Designing IP Addressing and Selecting Routing Protocols

Designing for Cisco Internetwork Solutions (DESGN) v2.0

Designing IP Addressing

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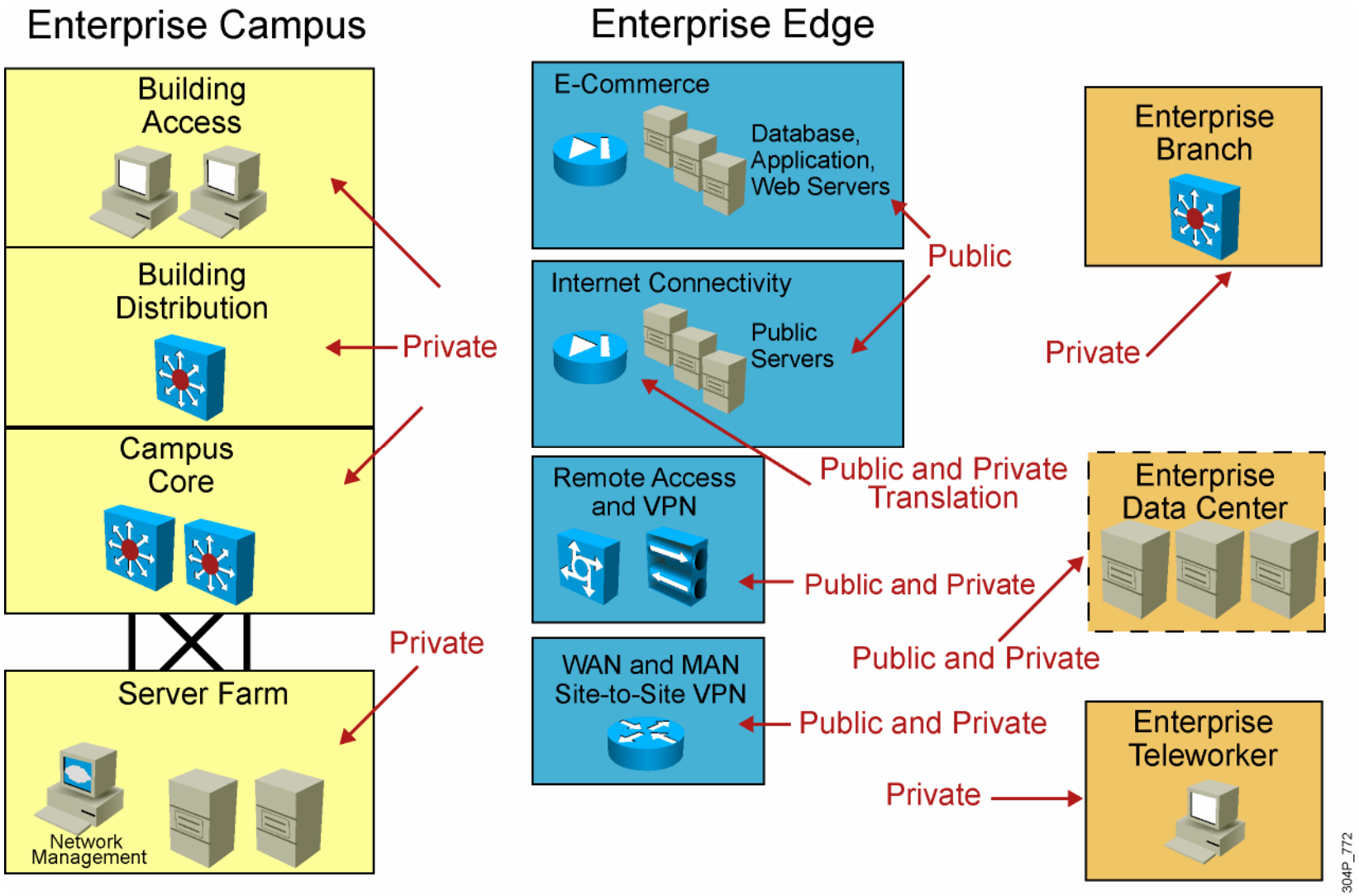
Prerequisite Knowledge

- IPv4 address and mask structure
- IPv4 classes and CIDR
- Static addressing
- Dynamic addressing with DHCP
- DNS
- Private and public addresses
- NAT and PAT
  - Static NAT
  - Dynamic NAT
  - Overloading

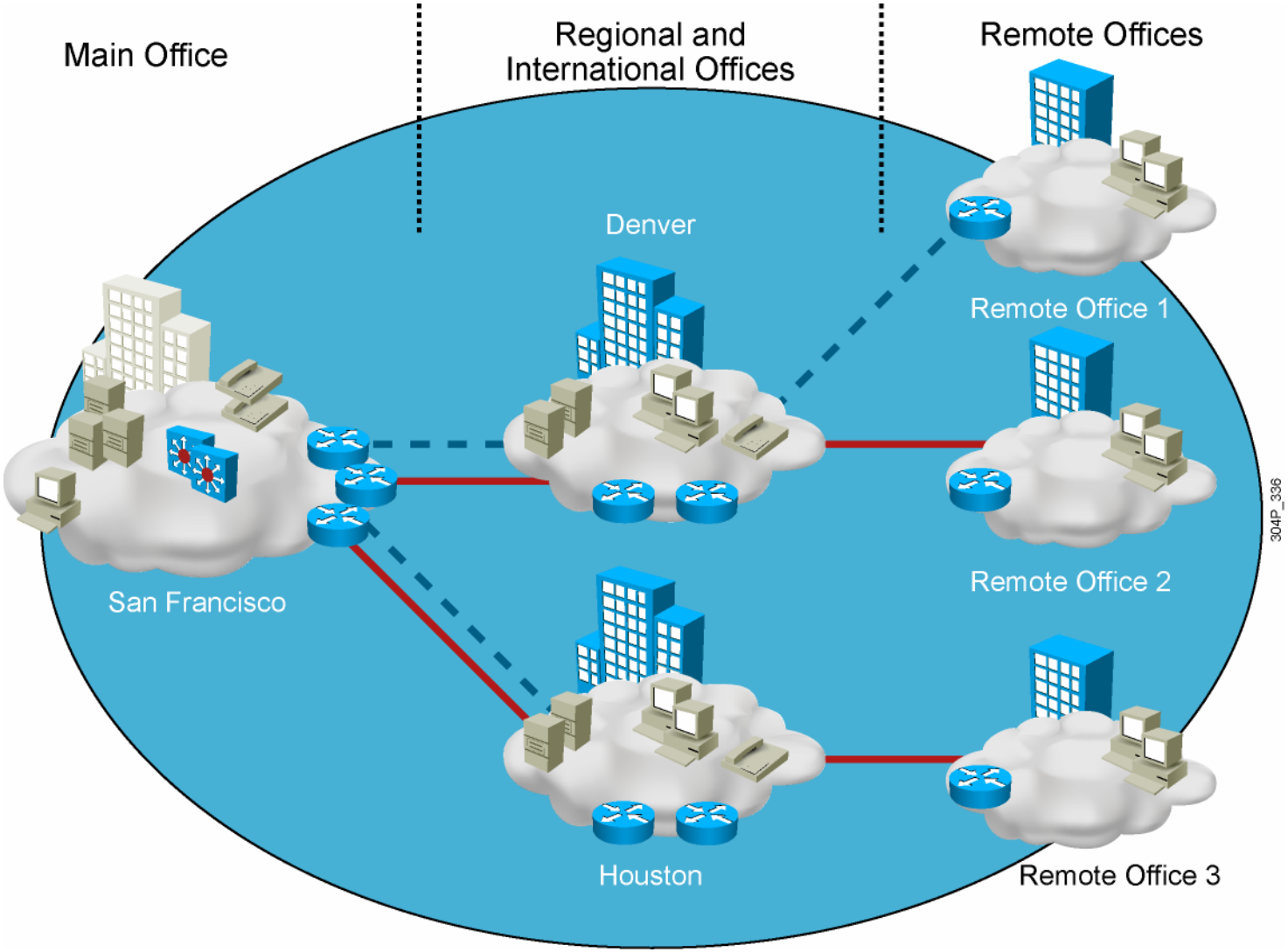
Private and Public IPv4 Address Guidelines



Network Size and IP Addressing Planning

- How many locations are in the network?
- How many devices in each location?
- What are the IP addressing requirements for individual locations?
- What subnet size is appropriate?

