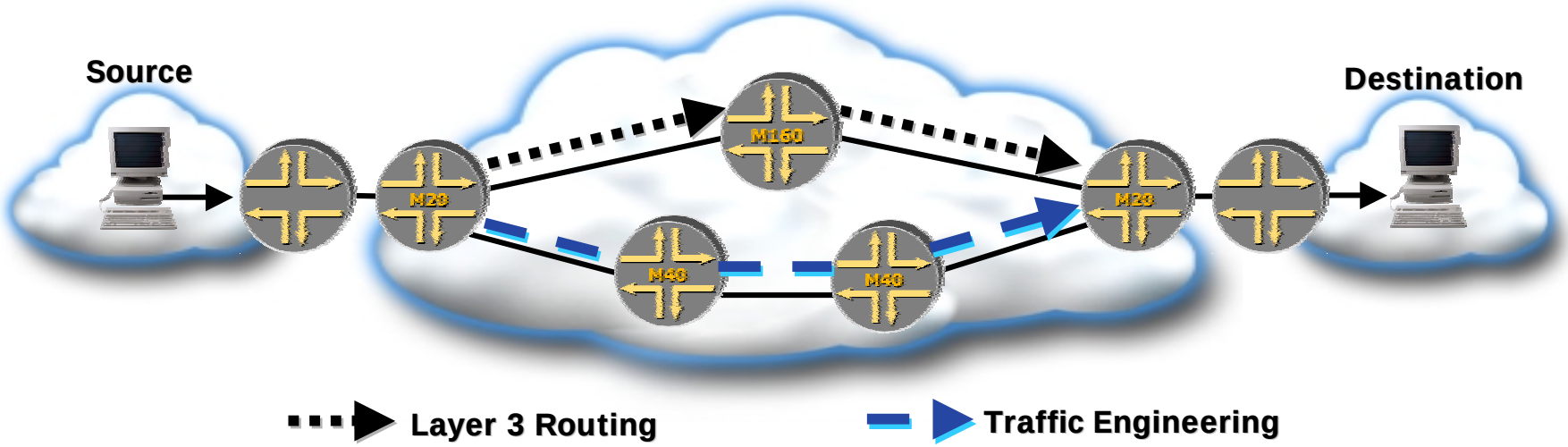
The MPLS Advantage

Part II:
Traffic Engineering

Agenda: MPLS Traffic Engineering

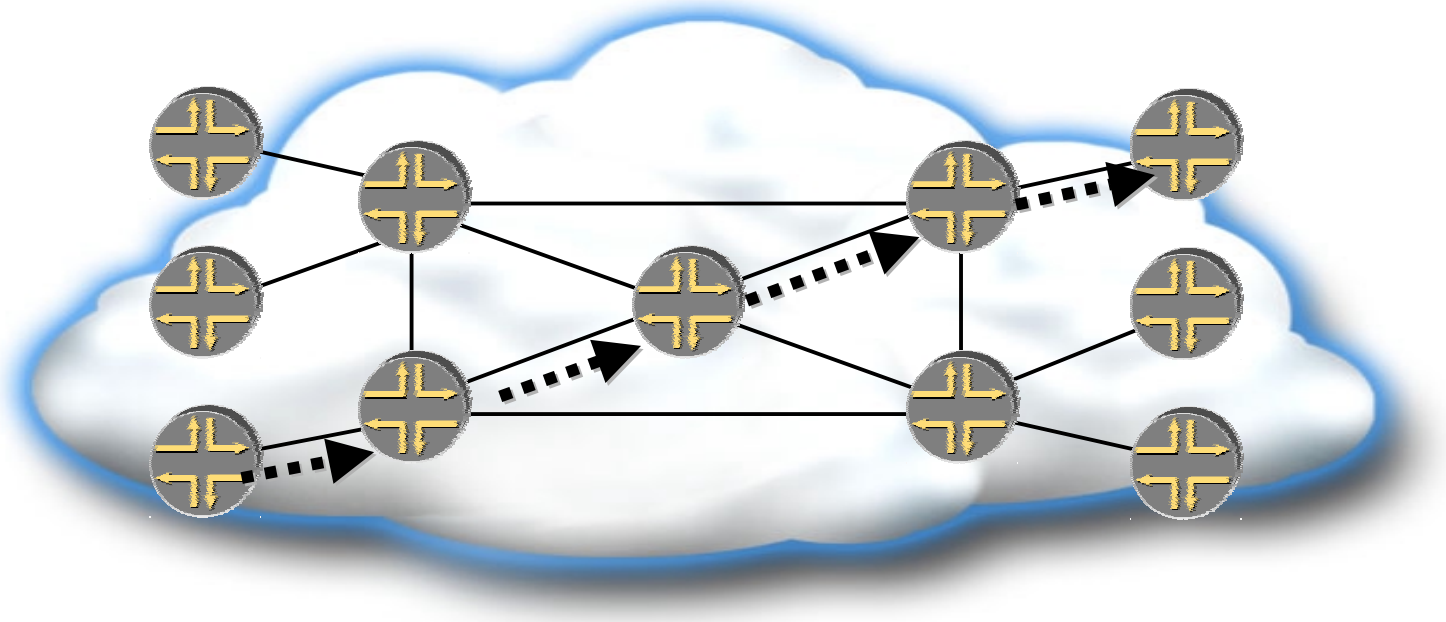
- What is traffic engineering?
- Two approaches to MPLS traffic engineering
- Limited deployment case studies
- Large scale deployment design considerations

