Enterprise Campus and Data Center Design Review

- Analyze organizational requirements:
  - Type of applications, traffic volume, and traffic pattern
  - Redundancy and backup needed
- Characterize the existing network and sites:
  - Technology used and location of hosts, servers, terminals, and other end nodes
- Develop enterprise campus and enterprise data center network designs:
  - Based on requirements, implement two or three hierarchical layers.
  - Select hardware and software components to support requirements.

Module Summary

- Campus network design is influenced by application, environmental, and infrastructure device characteristics.
- An enterprise campus network is constructed hierarchically with building access, building distribution, and campus core layers.
- An enterprise data center network is constructed hierarchically, with data center access, data center aggregation, and data center core layers.

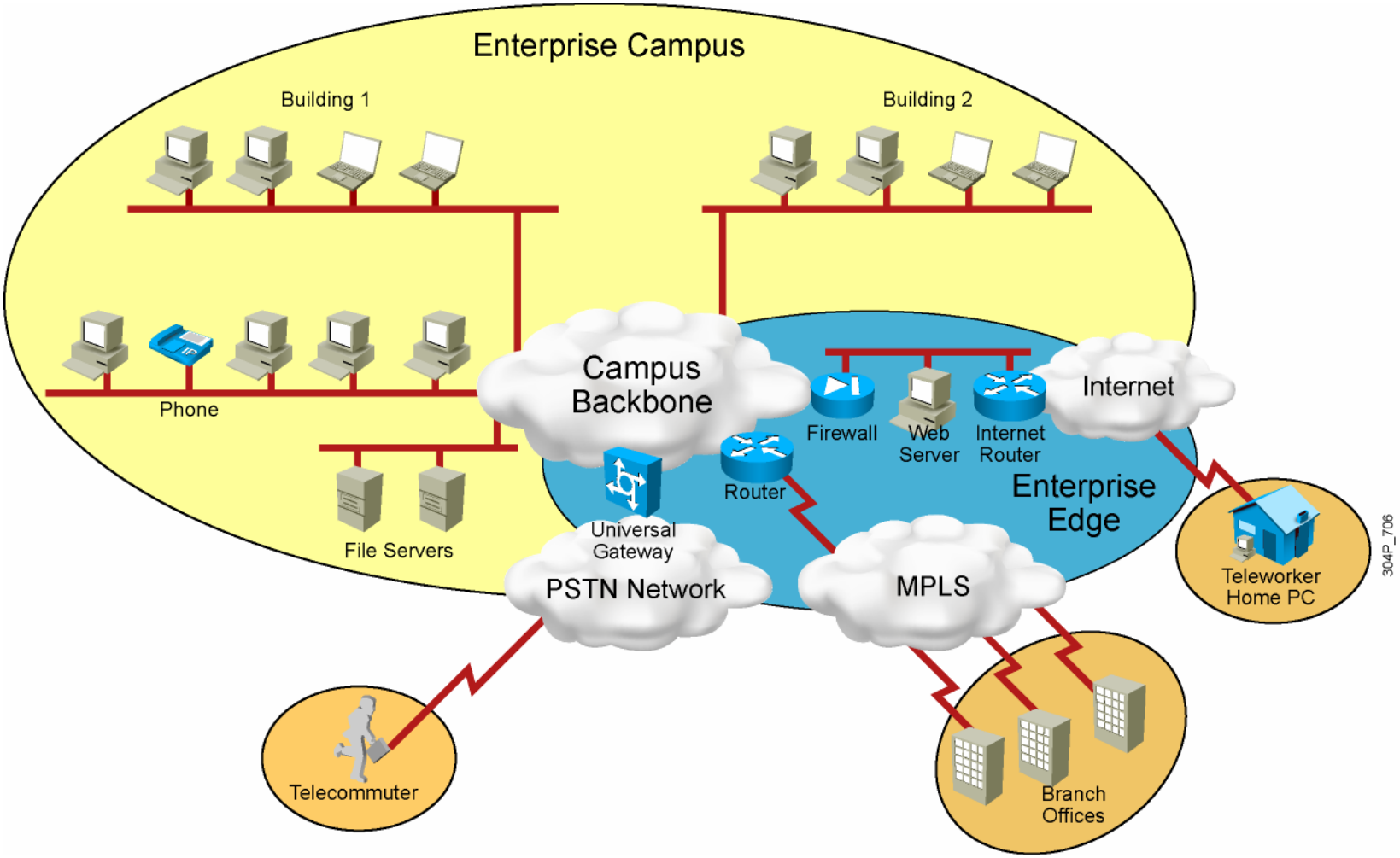
Designing Remote Connectivity

Designing for Cisco Internetwork Solutions (DESGN) v2.0

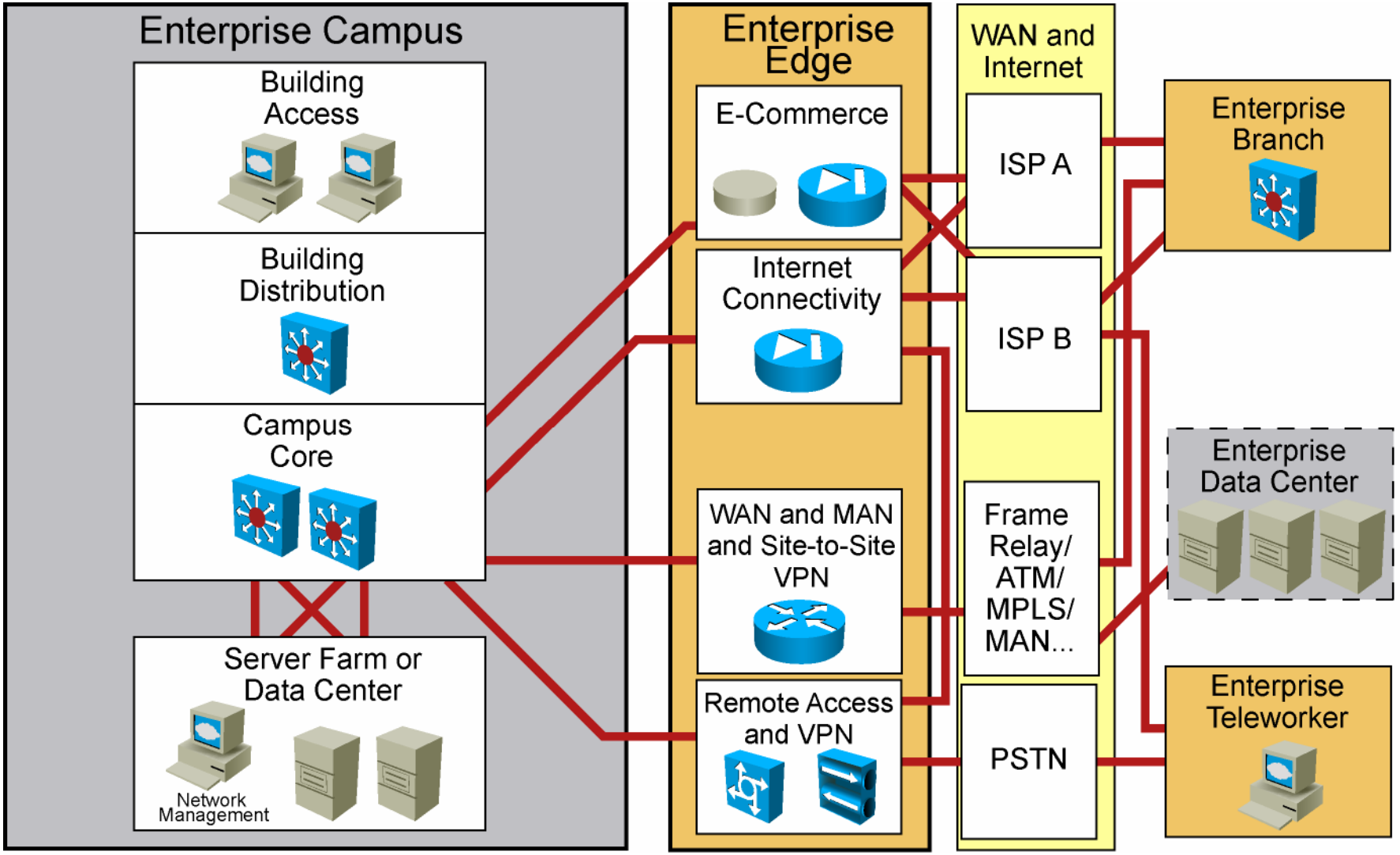
Identifying WAN Technology Considerations

