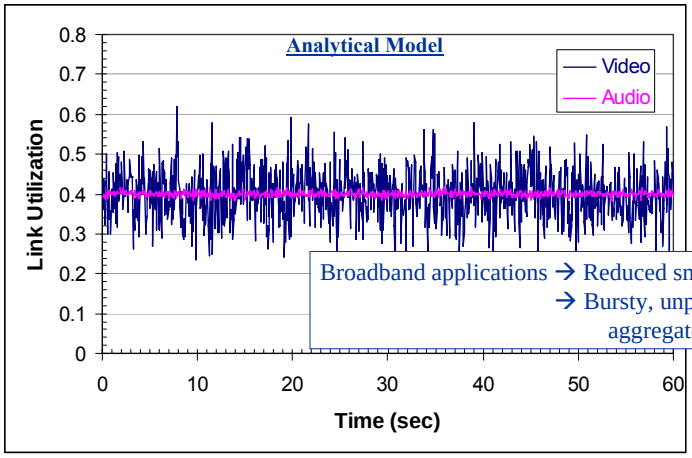
- Web-hosting and Data-warehousing services
- Internet gaming and streaming video services
- Video-on-demand and Bandwidth-on-demand services
- Distance education and Tele-medicine services
- Video conferencing services for global enterprises
- Banking, ERP, and CRM applications of global enterprises
- Bundled VoIP, Video telephony, and Wireless access services
- Bundled services for digital home network access, including

  broadband Internet, voice & video telephony, digital TV or HDTV

→ Different requirements for real-time performance, reliability, security, etc.

Broadband Applications

Statistical Multiplexing ~ 6250 **audio** (G.729) channels with ~ 9.6 kbps rate
on OC-3 (155Mbps) Link ~ 33 MPEG **video** channels with ~ 1.82 Mbps rate



Rationale for MPLS Traffic Engineering

- Broadband applications → bursty, unpredictable aggregate traffic
  → high peak-to-average ratios in link loading
- Common approach – Static over-provisioning with load-balancing
  e.g. 2 links carrying <40% average traffic
  – Not an acceptable QoS solution under a link failure
- Achieve high network utilization with overlapping path protection
- Support QoS from the user perspective using application based aggregation (FEC) and traffic engineering
- Intelligent path selection based on specific QoS requirements, network resources, and performance parameters

Multi-parameter Optimization

Traffic engineering objectives require multi-parameter optimization based on:

- Network performance parameters:
  - Total network throughput (total connections x data rates)
  - Number of hops in each path (leads to network loading)
  - Link loading distribution (congestion and under-utilization of links)
  - Blocking probability for arbitrary connection-requests
  - Stability and scalability of implementation
- Flow or connection based QoS parameters:
  - Available bandwidth
  - Total path delay
  - Packet drop rate
  - Path protection
  - Priority level (or CoS)
  - Delay jitter
  - Path attributes
  - Reliability

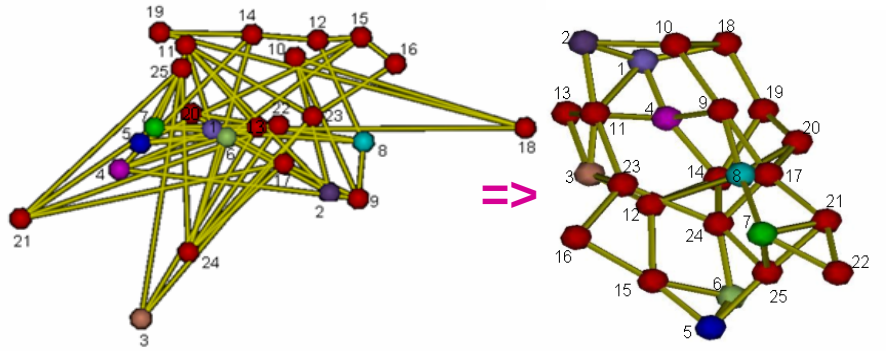
New Approach: VS Routing

- Minimize routing information – concise representation
  – elimination of redundant info.
  → better scalability, fast adaptability, and simple implementation
- Transform network topology information (VS embedding)
  into multi-dimensional network map (VS configuration)
  capable of geometric routing (directivity property)
- Dynamic information (link loading, failure, etc.) expressed by link costs
- Combine directivity and dynamic link info. for path selection (VS routing)
- Use VS routing for multiple path selection & multi-parameter optimization