What Is Traffic Engineering?



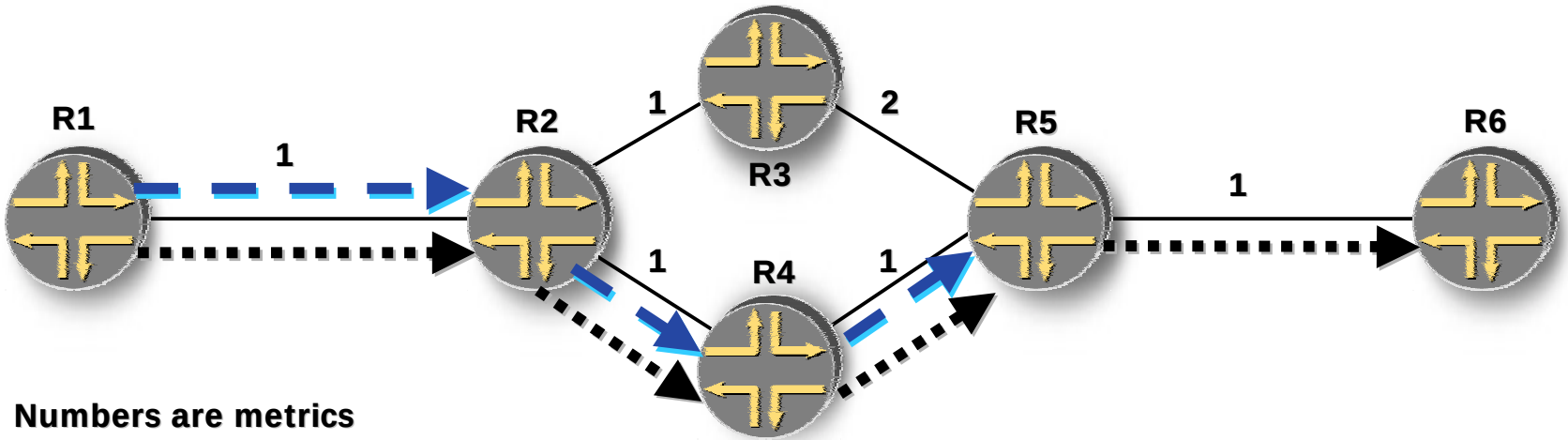
- Ability to control traffic flows in the network
  - Optimize available resources
  - Move traffic from IGP path to less congested path
  - Make efficient use of network resources

Traffic Engineering Mid 1990s



- Infrastructure
  - Routed core
    - Independent L3 decision at each hop
  - DS-1 and DS-3 trunks