Designing Remote Connectivity

Role of a WAN



Types of WAN Interconnections



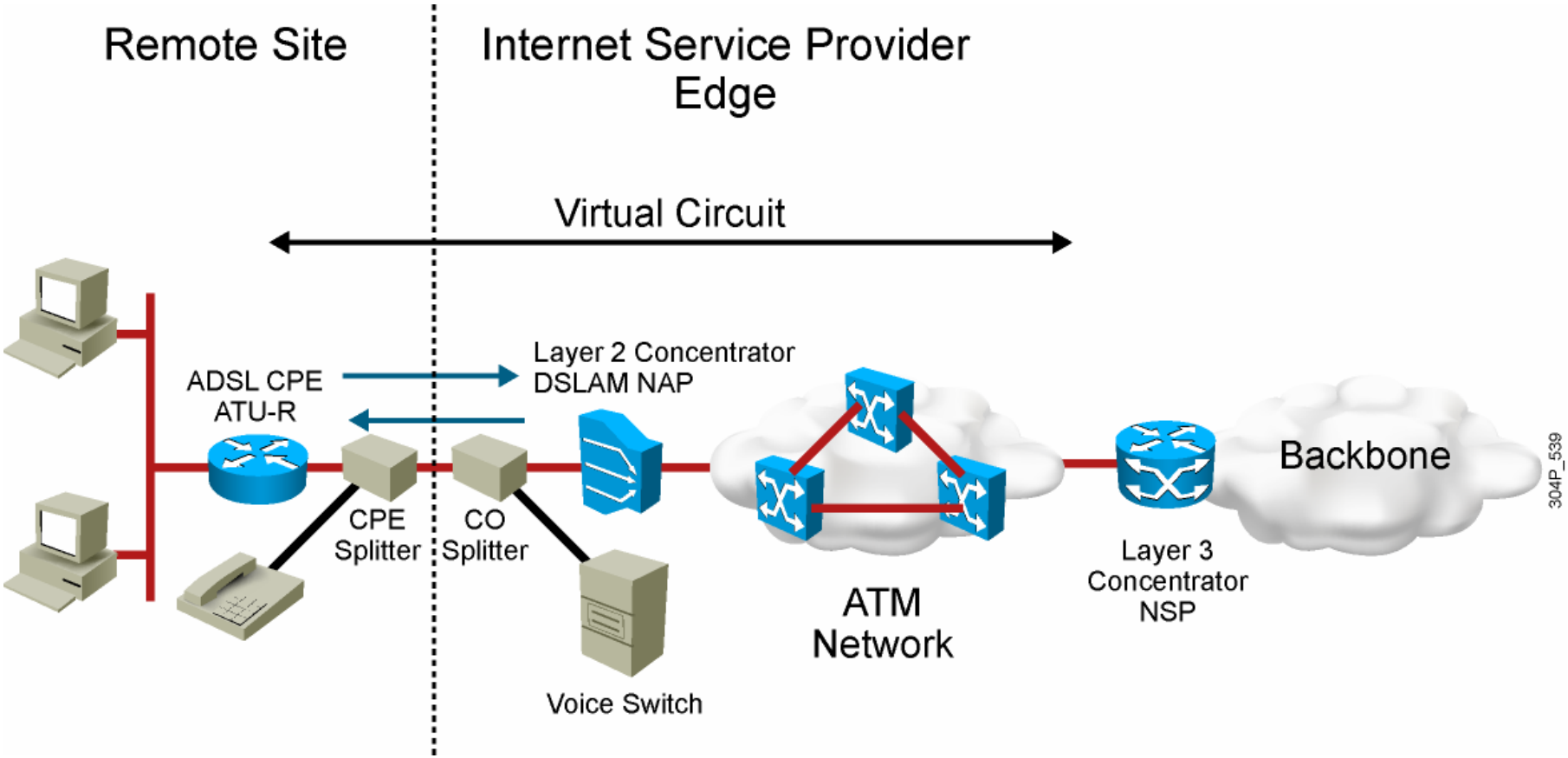
WAN Transport Technology Comparison

	Bandwidth	Latency and Jitter	Connect Time	Tariff	Initial Cost	Reliability
TDM	M	L	L	M	M	M
ISDN	L	M/H	M	M	L	M
Frame Relay	L	L	L	M	M	M
ATM	M/H	L	L	M	M	H
MPLS	M/H	L	L	M	M	H
Metro Ethernet	M/H	L	L	M	M	H
DSL	L/M*	M/H	L	L	L	M
Cable modem	L/M*	M/H	L	L	M	L
Wireless	L/M	M/H	L	L	M	L
SONET/SDH	H	L	L	M	H	H
DWDM	H	L	L	M	H	H
Dark fiber	H	L	L	M	H	H