Virtual Space Configuration

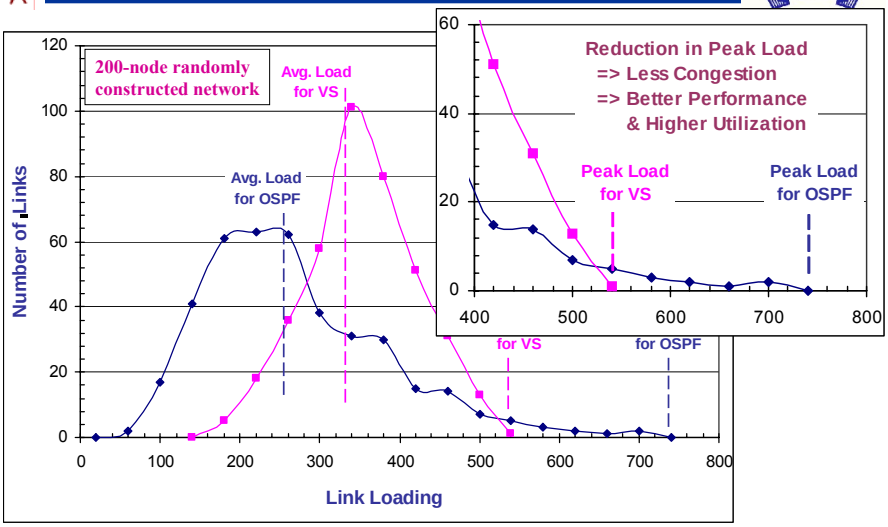
Embedding Network Topology Information into VS Configuration

Topology Information: Connectivity Matrix → Large Routing Tables => **VS: 18 → 5 => 18–19–14–24–6–5 or 18–10–9–8–7–25–5**



25-node, Random Network Topology **3-D Virtual Space Configuration**

Link Loading Distributions



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Technical Merits

	Traditional scheme	VS scheme
• Routing information scaling:	$N^2 - N^3$	log(N)
• Information database:	Thousands of strings	< 100 numbers
• Peak link loading:	–	~ 25% less
• Link state update time:	Slow	Fast
• Multiple QoS parameter support:	Partial	Full
• Resource requirements:	High	Low
• Failure recovery & convergence:	Slow	Fast

=> VS routing scheme is highly scalable, dynamic, robust, and simple.

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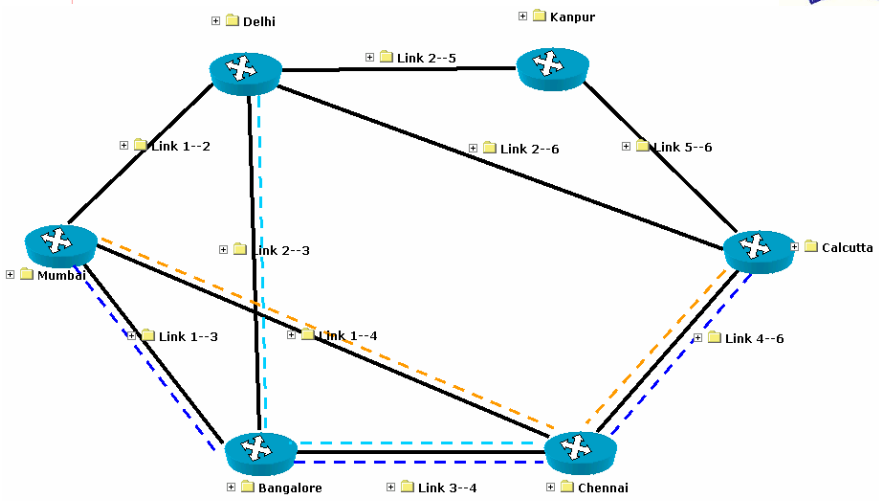
Vegayan Solution
MPLS-TE & NP Tool

