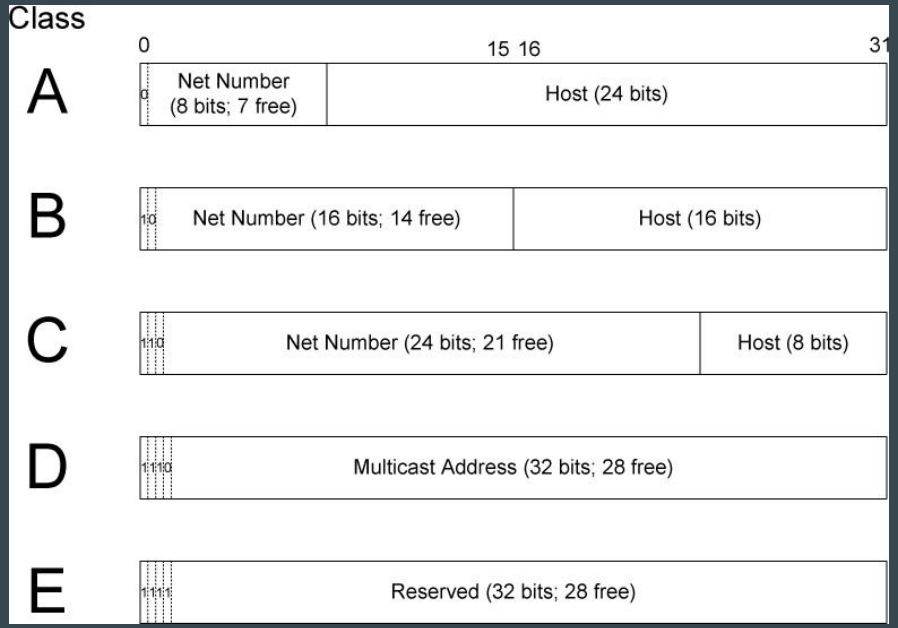
IPv4 Addressing - Chapter 2, Fall & Stevens

- 32-bit
- Written as *a.b.c.d*, where each of *a*, *b*, *c*, *d* ∈ [0,255]

Dotted-Quad Representation	Binary Representation
0.0.0.0	00000000 00000000 00000000 00000000
1.2.3.4	00000001 00000010 00000011 00000100
10.0.0.255	00001010 00000000 00000000 11111111
165.195.130.107	10100101 11000011 10000010 01101011
255.255.255.255	11111111 11111111 11111111 11111111

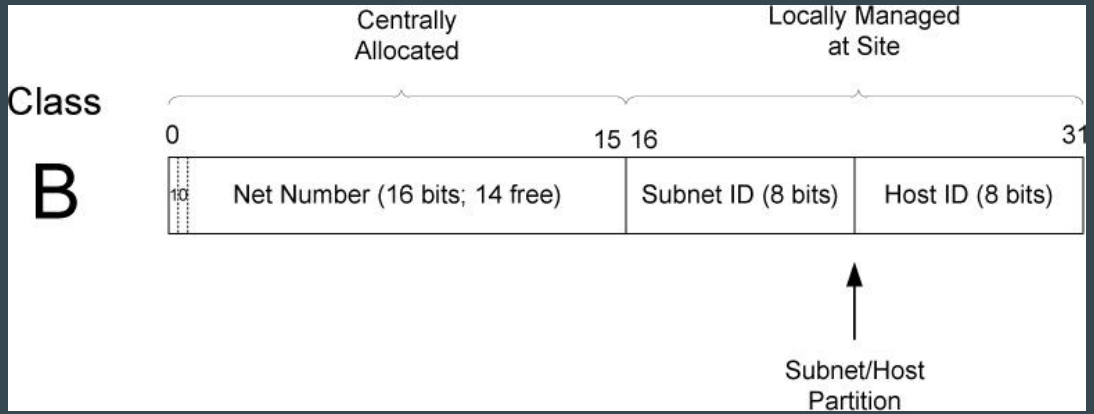
An IP address is not flat

Originally, classful addressing



Subnetwork Addressing

- Host portion can be subdivided.
- Publicly-routed Internet still sees only classful networks.
- Example:



Need for a “subnet mask”