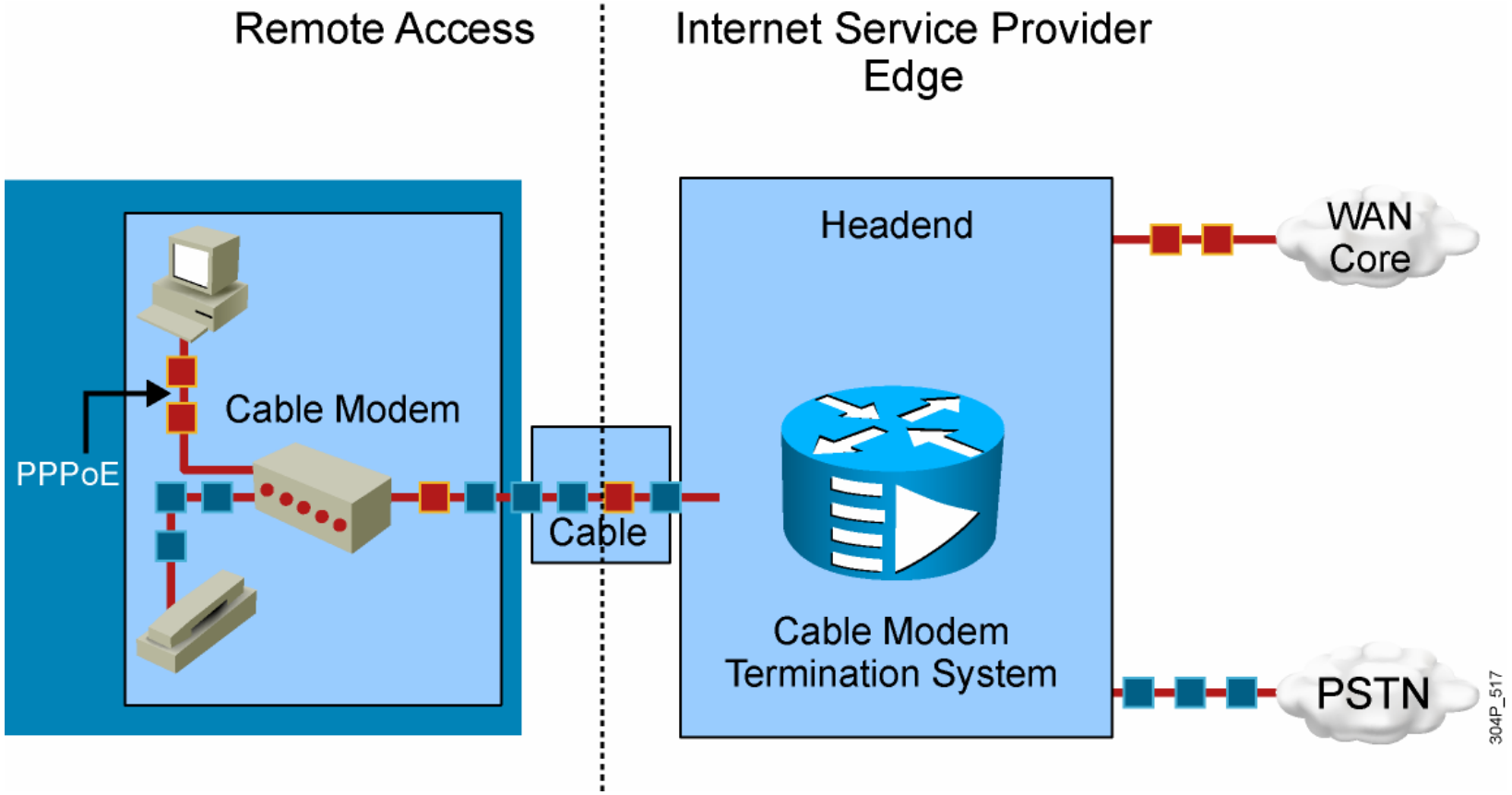
*Unbalanced Tx and Rx

L = low, M = medium, H = high

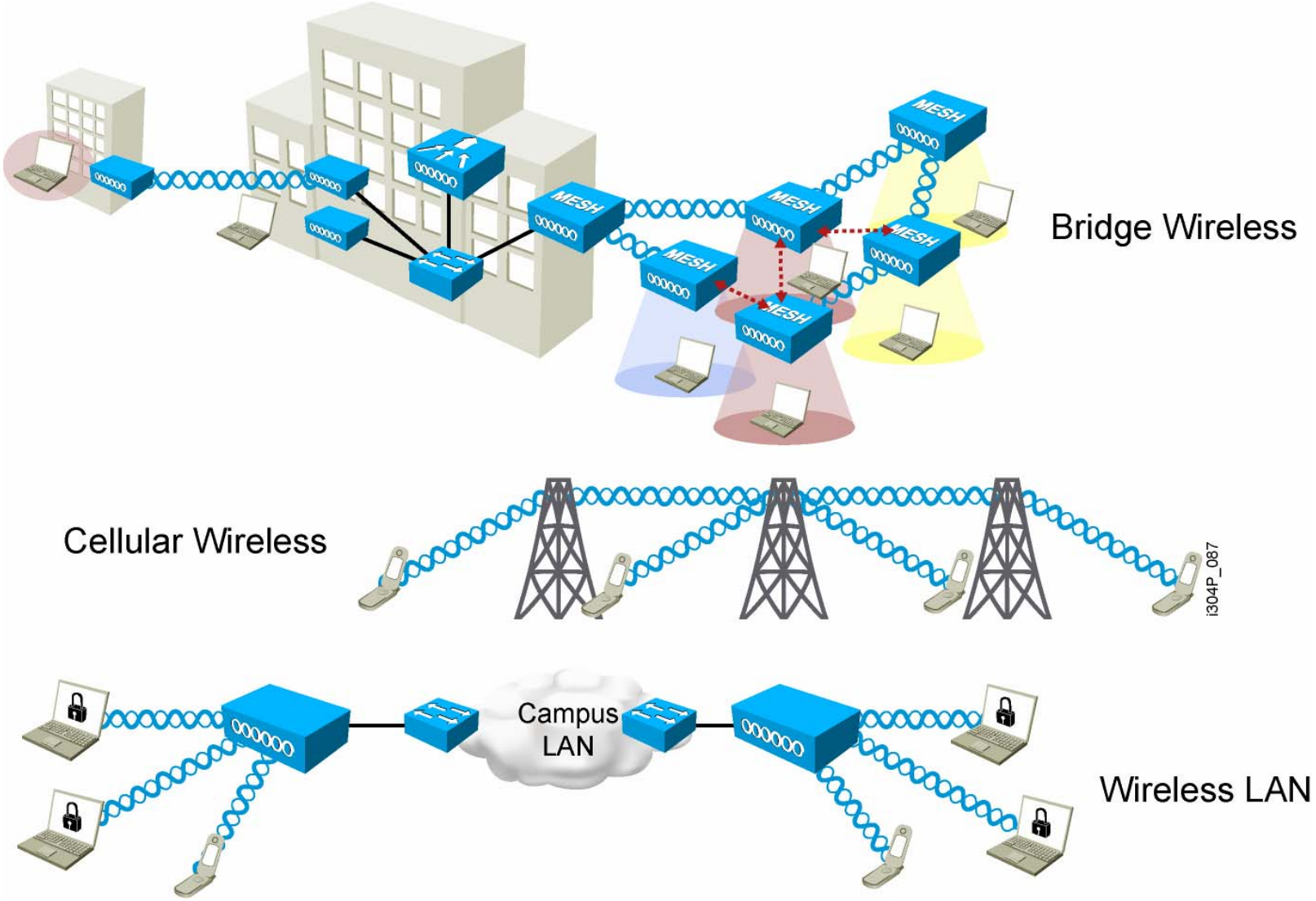
Example: ADSL Implementation



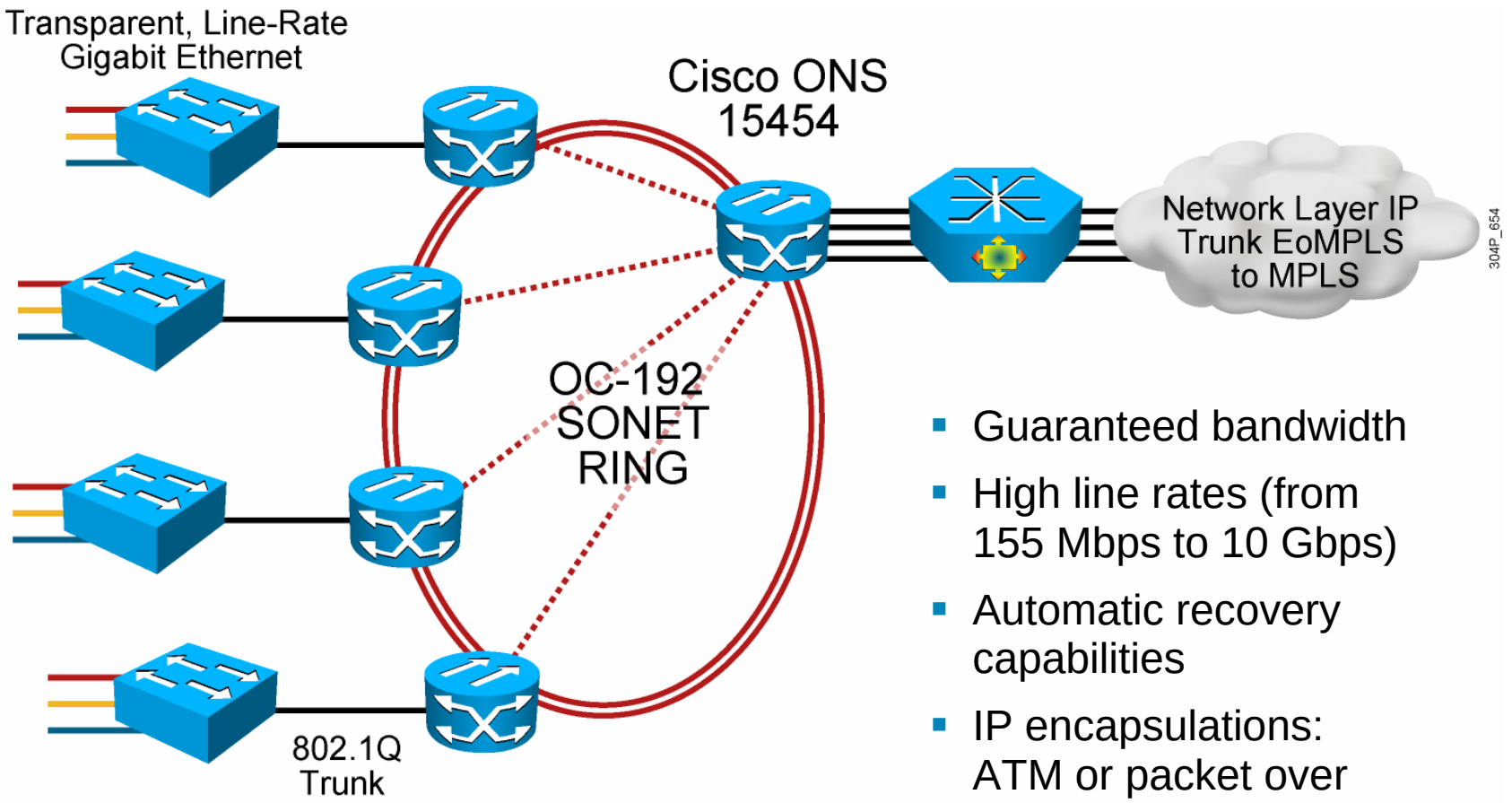
Example: Data and Voice over Cable



Example: Three Uses of Wireless

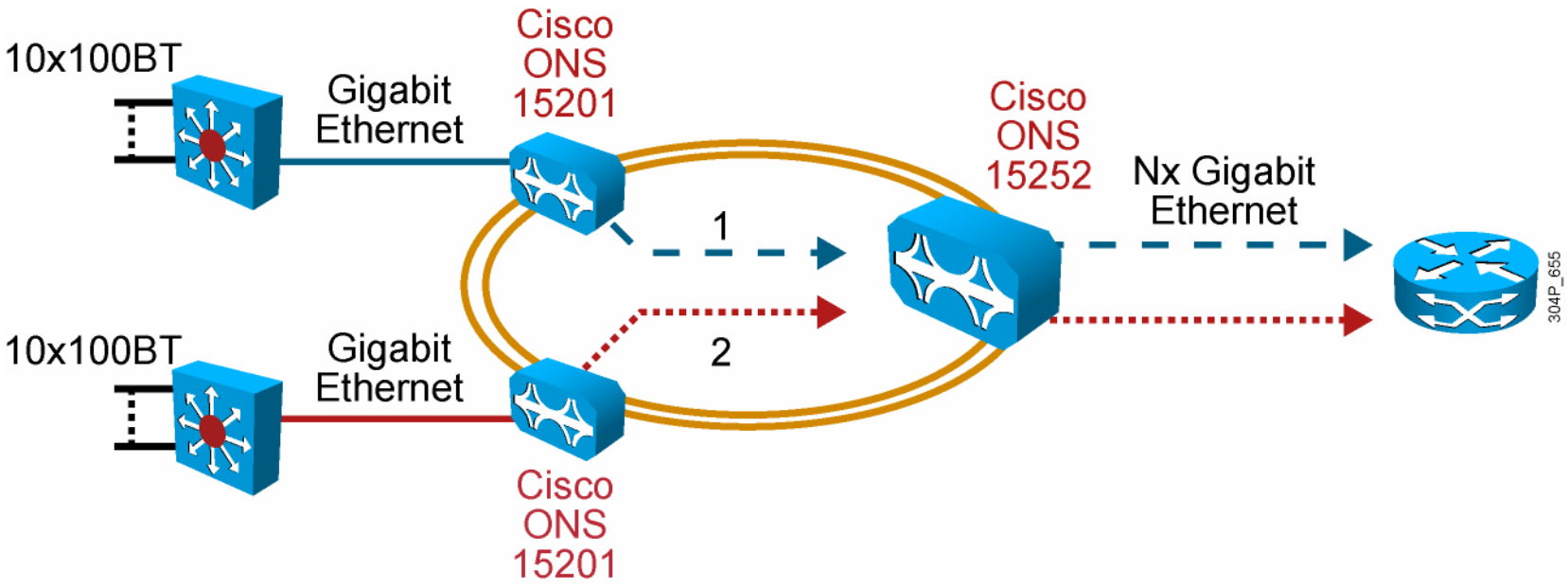


Example: SONET/SDH



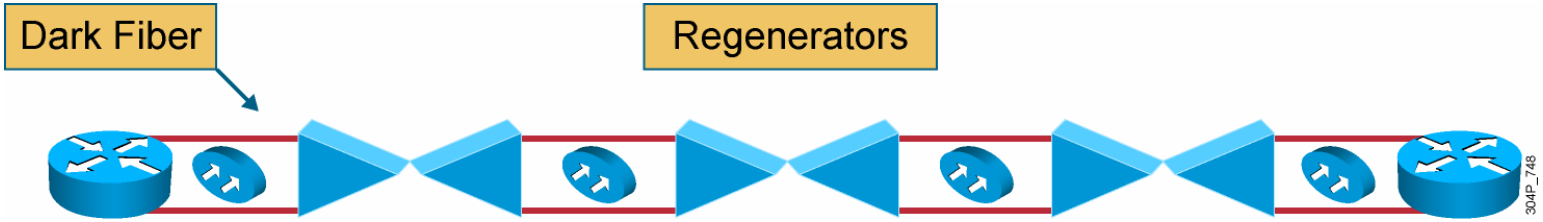
- Guaranteed bandwidth
- High line rates (from 155 Mbps to 10 Gbps)
- Automatic recovery capabilities
- IP encapsulations: ATM or packet over SONET/SDH (POS)

Example: DWDM



- Improved signaling mechanisms to optimize bandwidth usage
- Used inside the SONET/SDH ring

Example: Dark Fiber



- Edge devices directly connected to regenerators or DWDM concentrators
- Edge devices able to use any Layer 2 encapsulation

WAN Transport Technology Pricing Considerations

- Pricing used to include an access circuit and a distance-sensitive rate.
- Access circuit provisioning generally takes 60 days or more lead time.
  - Metro Ethernet availability is spotty, and lead times are long.
- For Frame Relays and ATM, pricing includes an access circuit charge,
  per-PVC and possibly per-bandwidth (CIR or MIR) charges.
- MPLS VPN pricing is generally comparable with Frame Relays and ATM.

WAN Transport Technology Contract Considerations

- Tariffed commercial services are at published rates and subject to restrictions.
- Time to contract can be one month for standard tariff rates, longer if you negotiate SLAs.
- Contract periods are usually one to five years for most WAN services.
- For dark fiber, contract periods are generally 20 years.

Methodology Used in Enterprise Edge Design

Planning and designing the enterprise edge is based on the PPDIOO methodology:

- Analyze network requirements, including type of applications, traffic volume, and traffic patterns.
- Characterize the existing network for technology used and location of hosts, servers, terminals, and other end nodes.
- Design the topology based on availability of technology, the projected traffic pattern, and technology performance constraints and reliability.