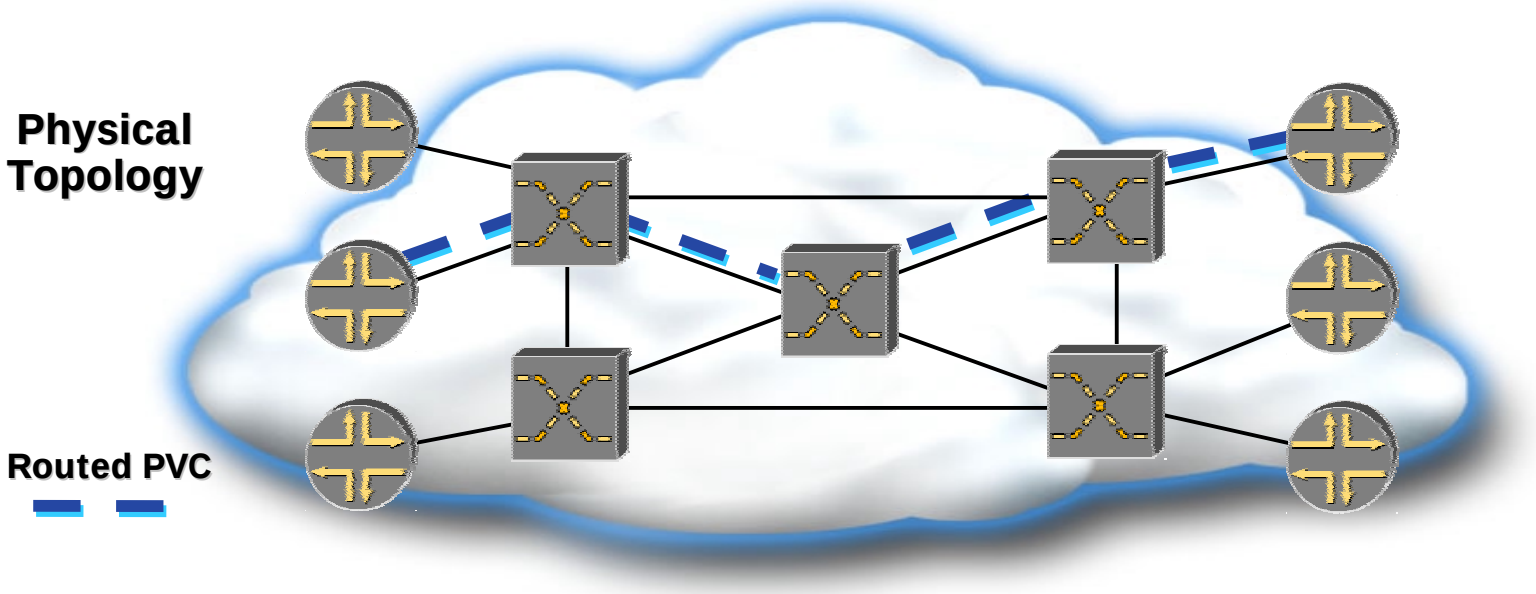
Traffic Engineering Mid 1990s



Numbers are metrics

- TE Mechanisms
  - Over provisioning
  - Metric manipulation
- Limitations
  - S/W router became a bottleneck
  - Trial-and-error approach
  - Not scalable