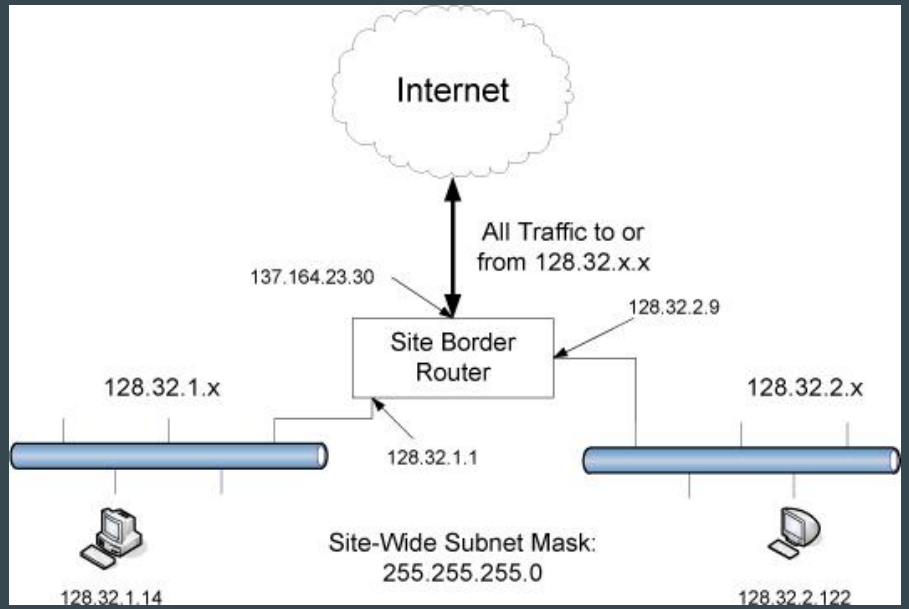
Identifies network + subnetwork portion of address.

Dotted-Decimal Representation	Shorthand (Prefix Length)	Binary Representation
128.0.0.0	/1	10000000 00000000 00000000 00000000
255.0.0.0	/8	11111111 00000000 00000000 00000000
255.192.0.0	/10	11111111 11000000 00000000 00000000
255.255.0.0	/16	11111111 11111111 00000000 00000000
255.255.254.0	/23	11111111 11111111 11111110 00000000
255.255.255.192	/27	11111111 11111111 11111111 11100000
255.255.255.255	/32	11111111 11111111 11111111 11111111

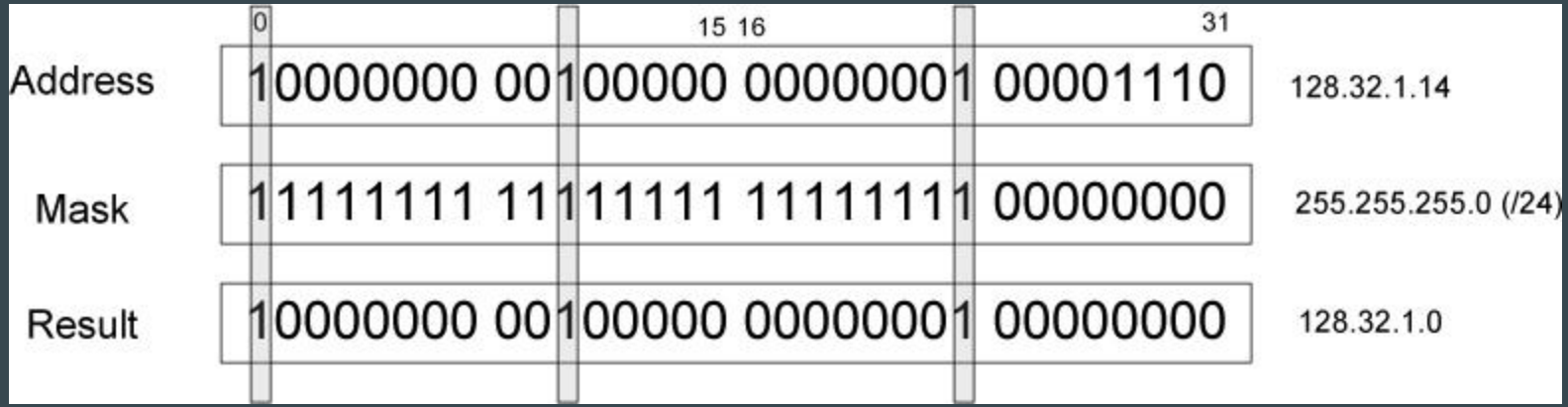
What's the big deal?

