Business Applications For Internet QoS

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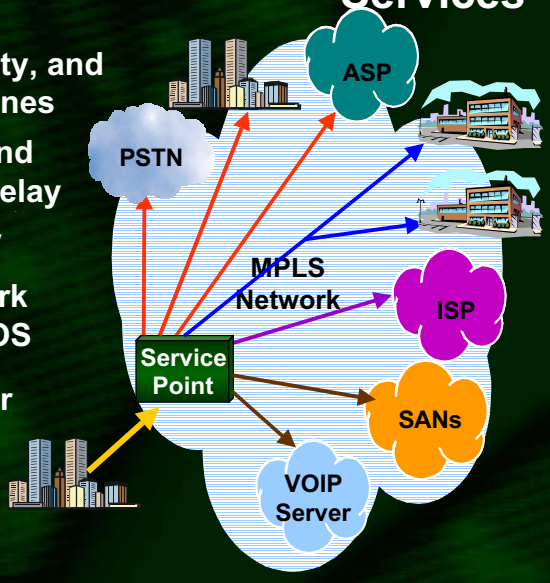
Business Customers Require Reliable Services

- Security, predictability, and reliability of leased lines
- Cost effectiveness and flexibility of Frame Relay
- Internet Connectivity
- Applications that work due to end to end QOS
- 99.999% reliability for mission critical applications



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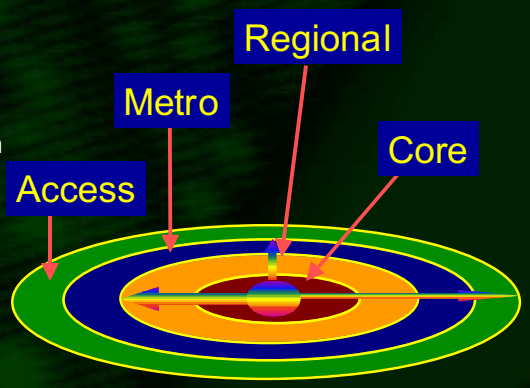
Service Providers Reply with Optical Networks

- Provisioned bandwidth with extremely low bit error rates
- Provides the foundation to deliver reliable customer services
- But – customers have IP, not optical, access and applications – IP QoS support is also required



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Multiple Attempts at IP QoS

- The Internet Engineering Task Force (IETF) has added QoS capabilities to IP in fits and starts
  - Resource reSerVation Protocol (RSVP): First attempt, provides QoS to individual flows or applications, but not scalable for wide deployment
  - Differentiated Services (Diff-Serv): Next attempt, scalable for wide area use, but only provides coarse QoS granularity
  - Multi-Protocol Label Switching (MPLS): Puts it all together – scalable use of RSVP-TE for IP traffic engineering and bandwidth reservation, combined with Diff-Serv for multiple services within traffic engineered tunnels

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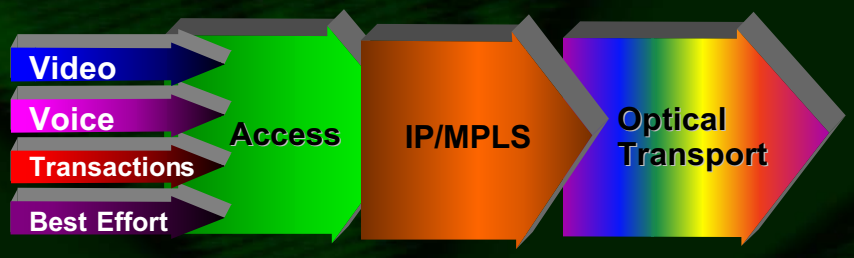
IP/MPLS-Based Approach

- IP is the ubiquitous network layer protocol
- MPLS used as the unifying data link layer for traffic engineering and QoS