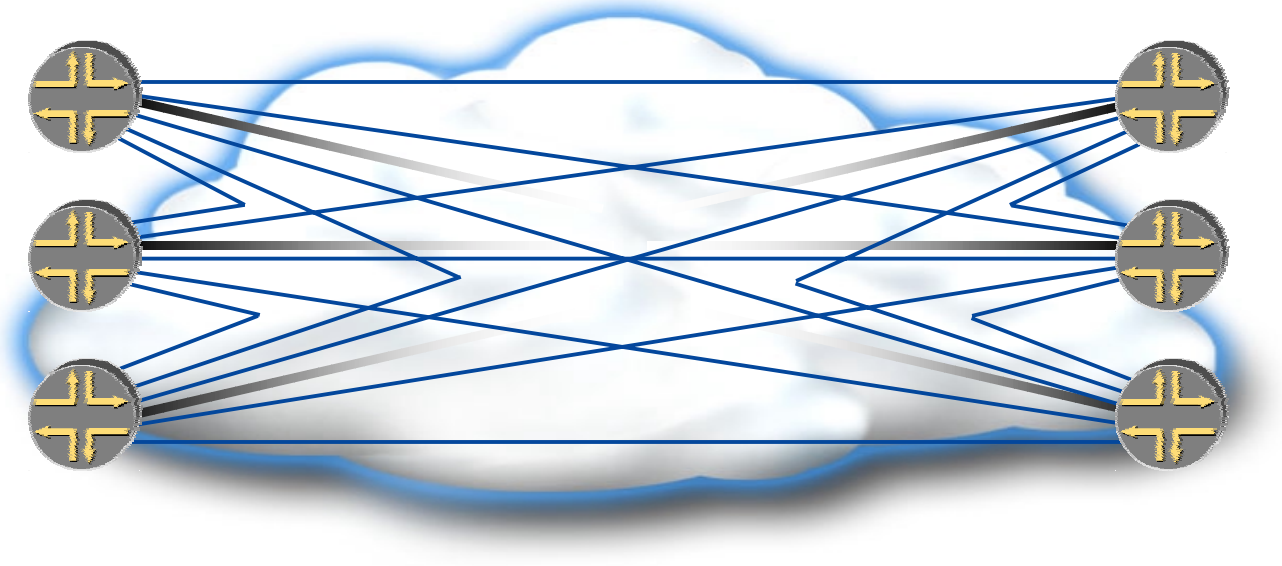
Traffic Engineering Mid to Late 1990s



- Infrastructure
  - Routed edge / ATM core
    - L3 decision at edge router
    - L2 decision at each core switch
  - Dense PVC meshes
  - OC-3, OC-12, and OC-48 trunks

Traffic Engineering Mid to Late 1990s

Logical Topology



- **TE Mechanisms**
  - PVC routing
  - Overlay network
- **Limitations**
  - Two networks to manage - IP and ATM
  - Cell tax
  - OC-48+ SAR interfaces
  - “N-squared” PVCs
  - IGP stress

Traffic Engineering in the 21st Century

Question: **Is there a better solution for the 21st century?**

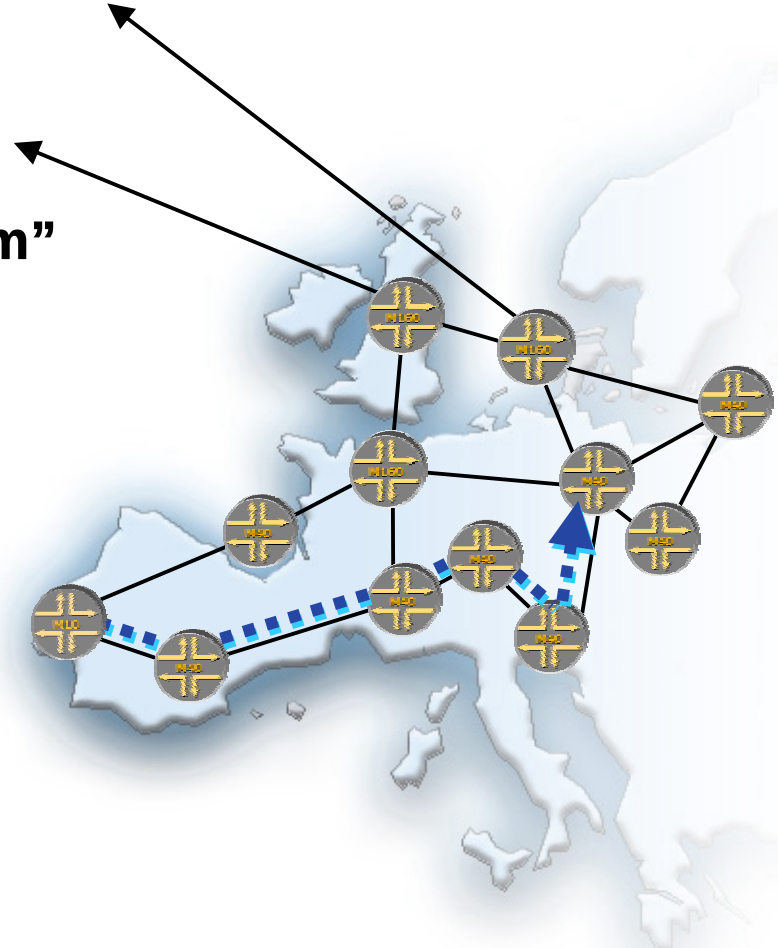
Answer: **Yes … Multiprotocol Label Switching (MPLS)**