Network equipment (router) support.

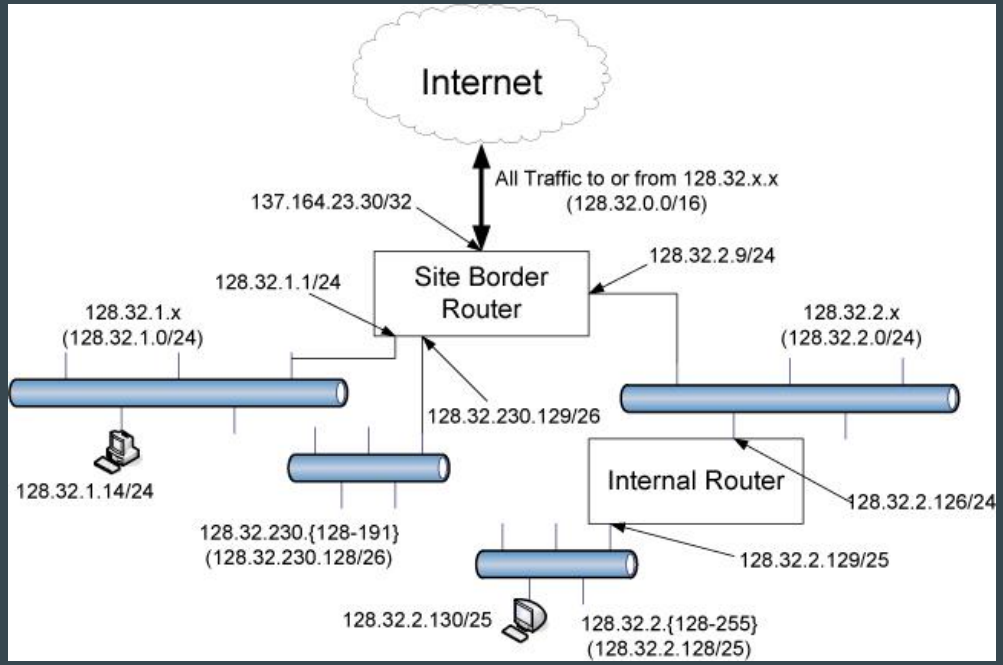
Example:



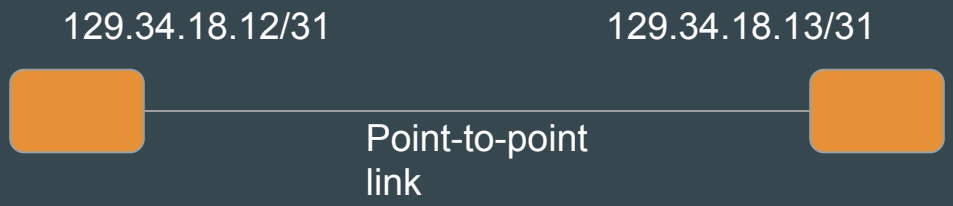
Application of mask - example



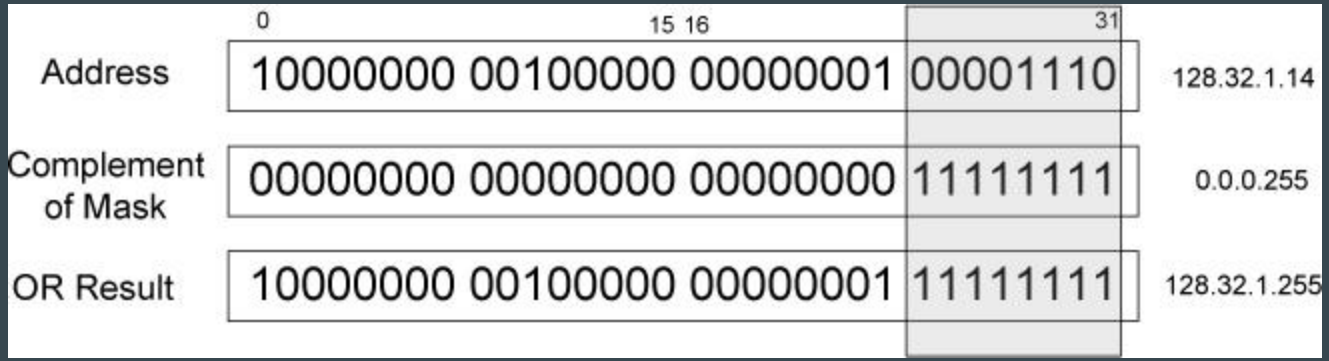
Variable Length Subnet Mask (VLSM)