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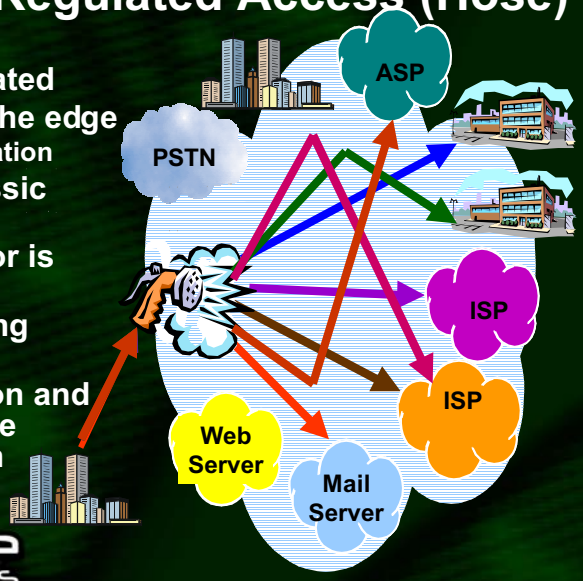
IP/MPLS QoS Service Models
Regulated Access (Hose)

- Network access is metered and regulated
- Traffic policed on the edge
  - Per class or application
- Well suited for classic Internet traffic
- End to end behavior is not guaranteed
- Simpler provisioning
- Traffic engineering prevents congestion and optimizes backbone resource utilization



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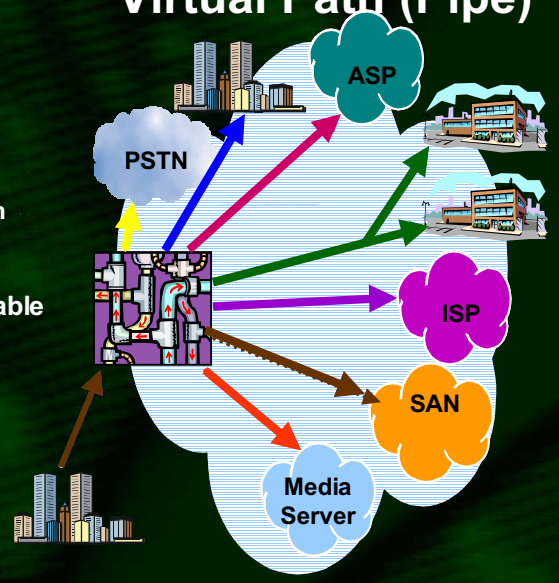
IP/MPLS QoS Service Models Virtual Path (Pipe)

- Pipes have various characteristics
  - Priorities
  - Reserved bandwidth
  - Minimums & maximums
  - Share excess bandwidth
  - Restoration priorities
- Pipes are allowed into networks based on available resources
- Provide end to end deterministic behavior
- Make full use of MPLS connection-oriented capabilities



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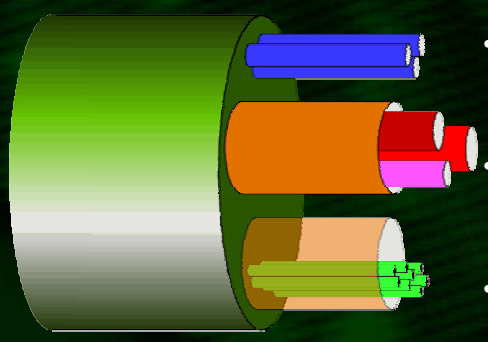
Multiple QoS Models on the Same Network



- Fixed size, high priority (voice, virtual wire)
- Guaranteed minimum with a specified maximum (media, SANs)
- Best effort, expandable to peak capacity (email, web)
- Multiple service classes within a flow

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IP/MPLS Allows Service Provider Convergence

- In addition to QoS-enabled IP services, MPLS also supports
  - Carriage of layer 2 frames and cells
    - ATM (cells and AAL5 frames)
    - Frame Relay
    - Ethernet (with and without VLAN tags)
    - PPP
    - HDLC frames
  - Emulating leased line services over MPLS
  - Allowing service providers to have a single IP/MPLS-based infrastructure for Layer 1, 2, and 3 services

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QoS Issues – Getting Technical

- Key question: Can IP/MPLS provide the required QoS for these applications?
  - Core issues
  - Edge Issues
- Simulation and experience show low delays and jitter in IP/MPLS-based core networks due to:
  - High speed trunks
  - Traffic engineering
  - Diff-serv to provide aggregate, scalable QoS

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QoS Issues at the Edge

- Sophisticated QoS mechanisms are most important at the network edge, due to slower interfaces, potential congestion, and non-aggregated flows
- Some IP/MPLS edge switch vendors are providing same queuing and scheduling mechanisms found in ATM switches:
  - Flow classification
  - Per-flow policing, queuing, shaping, scheduling
  - Priority and weighted fair queuing
  - Admission control