Determining General Network Topology



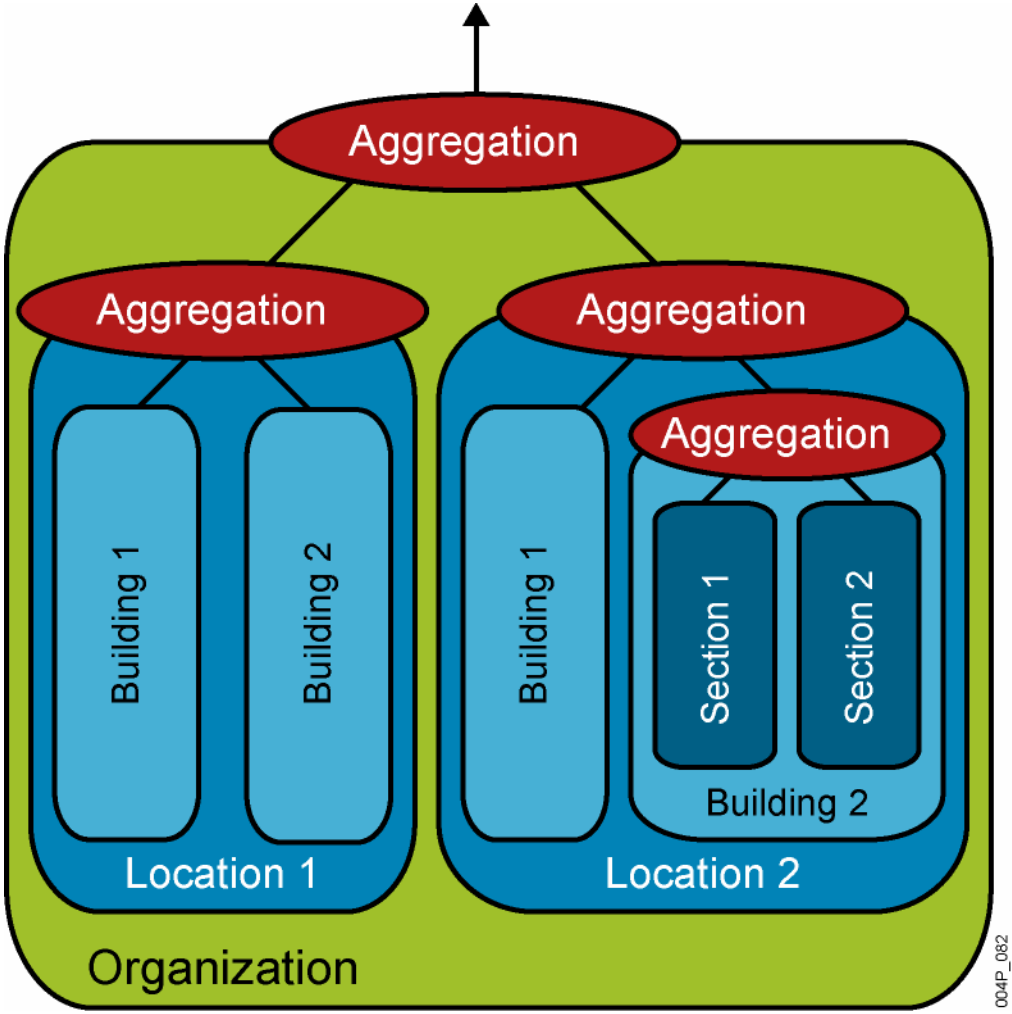
IP Address Requirements by Location

Location	Office Type	Workstations	Servers	IP Phones	Router Interfaces	Switches Layer 3	Firewall and Net Device Interfaces	Reserve	Total
San Francisco	Main	600	35	600	17	26	12	20%	1290
Denver	Regional	210	7	210	10	4	0	20%	441
Houston	Regional	155	5	155	10	4	0	20%	329
Remote Office 1	Remote	12	1	12	2	1	0	10%	28
Remote Office 2	Remote	15	1	15	3	1	0	10%	35
Remote Office 3	Remote	8	1	8	3	1	0	10%	21
Total		1000	50	1000	45	37	12		2144

IP Addressing Hierarchy

Reasons to implement include:

- Influence of IP addressing on routing
- Modular design and scalable solutions
- Support for route aggregation



Route Summarization Groups

- Benefits of hierarchical addressing include:
  - Support for route summarization groups
  - Efficient aggregation of routing advertisements
- Poorly designed IP addressing results in:
  - Excess routing traffic, leading to additional bandwidth consumption
  - Increased routing table recalculations, degrading router performance

Example: Address Blocks by Location

Location	Counts	Rounded Power of 2	Address Block
San Francisco Campus	1290		
Denver Region			
Denver Office 1	441		
Remote Office 1	28		
Remote Office 2	35		
Houston Region			
Houston Campus	329		
Remote Office 3	21		

Example: Address Blocks by Location

Location	Counts	Rounded Power of 2	Address Block
San Francisco Campus	1290	2048	
Denver Region			
Denver Office 1	441	512	
Remote Office 1	28	64	
Remote Office 2	35	64	
Houston Region			
Houston Campus	329	512	
Remote Office 3	21	64	