E.g., mask of /31



Broadcast address



- Efficient broadcast - only 1 packet till destination network.
- A big security issue - routers disable “directed broadcast” by default.

Classless Inter-Domain Routing (CIDR) - motivation

1. By 1994, ≥ half of all class B network IDs already allocated.
2. 32-bit address inadequate.
3. # entries in the global routing table ≅ 65,000.

Proposed Solution

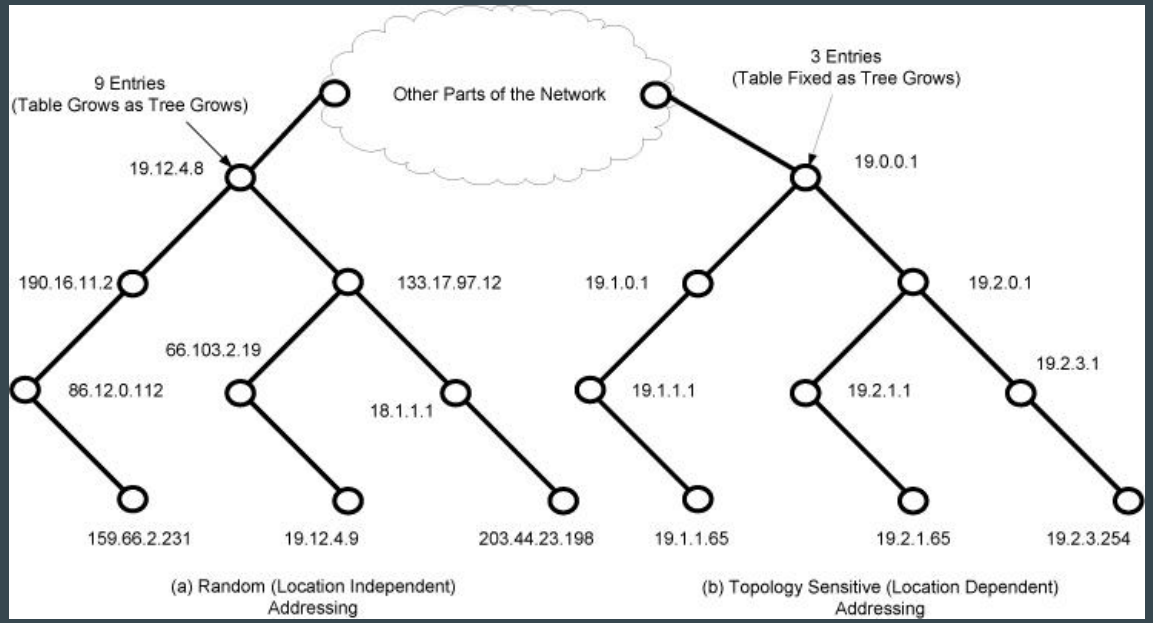
- Simultaneously:
  - Remove class breakdown.
    - E.g., allow network 129.0.18.0/24
  - Allow aggregation in routing tables.
    - E.g., destination 129.0.0.0/8

Reducing size of routing table

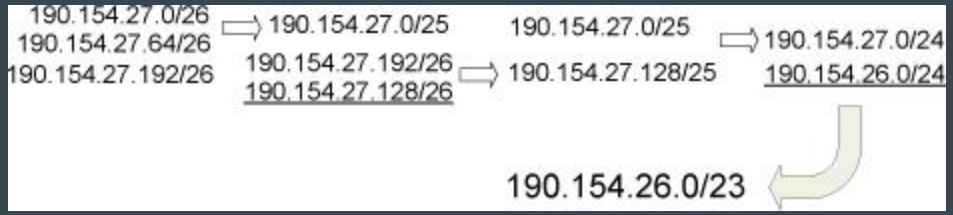
- Removing class aggregation does not help with reducing routing entries.
- But assignment of IP addresses in a way that is sensitive to topology can.
  - E.g., hierarchical routing.