- **The MPLS Advantage**
  - **Public and private service integration**
  - **A fully integrated IP solution**
  - **Traffic engineering**
  - **Lower cost**
  - **A CoS enabler**
  - **Failover/link protection**
  - **Multiservice and VPN support**

Two Approaches to MPLS Traffic Engineering

Limited MPLS Deployment

- MPLS is used for a few “problem” paths only
- Immediate solution to a complex problem
- Augments existing IP network architecture
- Minimal effort
- Minimal financial risk
- Provides experience with an emerging technology

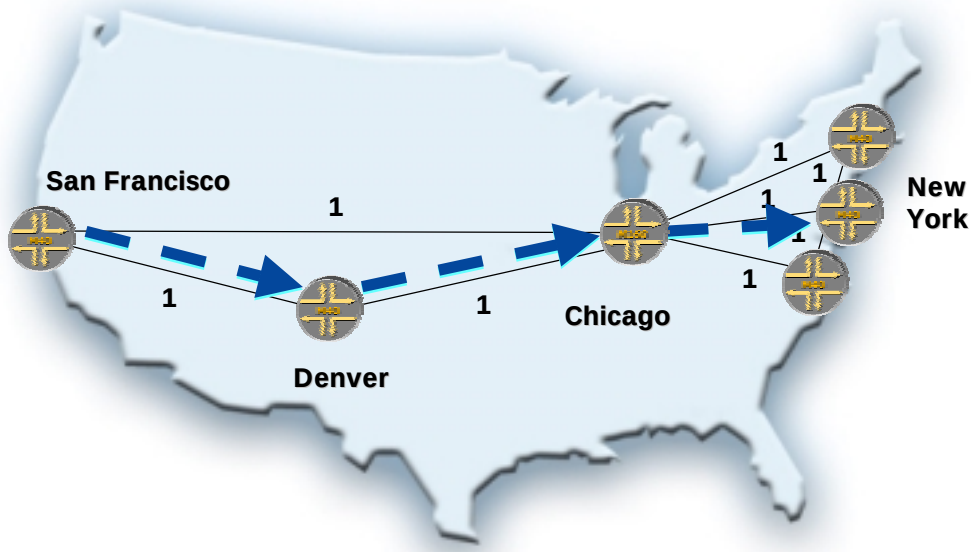


Case Study 1

Deferring a Link Upgrade

SF Routing Table

Destination	Next hop
New York	Blue LSP
Chicago	Chicago
Boston	Chicago
Wash, DC	Chicago