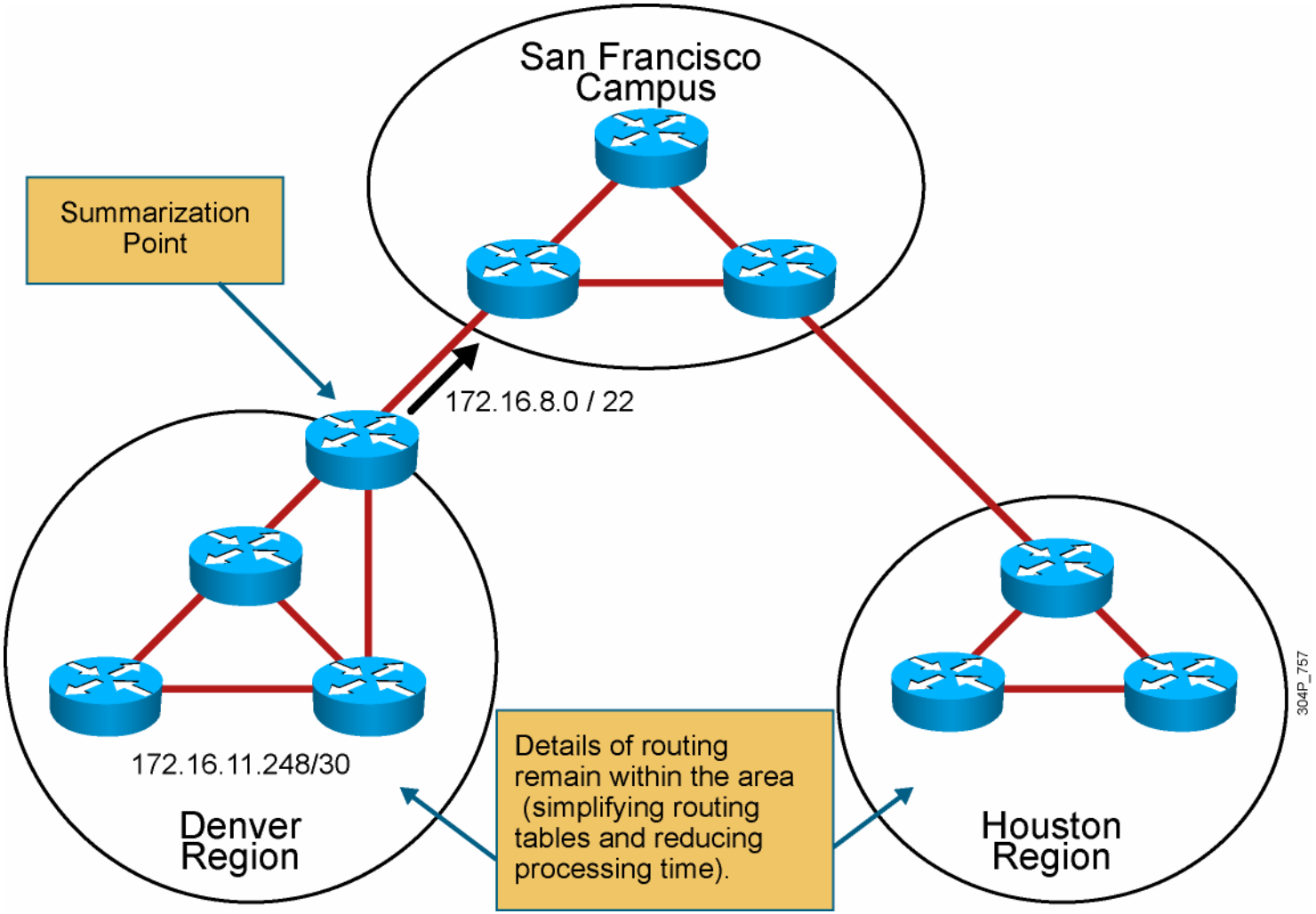
Example: Address Blocks by Location

Location	Counts	Rounded Power of 2	Address Block
San Francisco Campus	1290	2048	
Denver Region		1024	
Denver Office 1	441	512	
Remote Office 1	28	64	
Remote Office 2	35	64	
Houston Region		1024	
Houston Campus	329	512	
Remote Office 3	21	64	

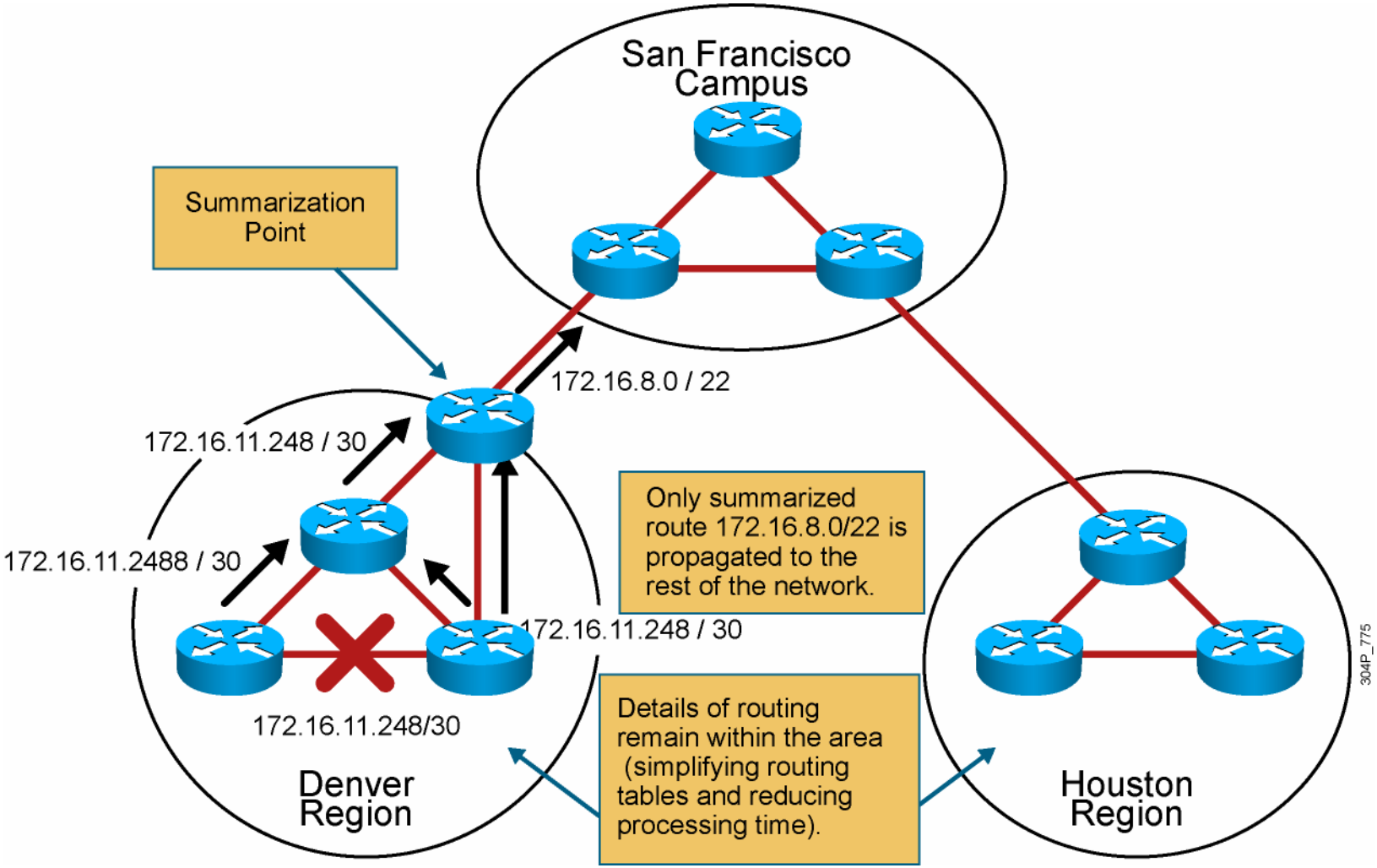
Example: Address Blocks by Location

Location	Counts	Rounded Power of 2	Address Block
San Francisco Campus	1290	2048	172.16.0.0 – 172.16.7.255 /21
Denver Region		1024	172.16.8.0 – 172.16.11.255 /22
Denver Office 1	441	512	172.16.8.0 – 172.16.9.255 /23
Remote Office 1	28	64	172.16.10.0 /26
Remote Office 2	35	64	172.16.10.64 /26
Houston Region		1024	172.16.12.0 – 172.16.15.255 /22
Houston Campus	329	512	172.16.12.0 – 172.16.13.255 /23
Remote Office 3	21	64	172.16.14.0 /26