Hierarchical Routing

"if the network topology were arranged as a tree and addresses were assigned in a way that was "sensitive" to this topology, very small routing tables could be used while still maintaining shortest-path routes to all destinations."



Route Aggregation



(Underlined prefixes are those that happen to be added later.)

Special-use IP addresses

Prefix	Special Use	Reference
0.0.0.0/8	Hosts on the local network. May be used only as a source IP address.	[RFC1122]
10.0.0.0/8	Address for private networks (intranets). Such addresses never appear on the public Internet.	[RFC1918]
127.0.0.0/8	Internet host loopback addresses (same computer). Typically only 127.0.0.1 is used.	[RFC1122]
169.254.0.0/16	"Link-local" addresses—used only on a single link and generally assigned automatically. See Chapter 6.	[RFC3927]
172.16.0.0/12	Address for private networks (intranets). Such addresses never appear on the public Internet.	[RFC1918]
192.0.0.0/24	IETF protocol assignments (IANA reserved).	[RFC5736]
192.0.2.0/24	TEST-NET-1 addresses approved for use in documentation. Such addresses never appear on the public Internet.	[RFC5737]
192.88.99.0/24	Used for 6to4 relays (anycast addresses).	[RFC3068]
192.168.0.0/16	Address for private networks (intranets). Such addresses never appear on the public Internet.	[RFC1918]
198.18.0.0/15	Used for benchmarks and performance testing.	[RFC2544]
198.51.100.0/24	TEST-NET-2. Approved for use in documentation.	[RFC5737]
203.0.113.0/24	TEST-NET-3. Approved for use in documentation.	[RFC5737]
224.0.0.0/4	IPv4 multicast addresses (formerly class D); used only as destination addresses.	[RFC5771]
240.0.0.0/4	Reserved space (formerly class E), except 255.255.255.255.	[RFC1112]
255.255.255.255/32	Local network (limited) broadcast address.	[RFC0919] [RFC0922]

IP Address Allocation

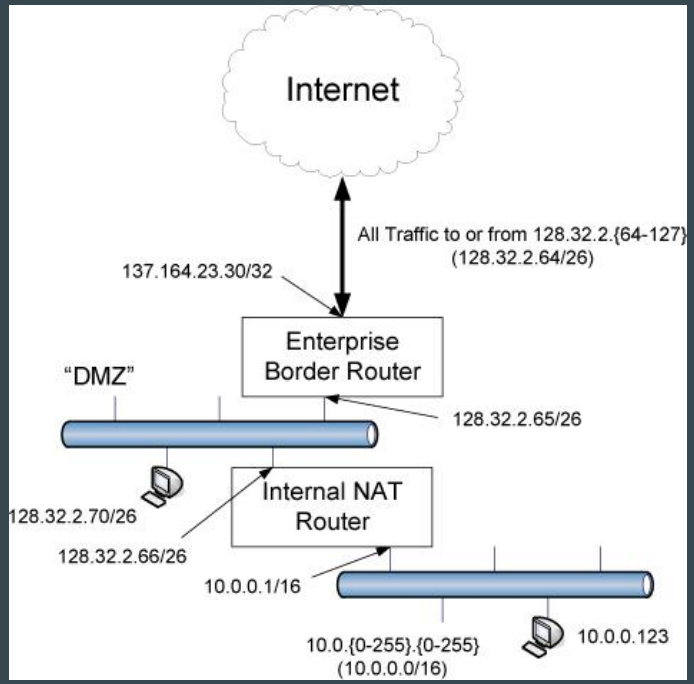
- Internet Assigned Numbers Authority - IANA
- Has delegated entire pool to Regional Internet Registries (RIRs)

RIR Name	Area of Responsibility	Reference
AfriNIC—African Network Information Center	Africa	http://www.afrinic.net
APNIC—Asia Pacific Network Information Center	Asia/Pacific Area	http://www.apnic.net
ARIN—American Registry for Internet Numbers	North America	http://www.arin.net
LACNIC—Regional Latin America and Caribbean IP Address Registry	Latin America and some Caribbean islands	http://lacnic.net/en/index.html
RIPE NCC—Réseaux IP Européens	Europe, Middle East, Central Asia	http://www.ripe.net