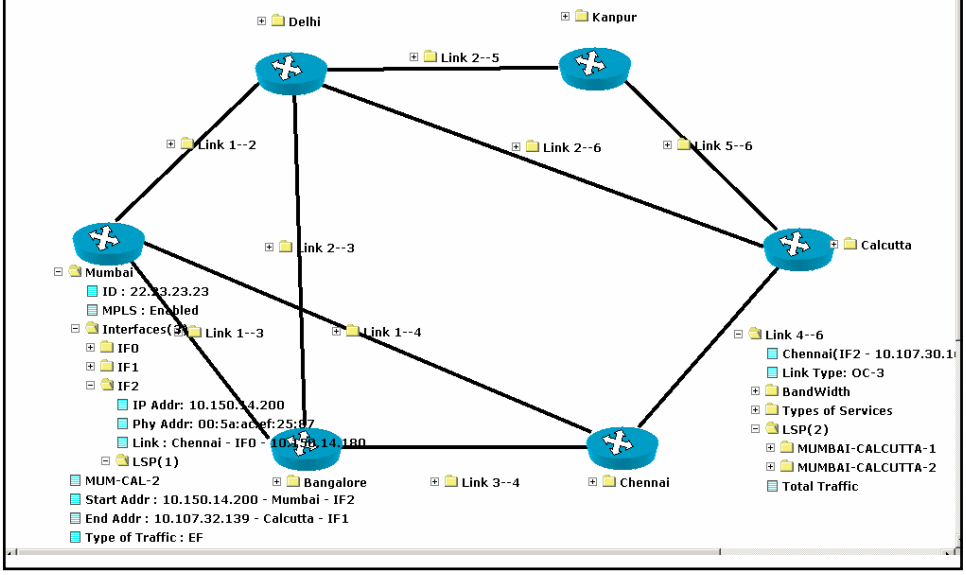
Vegayan provides a centralized (NOC based), off-line tool for MPLS Traffic Engineering and Network Planning that enables optimization of network resources and individual paths to ensure:

- **Quality –** QoS support for converged services over core network
- **Performance –** Congestion avoidance, bandwidth & delay needs
- **Scalability –** Managing hundreds of tunnels in large networks
- **Prioritization –** Differential services for users or applications
- **Functionality –** Efficient multicast, LSP aggregation, VPN support
- **Reliability –** Failure recovery and fast protection (FRR)
- **Manageability –** Ease in network management and planning

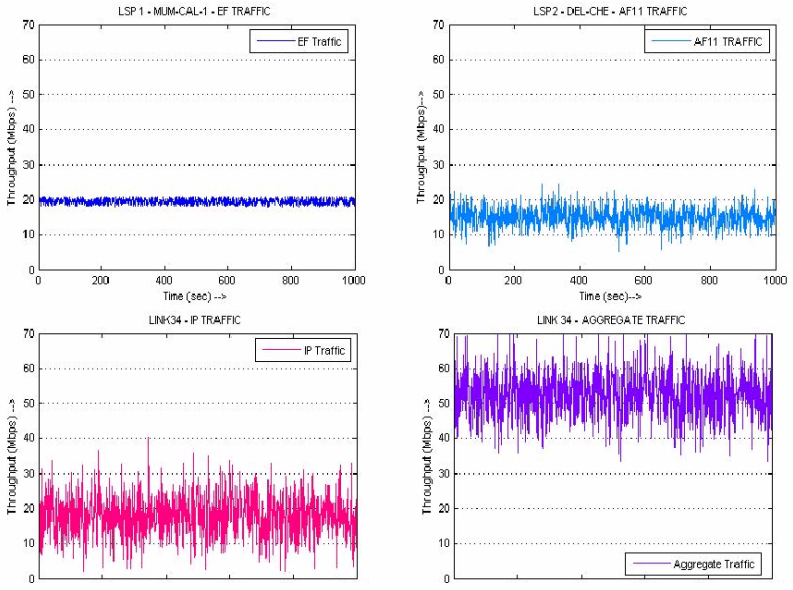
Vegayan MPLS Traffic Engineering & Network Planning Tool



Vegayan MPLS Traffic Engineering & Network Planning Tool



Vegayan MPLS-TE & NP Tool



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Conclusions

- MPLS technology enables “Triple-play” in the core networks.
- Performance of MPLS network can be optimized using an overlay tool for traffic engineering and network planning.
- Vegayan is developing an MPLS-TE & NP tool that is simple, efficient, and scalable, based on new VS routing scheme.
- Tool supports optimization of network resources, QoS parameters, protection and analysis of critical scenarios & future plans.

Ref.: [1] High Performance Switching & Routing (HPSR) 2003, Torino, Italy

[2] International Conf. on Communications (ICC) 2004, Paris, France

[3] MPLS World Congress (MPLS) 2005, Paris, France

[4] “Highly scalable, dynamic, and robust routing scheme based on Virtual Space representation”, *submitted (available upon request)*, 2006