Example: Hierarchical IP Addressing Plan



Example: Hierarchical IP Addressing Plan



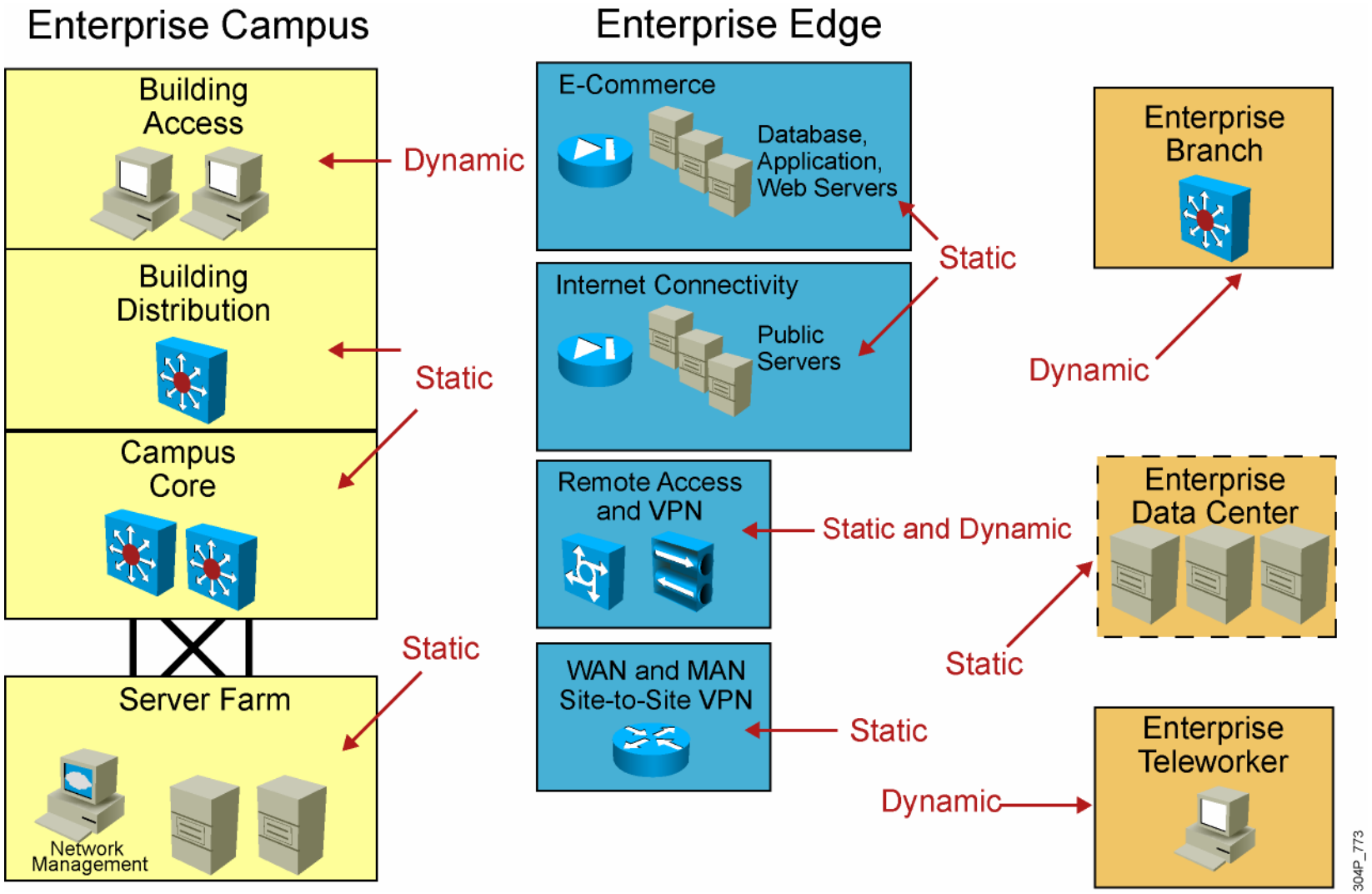
Managing IP Addresses

- Using DHCP in the enterprise.
- Using DNS in the enterprise.
- Using NAT in the enterprise.

Recommended Practices for IP Address Assignment

	Method	
Criteria	Strategic Address Assignment	Dynamic Address Assignment with DHCP
Node type	Infrastructure devices such as routers and switches	End-user devices
Number of end user devices	Up to 30 end-user devices	More than 30 end user devices
Renumbering	Requires manual reconfiguration of all hosts	Only DHCP server reconfiguration is needed
Address tracking	Easy address tracking	Requires additional DHCP server configuration
Additional parameters	Manual configuration of all hosts required	Only DHCP server needs to be configured
High availability	IP addresses are available at any time	Redundant DHCP server is required
Security concerns	Minor security risk	Any device gets IP address

Example: IP Address Assignment Methods in an Enterprise Network



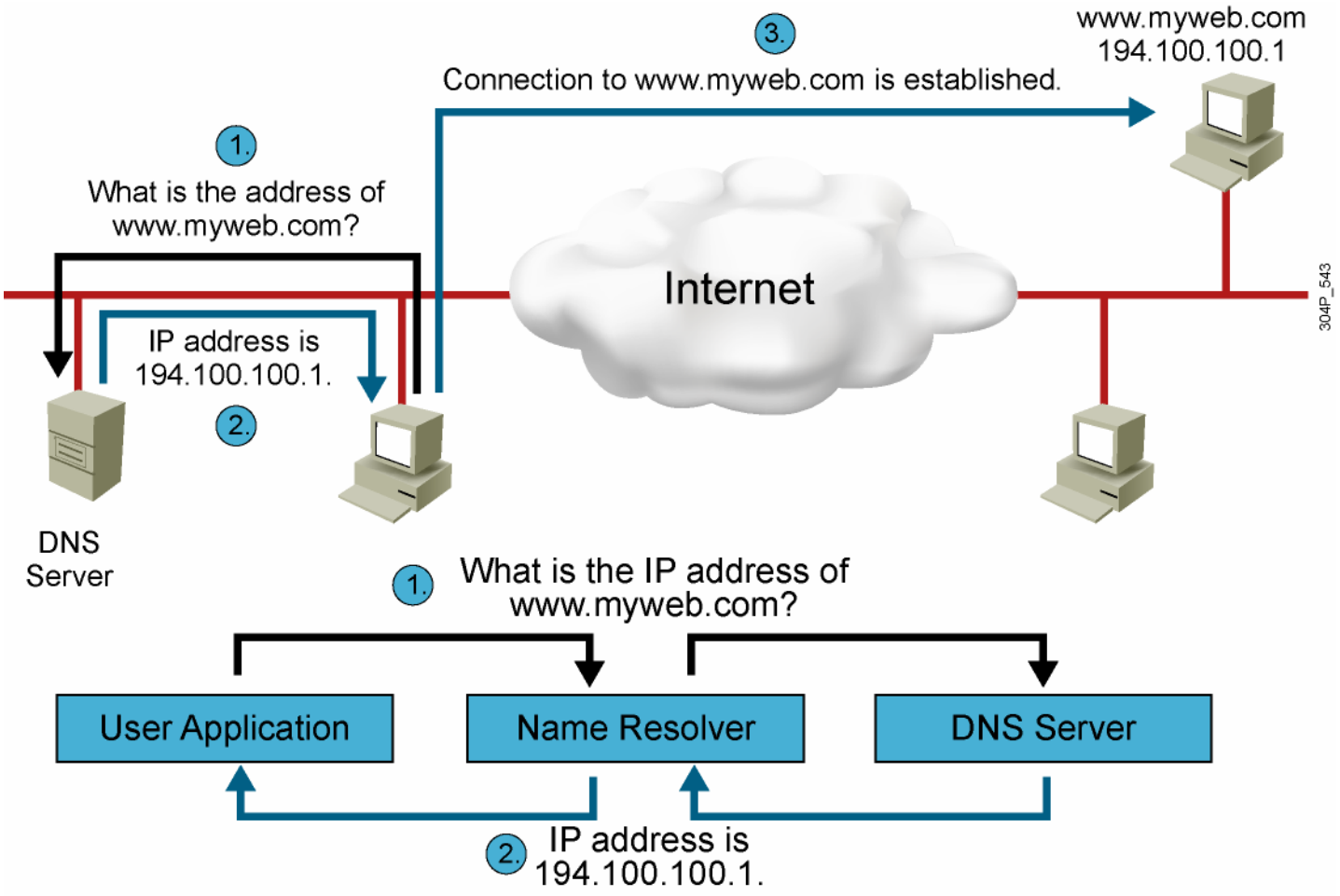
Static vs. Dynamic Name Resolution

- Names used to ease computer-human interaction
- Names resolved to IP addresses
- Different name resolution strategies:
  - Static
  - Dynamic