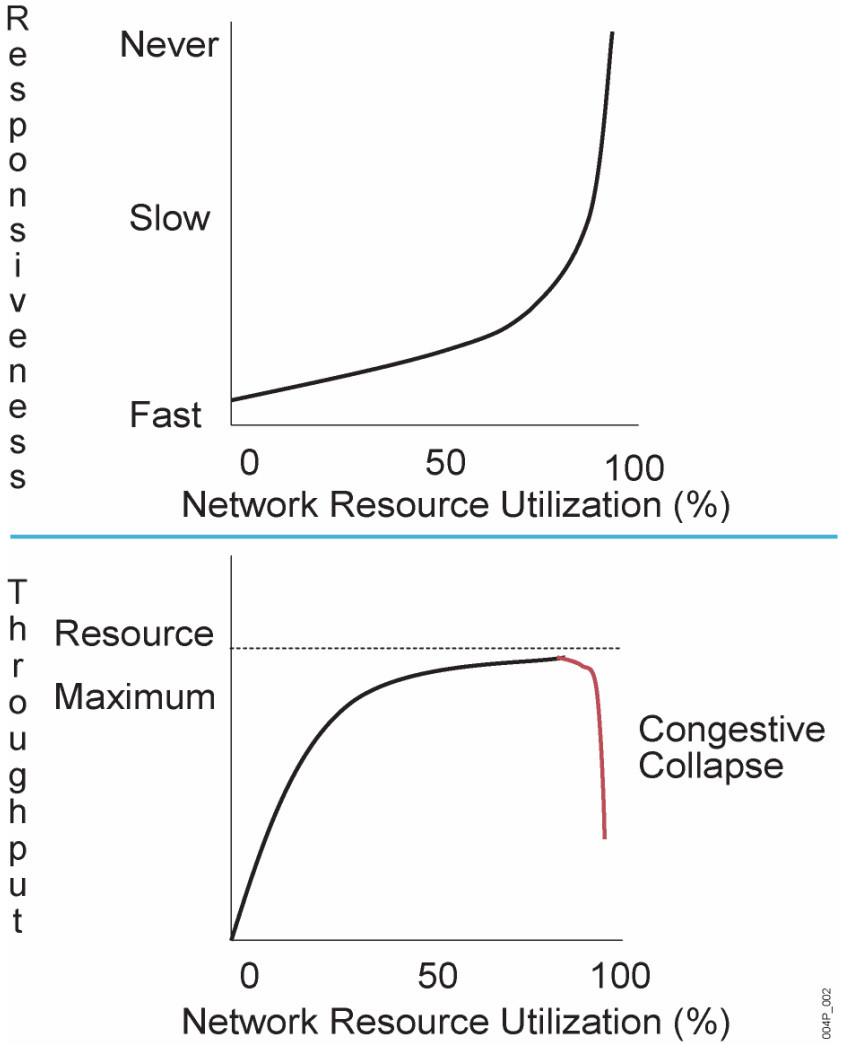
Identifying Application Requirements

	Data File Transfer	Interactive Data Application	Real-Time Voice	Real-Time Video
Response time	Reasonable	Within a second	Round trip less than 250 ms with delay and with low jitter	Minimum delay and jitter
Throughput and packet loss tolerance	High/medium	Low/low	Low/low	High/medium
Downtime (high reliability has low downtime)	Reasonable	Low	Low	Minimum

Zero Downtime for Mission-Critical Applications

Determining the Maximum Offered Traffic

- WAN resources have finite capacity.
- End users require minimum response times.
- Network managers require maximum link utilization.



Determining Physical Media Bandwidth

Bandwidth	<= 1.5/2 Mbps	From 1.5/2 Mbps to 45/34 Mbps	From 45/34 Mbps to 100 Mbps	From 100 Mbps to 10 Gbps
Copper	Serial or async serial, ISDN, TDM, X.25, Frame Relay, ADSL	ADSL (8 Mbps downstream		
Fiber		Ethernet, TDM (T3 or E3)	Fast Ethernet, ATM over SONET/SDH, POS	10-Gigabit Ethernet, Gigabit Ethernet, ATM over SONET/SDH, POS
Coaxial		Shared bandwidth: 27 Mbps downstream, 2.5 upstream		
2.4/5 GHz WAN wireless		Varies based on distance and RF quality		

Evaluating Cost-Effectiveness of Design and Implementation

	Investment and Running Costs
Private	Owner must buy, configure, and maintain the physical layer connectivity and the terminal equipment that connects each location.
Leased	Fixed bandwidth is leased from a carrier company with private or leased terminal equipment.
Shared	Physical resources in campus backbone are shared with many users.

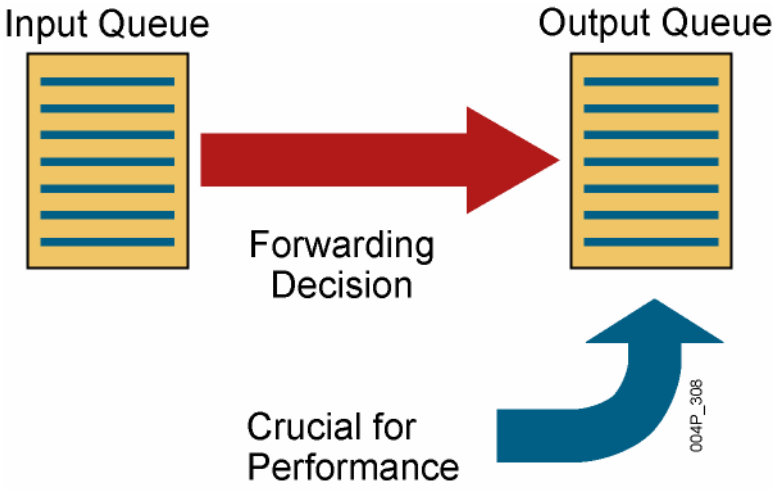
Bandwidth Usage in a WAN

Optimize the bandwidth usage on WAN links to improve network efficiency using:

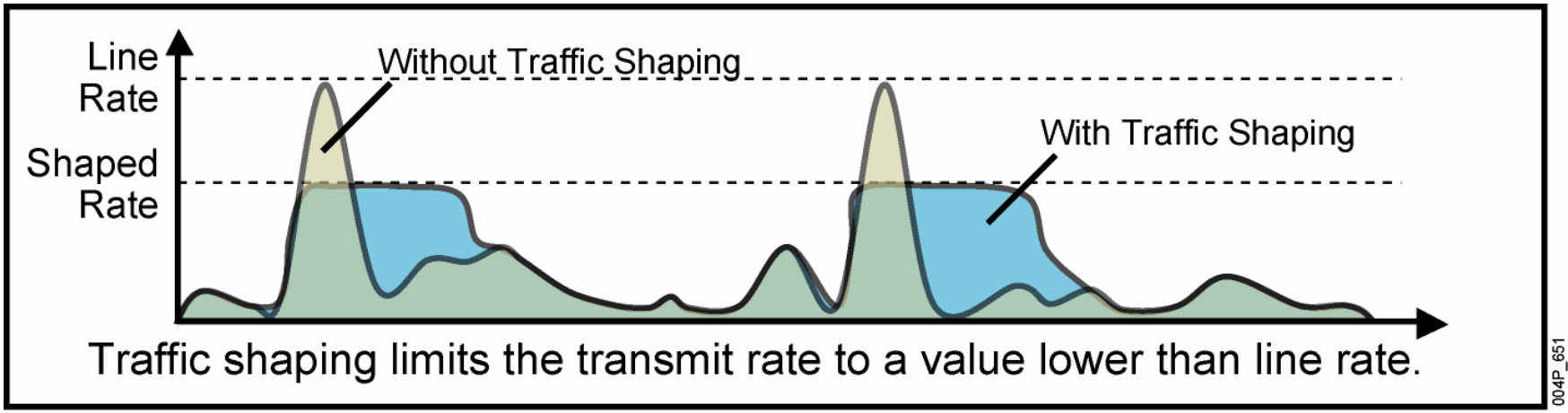
- Data compression: Reduces the size of a frame of data to transmit over a network link
- Bandwidth combination: Logically aggregates physical links
- Window size: Adjusts link reliability versus throughput
- Queuing: Avoids congestion for some traffic by giving it priority over other traffic
- Traffic shaping and policing: Avoids congestion by policing inbound and outbound flows