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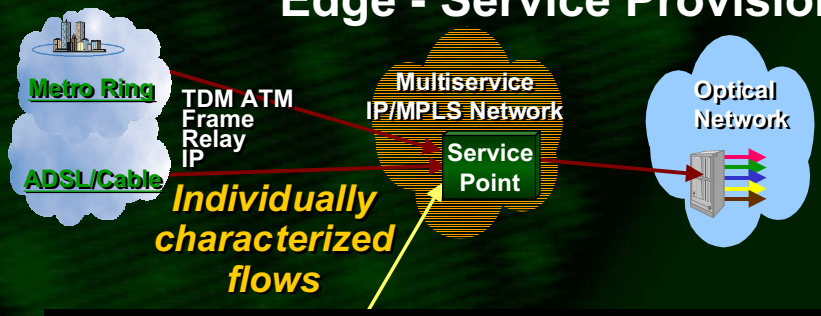
Building the Multiservice Edge - Service Provisioning



- Multiservice
- Packet classification
- Input policing
- Per-flow queuing
- Per-flow scheduling and shaping
- End-to-end traffic engineering tunnel creation

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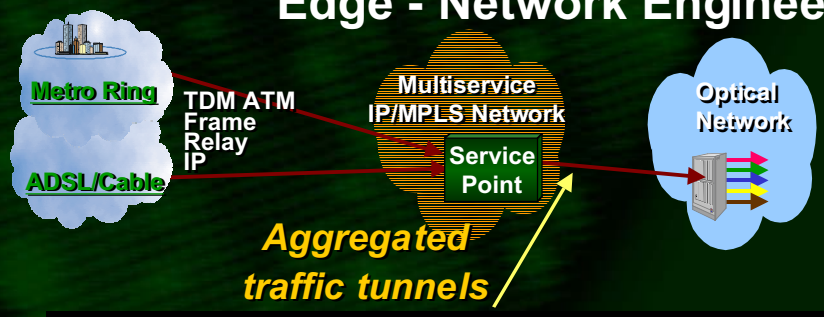
Building the Multiservice Edge - Network Engineering



- Aggregate QoS
- Flow merging
- Bandwidth management
- Congestion management
- Tunnel protection switching and restoration
- Performance statistics

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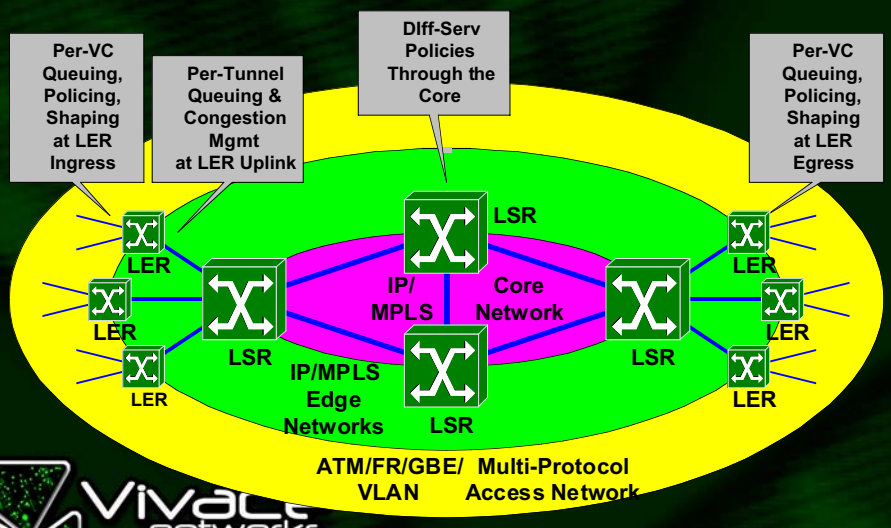
Putting It All Together



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In Conclusion ….

- IP/MPLS provides the ability to combine
  - Per-application and per-flow QoS at the edge
  - Traffic engineering and Diff-Serv in the core
  - Real service level agreements
- These provide business customers with reliable, predictable end-to-end service guarantees for their network applications

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15

Thank you!

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16