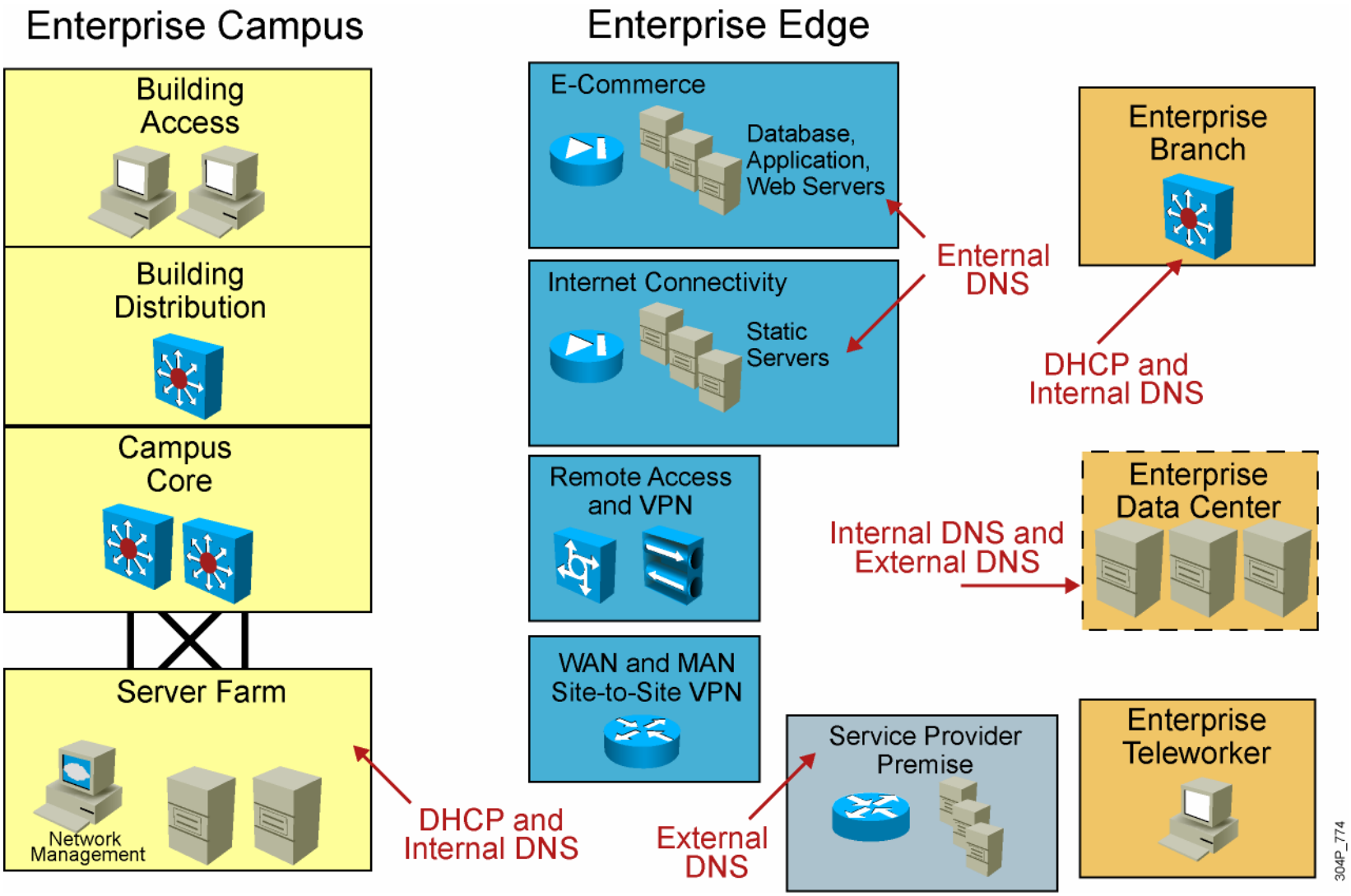
Recommended Practices for Name Resolution

	Method	
Criteria	Static Name Resolution	Dynamic Name Resolution
Number of hosts	Up to 30 hosts	More than 30 hosts
Isolated network	Applicable	Applicable
Internet connectivity	Not applicable	Mandatory
Frequent changes and addition of names	Not recommended	Recommended
Application depending on name resolution	Not recommended	Recommended

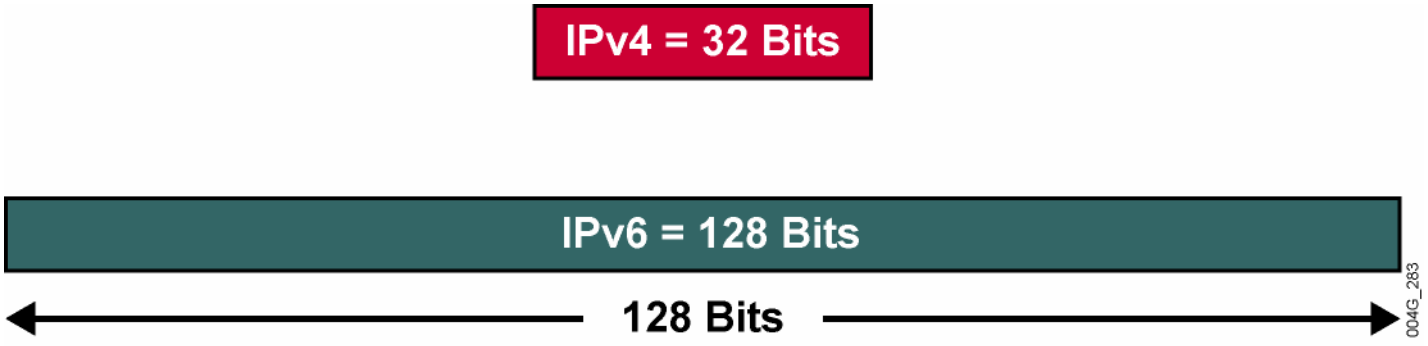
Using DNS for Name Resolution



Example: Locating DHCP and DNS Servers in the Network



IPv6 Address Structure



x:x:x:x:x:x:x:x, where x is 16 bits, represented by a hexadecimal number:

- 2031:0000:130F:0000:0000:09C0:876A:130B
- Can be also written as 2031:0:130F::9C0:876A:130B

Benefits of IPv6 Addressing

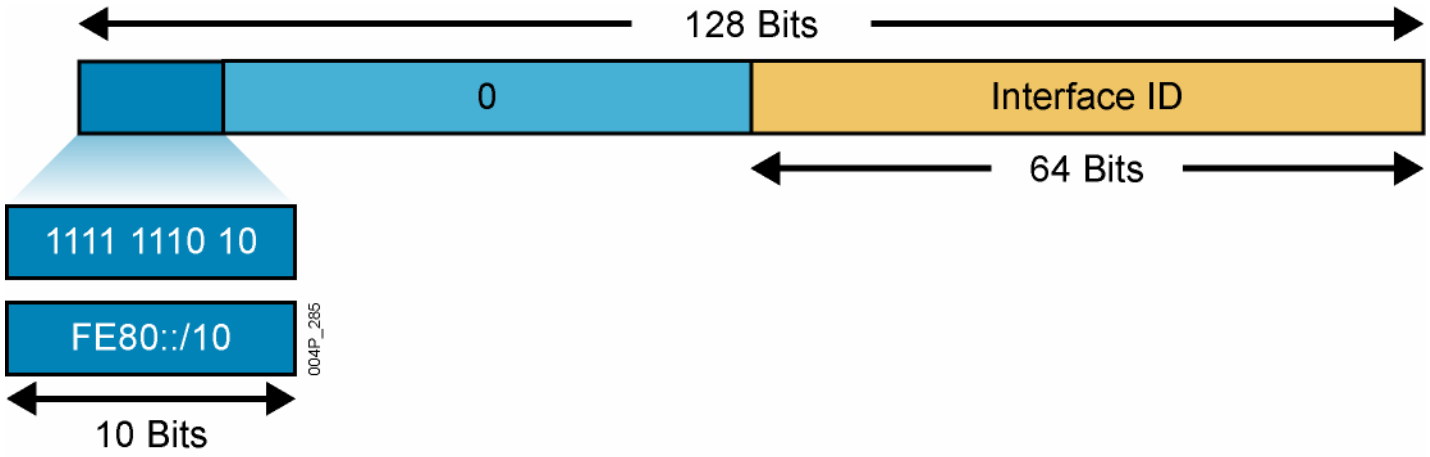
- Larger address space
- Globally unique IP addresses
- Site multihoming
- Header format efficiency
- Improved privacy and security
- Flow labeling capability
- Increased mobility and multicast capabilities