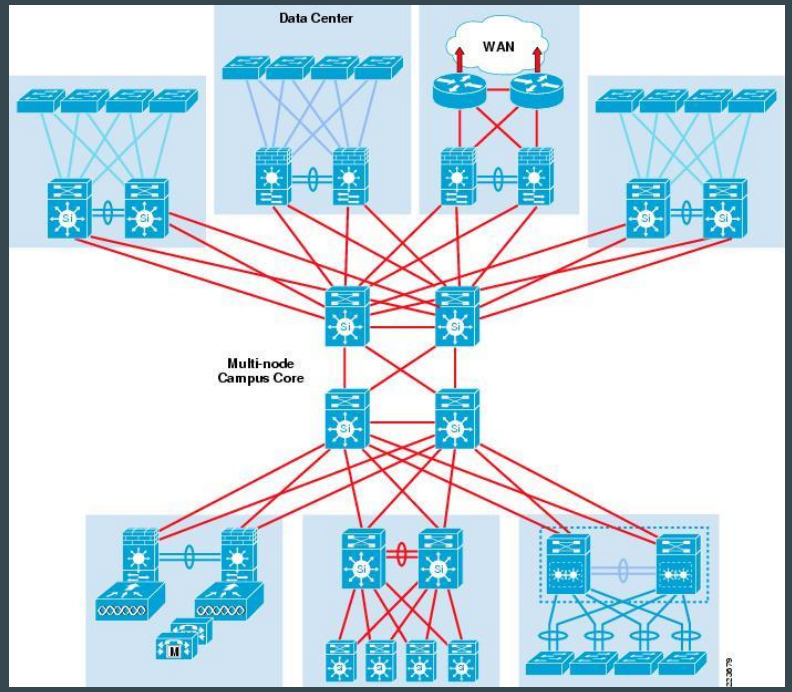
Address assignment

1. Single Provider/No Network/Single Address
2. Single Provider/Single Network/Single Address
3. Single Provider/Multiple Networks/Multiple Addresses
4. Multiple Providers/Multiple Networks/Multiple Addresses (Multihoming)

3. Single Provider/Multiple Networks/Multiple Addresses

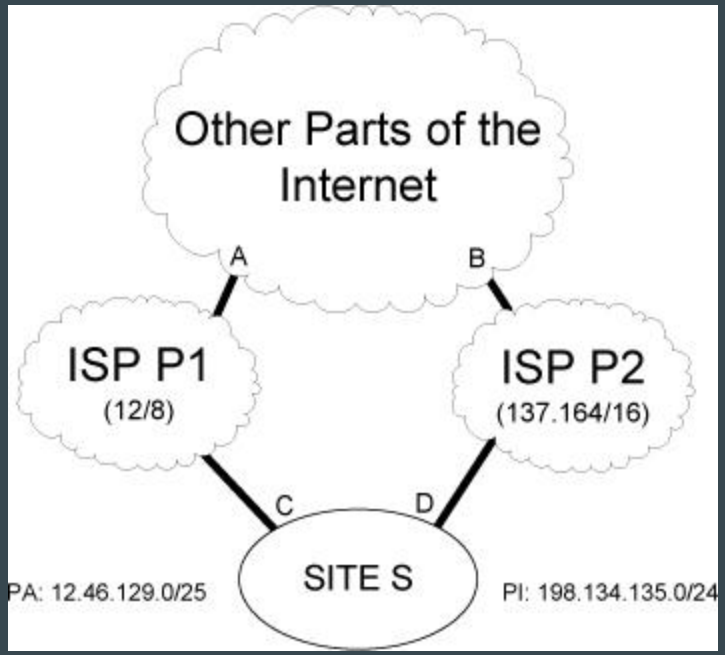


“Campus” network design



Cisco, Inc.,
“*Enterprise Campus 3.0 Architecture*.”

4. Multiple Providers/Multiple Networks/Multiple Addresses



IP address is used for both:

- Identification
- Location

This can be a bad thing.