CIDR

The Life Belt of the Internet

Early IP Addressings

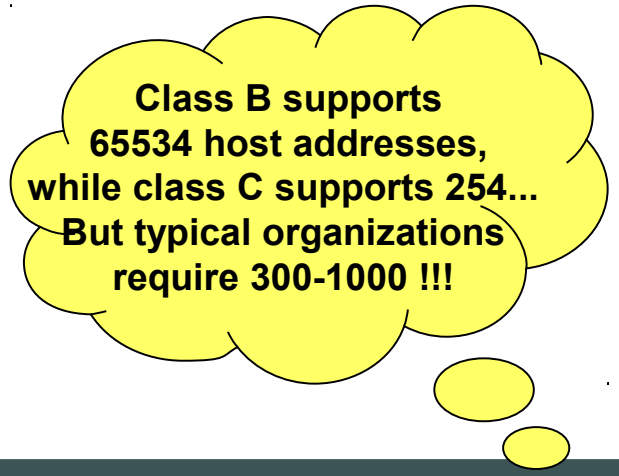
- Before 1981 only class A addresses were used
  - Original Internet addresses comprised 32 bits (8 bit net-id = 256 networks)
- In 1981 RFC 790 (IP) was finished and classes were introduced
  - 7 bit class A networks
  - 14 bits class B networks
  - 21 bits class C networks

Address Classes

- From 1981-1993 the Internet was Classful (!)
- Early 80s: Jon Postel volunteered to maintain assigned network addresses
  - Paper notebook
- Internet Registry (IR) became part of IANA
- Postel passed his task to SRI International
  - Menlo Park, California
  - Called Network Information Center (NIC)

Classful – Drawbacks

- "Three sizes *don't* fit all" !!!
  - Demand to assign as little as possible
  - Demand for aggregation as many as possible
- Assigning a whole network number
  - Reduces routing table size
  - But wastes address space



Subnetting

- Subnetting introduced in 1984
  - Net + Subnet (=another level)
  - RFC 791
  - Initially only statically configured
- Classes A, B, C still used for global routing !
  - Destination Net might be subnetted
  - Smaller routing tables

Routing Table Growth (88-92)

MM/YY	ROUTES ADVERTISED
Feb-92	4775
Jan-92	4526
Dec-91	4305
Nov-91	3751
Oct-91	3556
Sep-91	3389
Aug-91	3258
Jul-91	3086
Jun-91	2982
May-91	2763
Apr-91	2622
Mar-91	2501
Feb-91	2417
Jan-91	2338
Dec-90	2190
Nov-90	2125
Oct-90	2063
Sep-90	1988
Aug-90	1894
Jul-90	1727
Jun-90	1639
May-90	1580

MM/YY	ROUTES ADVERTISED
Apr-90	1525
Mar-90	1038
Feb-90	997
Jan-90	927
Dec-89	897
Nov-89	837
Oct-89	809
Sep-89	745
Aug-89	650
Jul-89	603
Jun-89	564
May-89	516
Apr-89	467
Mar-89	410
Feb-89	384
Jan-89	346
Dec-88	334
Nov-88	313
Oct-88	291
Sep-88	244
Aug-88	217
Jul-88	173

Growth in routing table size, total numbers
Source for the routing table size data is MERIT