IPv6 Address Scope Types

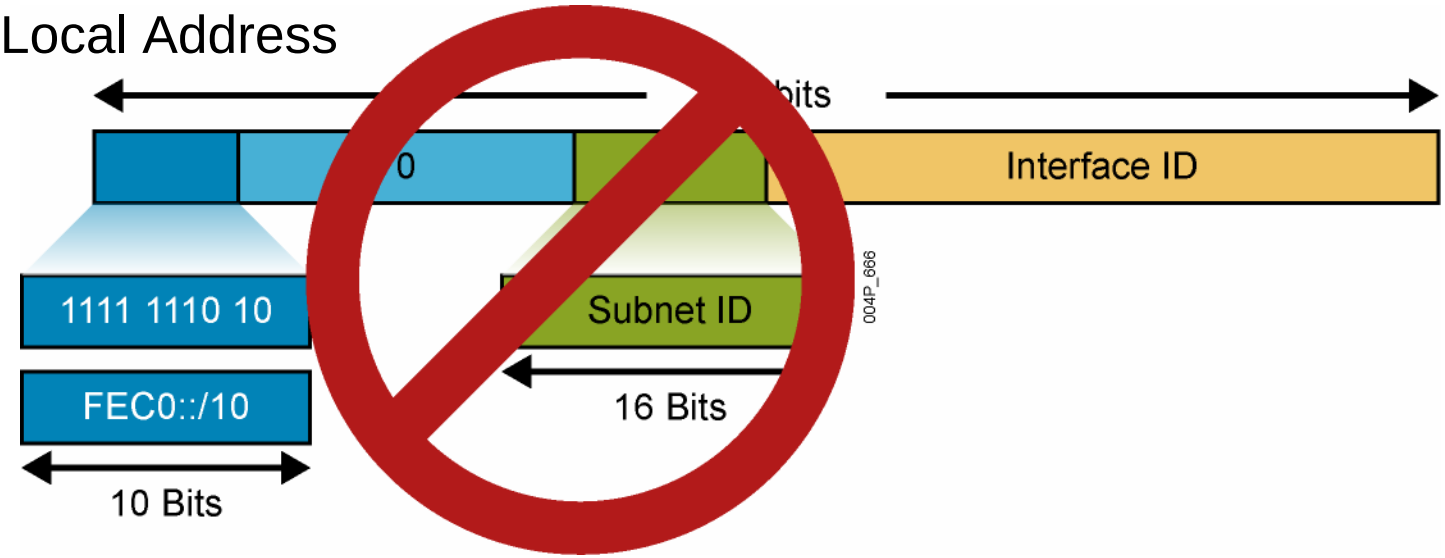
- IPv6 address scope types:
  - Unicast (one to one)
  - Anycast (one to nearest)
  - Multicast (one to many)
- Broadcast addresses not available

IPv6 Address Types: Link-Local and Site-Local

Link-Local Address

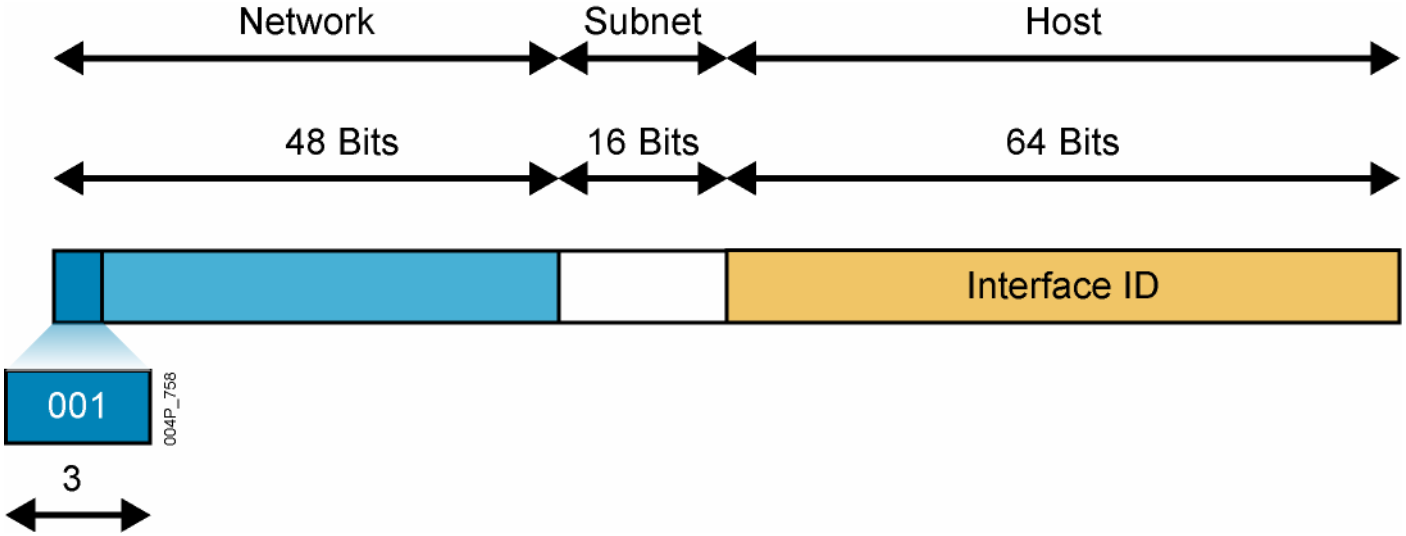


Site-Local Address

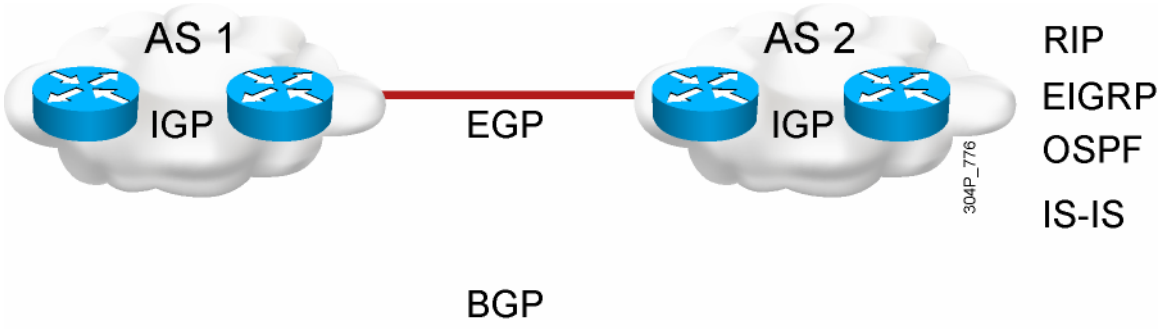


IPv6 Address Types: Global Aggregatable

Global Aggregatable Address



IPv6 Routing Protocol Considerations



- Interior Gateway Protocols (IGPs) for inside autonomous systems:
  - RIPng
  - EIGRP IPv6
  - OSPFv3
  - Integrated IS-IS
- Exterior gateway protocols (EGPs) for peering between autonomous systems:
  - BGP+

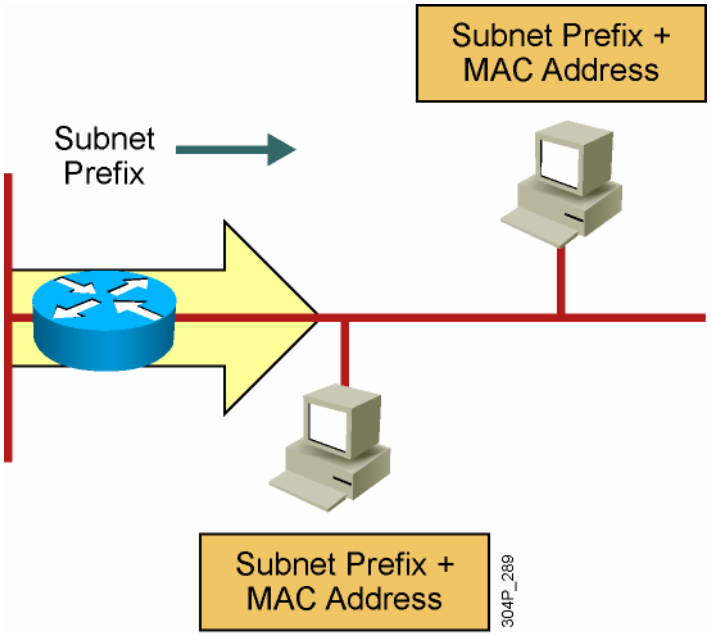
IPv6 Address Assignment Strategies

Static:

- Same as IPv4

Dynamic:

- Link-local
- Stateless
- Stateful using DHCPv6

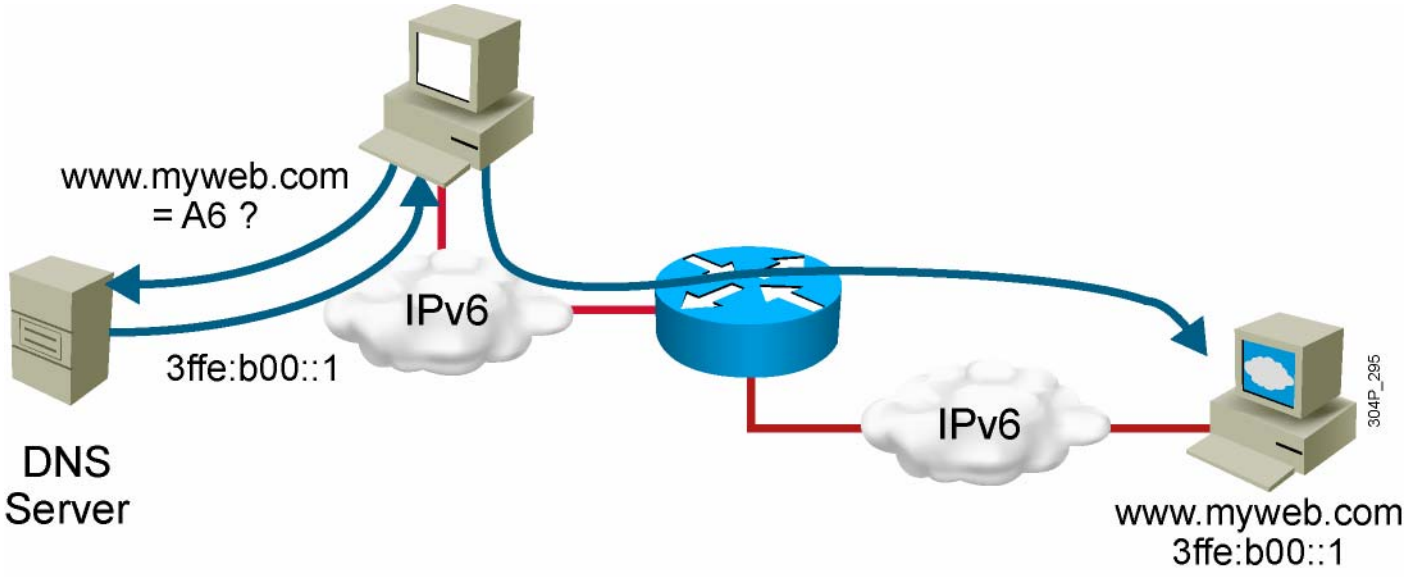


(Single Subnet Scope, Formed from Reserved Prefix and Link Layer Address)

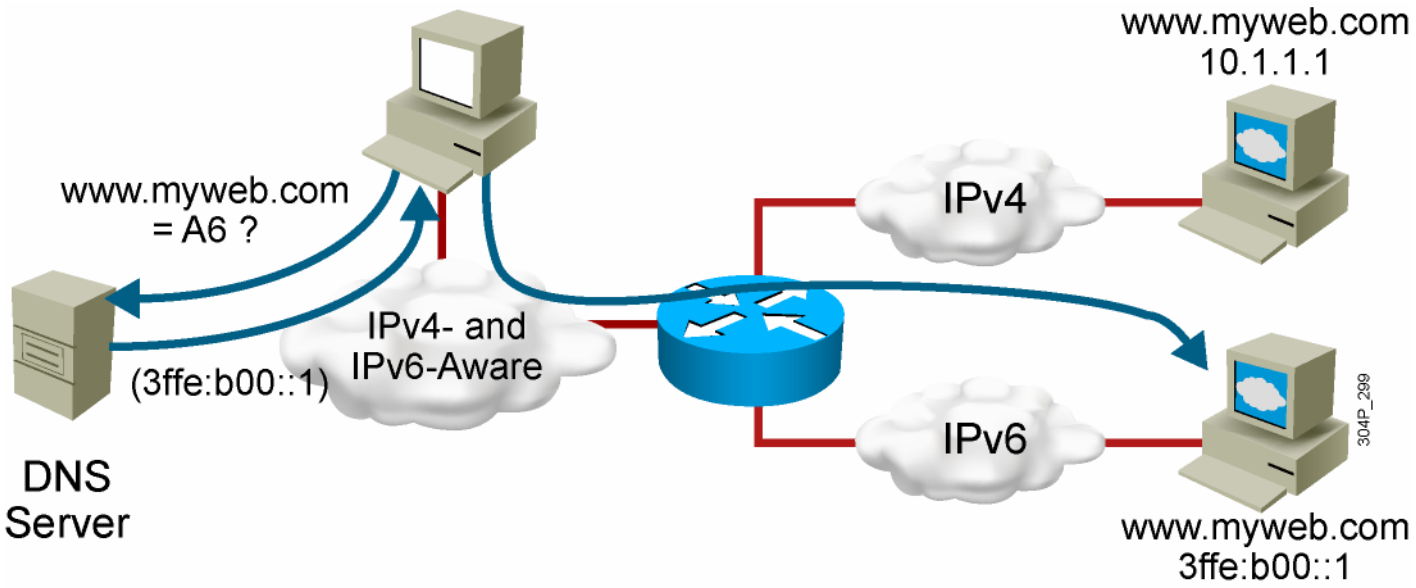
IPv6 Name Resolution

Static: Same as IPv4

Dynamic (autoconfiguration): DNS server with IPv6 stack support



IPv4- and IPv6-Aware Applications and Name Resolution



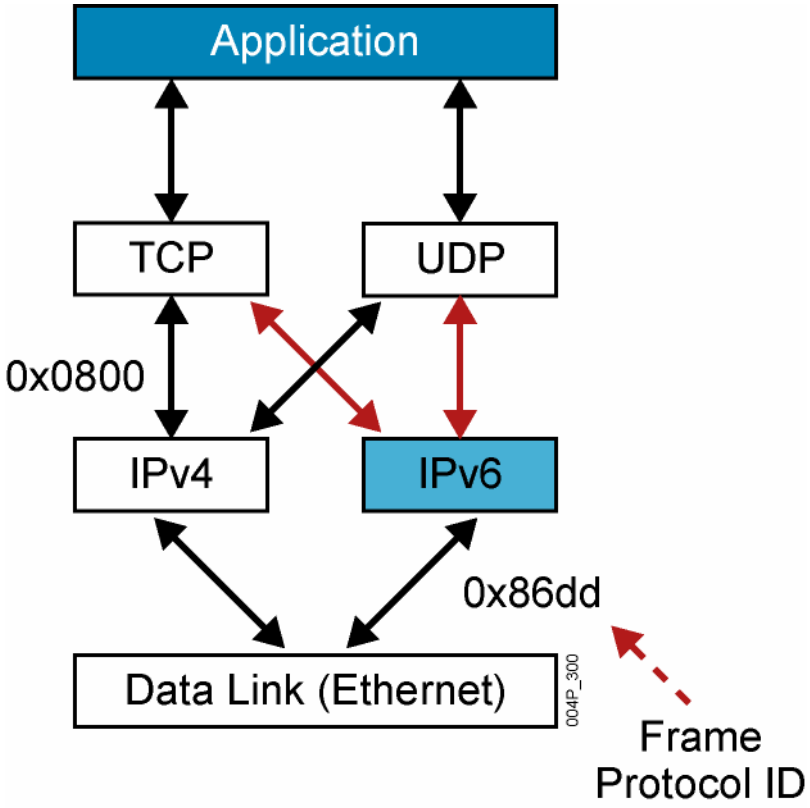
- In a dual-stack case, an application is IPv4- and IPv6-enabled.
- The application decides which stack to use and asks DNS for the address.