Queuing to Improve Link Utilization

- Queuing allows network administrators to manage varying demands of applications on networks and routers.
- Key types of queuing:
  - Priority queuing
  - Custom queuing
  - Weighted fair queuing
  - Class-based weighted fair queuing
  - Low latency queuing

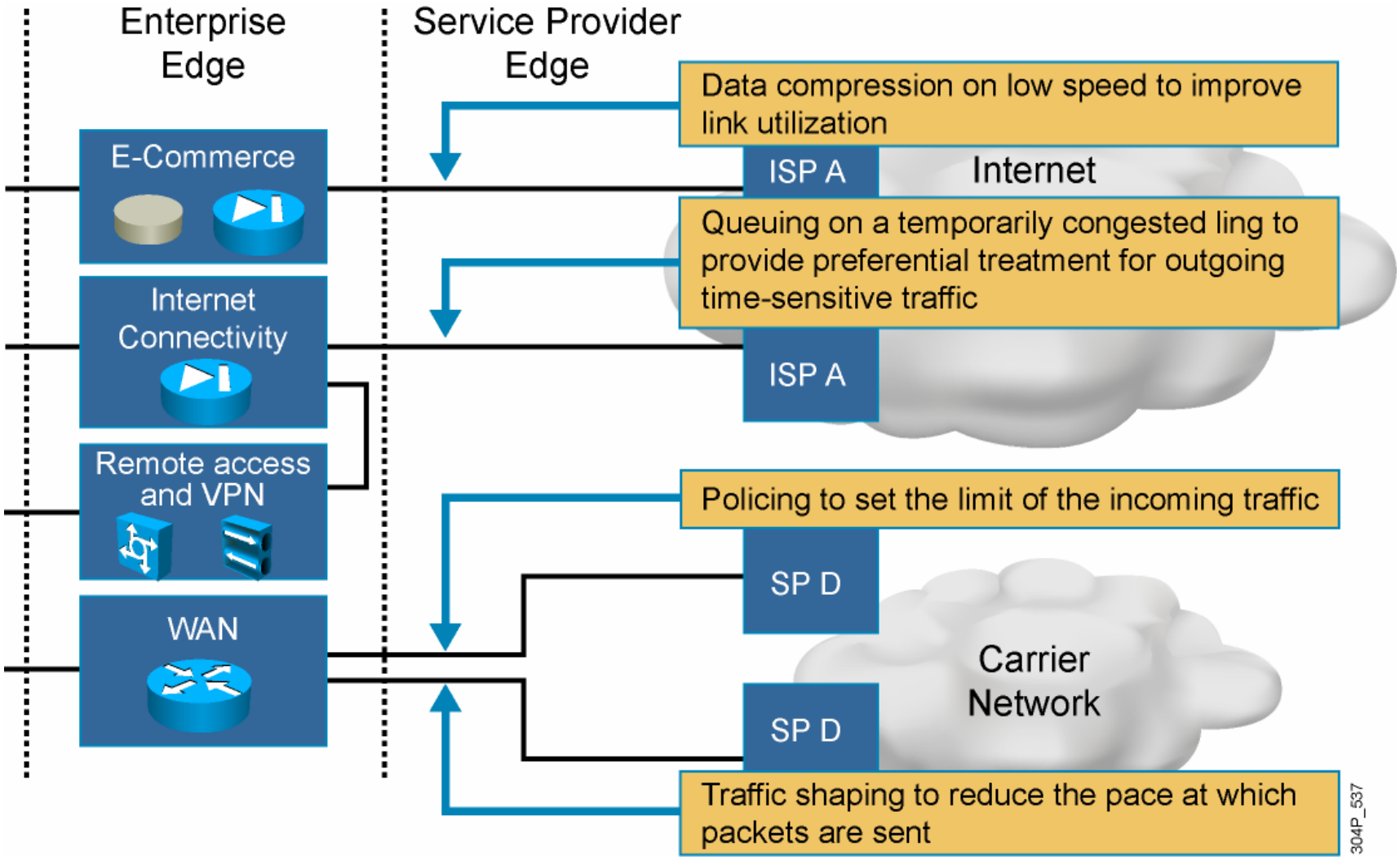


Traffic Shaping and Policing



- Usually found on egress ports, shaping buffers excess traffic, using a token bucket mechanism to release packets.
- Policers typically “tag” or “drop” traffic, depending on the mechanism, protocol, and severity of offense.
- Policing, historically in ATM, is on ingress ports and uses a “leaky bucket” mechanism.

Data Compression and QoS to Optimize Bandwidth Usage



Summary

- A WAN is a communications network that covers a relatively broad geographic area and carries a variety of traffic types using transmission facilities that are typically provided by service providers.
- The multiple WAN transport technologies vary in bandwidth, performance characteristics, and cost.
- In WAN design, enterprise edge connectivity requirements influence the trade-off between the cost of bandwidth and bandwidth efficiency.