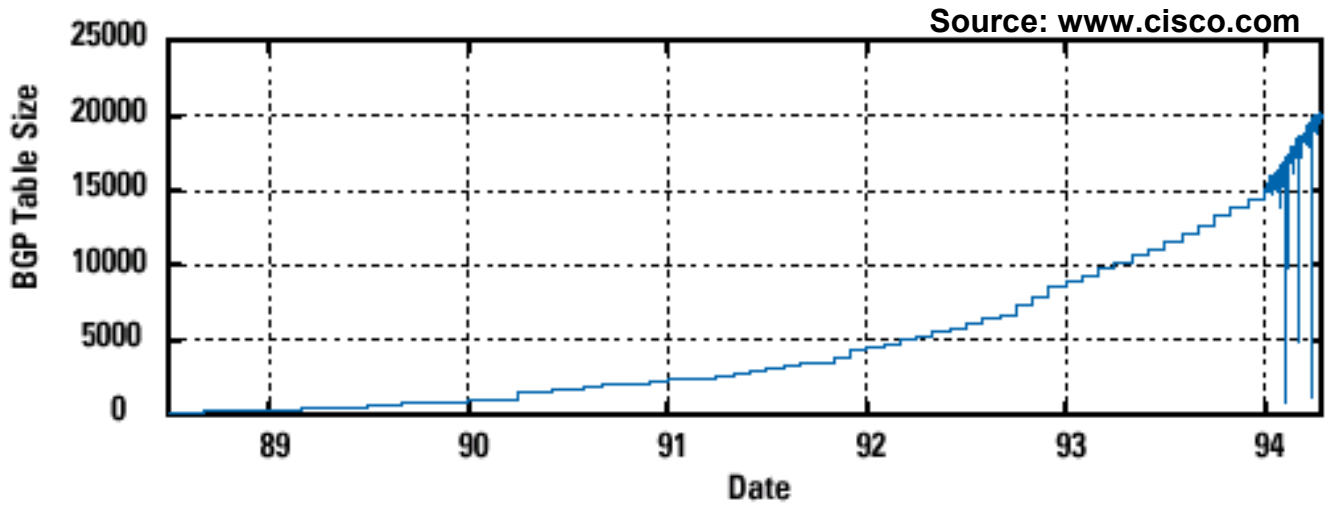
Network Number Statistics, April 1992

	Total	Allocated	Allocated %
Class A	126	48	54%
Class B	16383	7006	43%
Class C	2097151	40724	2%

Only 2% of more than 2 million Class C addresses assigned !!!