IPv4-to-IPv6 Transition Strategies

Three major transition strategies are available:

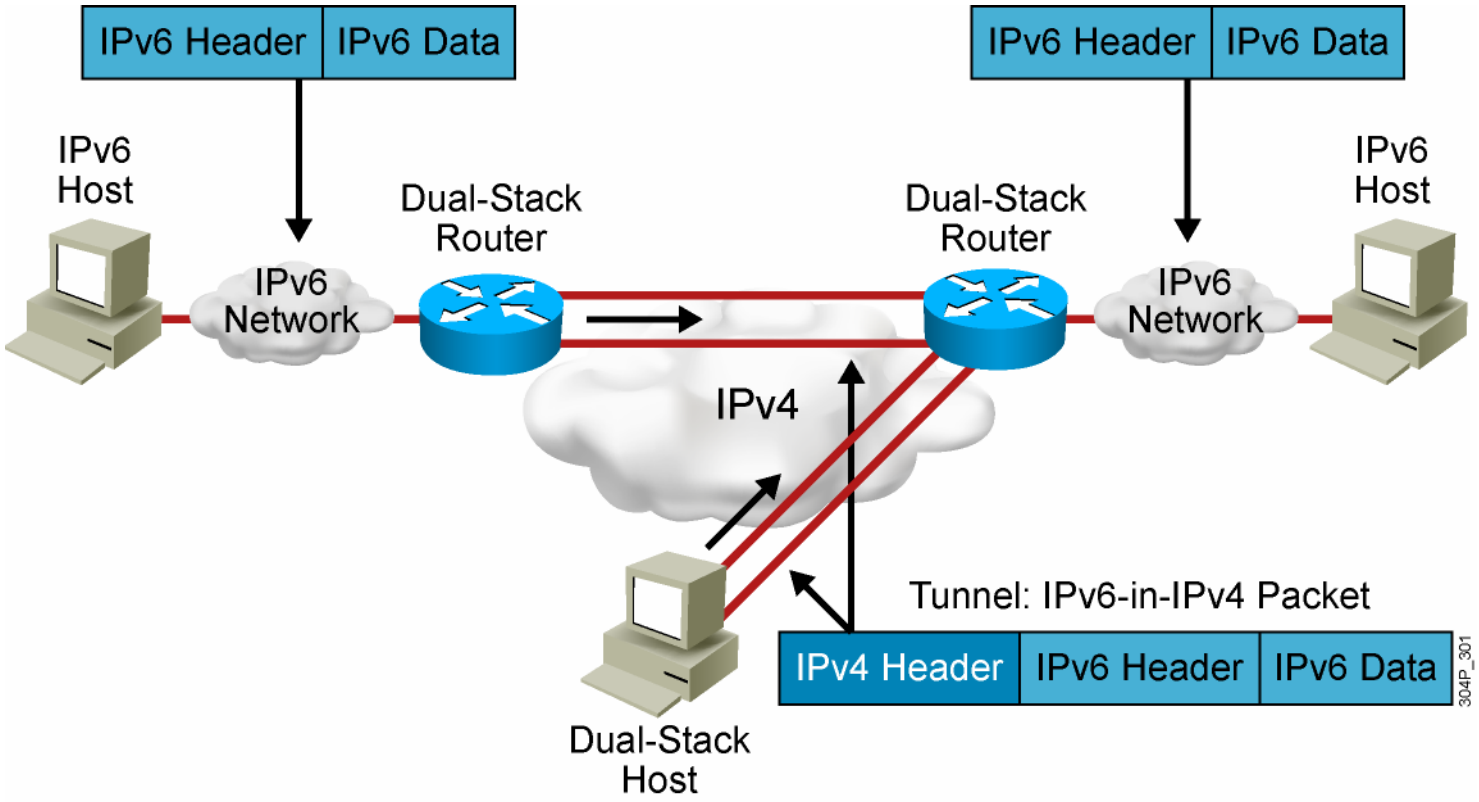
- Dual stack (IPv4 and IPv6 coexist in the same device and networks)
- Tunneling (IPv6 packets are encapsulated into IPv4 packets)
- Translation (IPv6-only devices can talk to IPv4 devices)

Dual-Stack Mechanism



- Both IPv4 and IPv6 stacks are enabled.
- Applications can talk to both stacks.
- IP version choice is based on name lookup and application preference.
- Popular operating systems support IPv6.

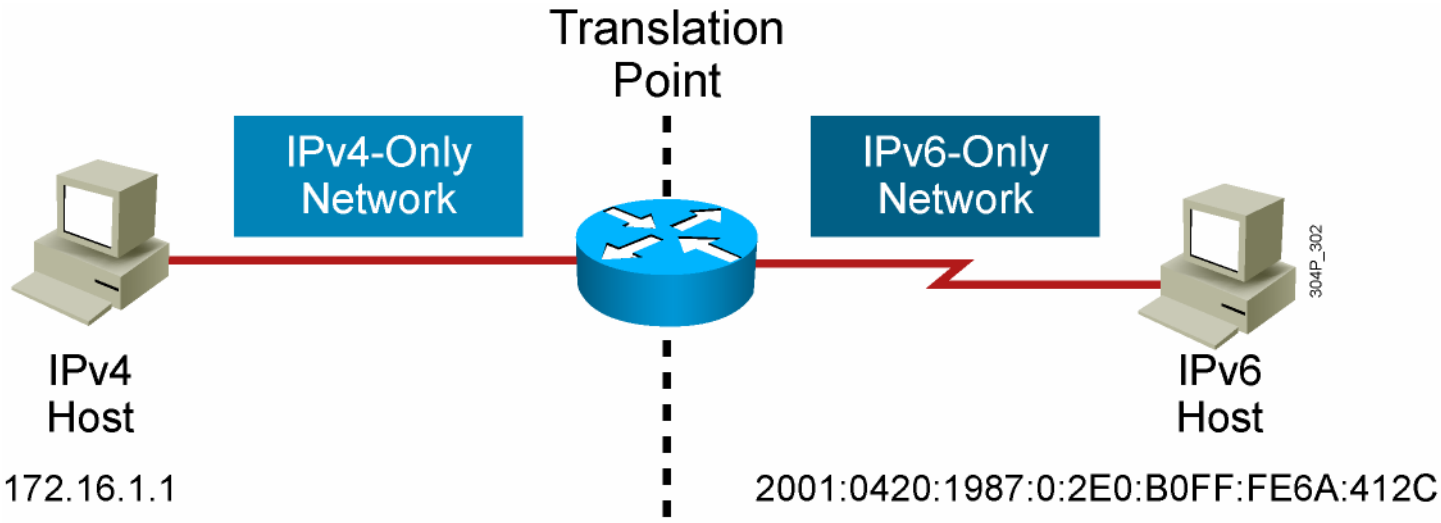
Tunneling Mechanism



Encapsulates the IPv6 packet in the IPv4 packet. Techniques:

- Manually configured
- Semiautomated
- Automatic

Translation Mechanism



Summary

- Key components of an IPv4 addressing scheme include IP address structure, address classes, subnetting, and masking.
- Well-designed hierarchical IP addressing enables efficient aggregation of routing advertisements, which consumes less bandwidth and router CPU.
  - Dynamic IP address assignment is a recommended practice in the enterprise.
  - Dynamic name resolution with a DNS server is a recommended practice in the enterprise.
- IPv6 was designed as a successor to IPv4 to overcome IPv4 limitations.
  - The IPv6 address structure and address types support a much larger address space than IPv4.
  - IPv6 supports two address types: link-local and global aggregatable.