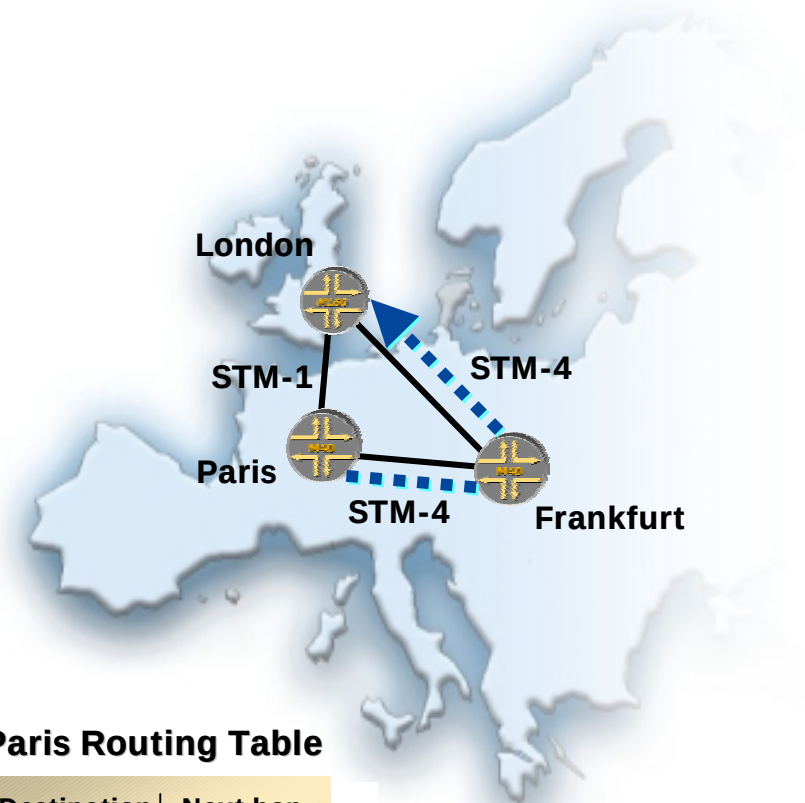


- **LSP from SF-to-NY via Denver & Chicago**
  - **Fine-grained control of SF-NY traffic**
  - **Network remains stable**
  - **Packet order maintained**

Case Study 2

Utilize Excess Bandwidth

- **Challenges**
  - **Paris to London link is approaching capacity**
  - **Under-utilized capacity from Frankfurt to London**
  - **Desire to deliver a "premium" Paris to London service**
- **Solution**
  - **Premium traffic takes LSP from Paris to London via Frankfurt**



Paris Routing Table

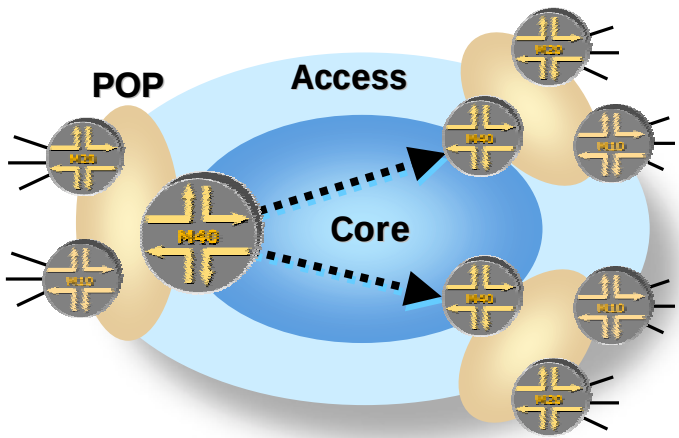
Destination	Next hop
London (premium)	Blue LSP
London (standard)	Direct

Large Scale MPLS Deployment

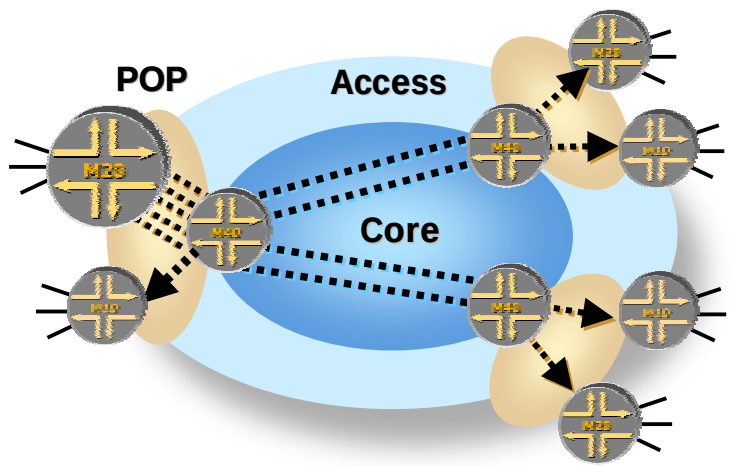
- Maintain and enhance traditional traffic engineering benefits of ATM
- Reduce operational expenses
- Reduce management expenses
- Increase bandwidth scalability
- Eliminate IGP stress

Design Considerations: Core Model Vs. Edge-to-edge Model

Core Model



Edge-to-Edge Model



	Core Model	Edge-to-edge Model
LSP ingress and egress	Core router	Edge (access) router
Number of LSPs	Order (# cities)^2	Order (# access routers)^2
Granularity of control	Coarse	Fine

Summary: MPLS Traffic Engineering

- What is traffic engineering?
  - A brief history of approaches to traffic engineering
- Two approaches to MPLS traffic engineering
- Limited deployment case studies
  - Deferring a link upgrade
  - Utilize excess bandwidth
- Large scale deployment design considerations
  - Core model vs. Edge-to-edge model