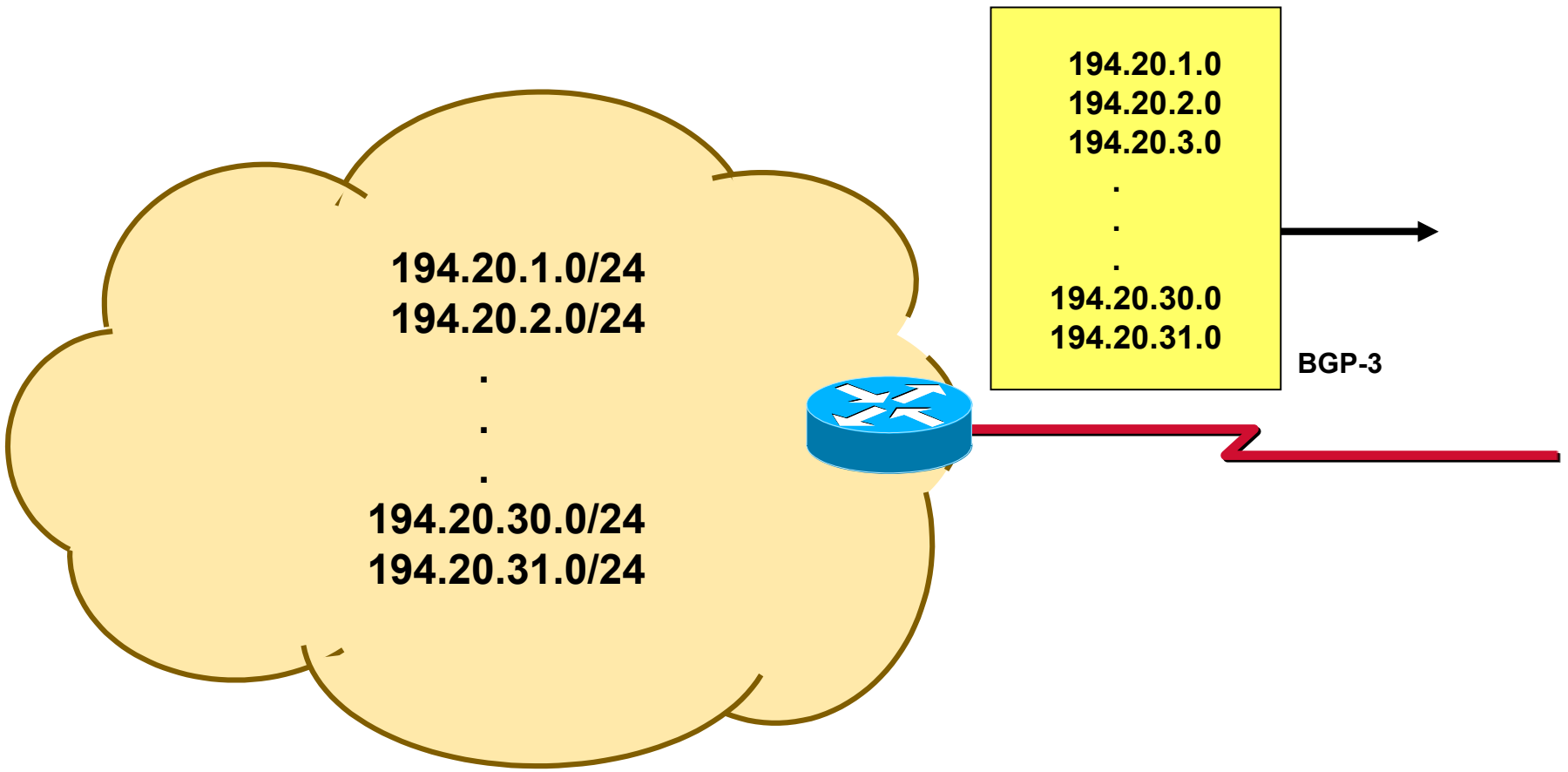
Source: RFC 1335

Supernetting (RFC 1338)

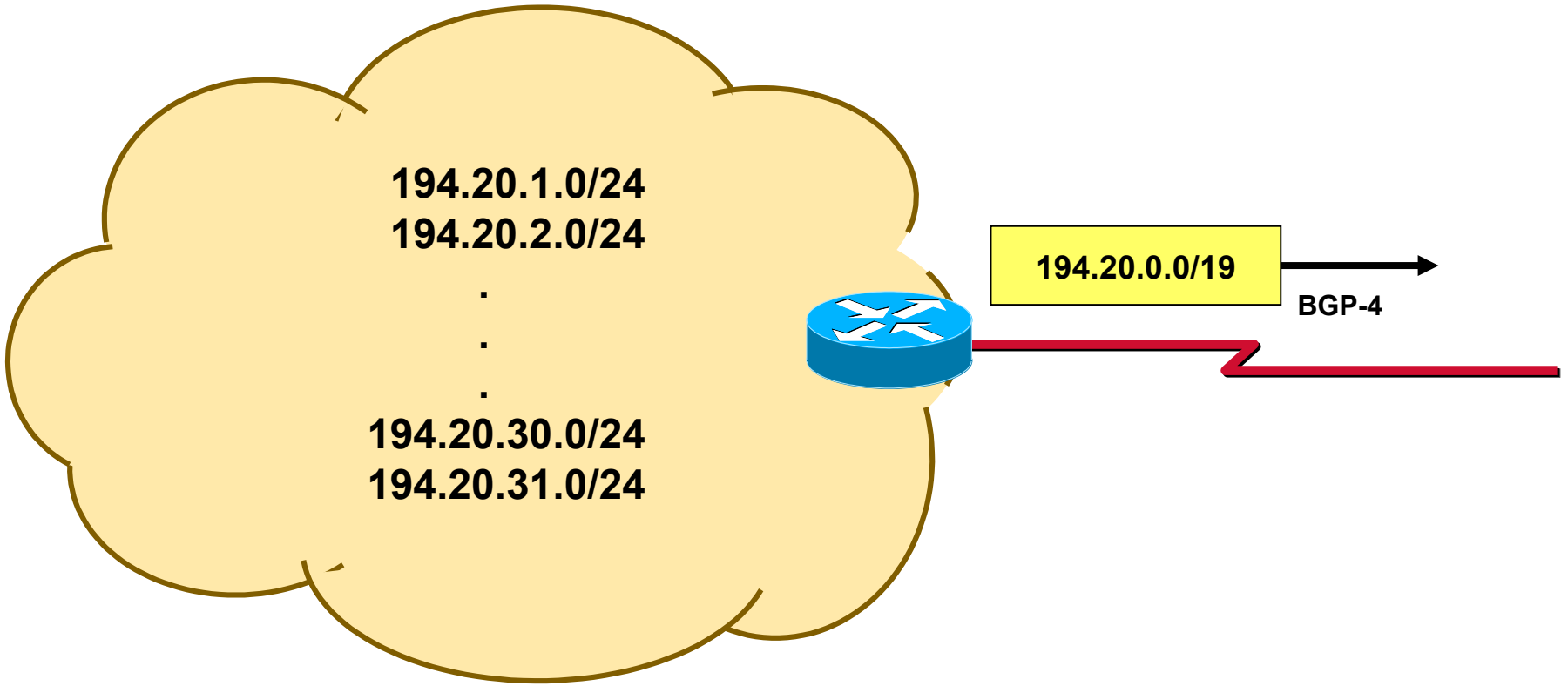


- In 1992: RFC 1338 stated scaling problem:
  - Class B exhaustion
  - No class for typical organizations available
  - Unbearable growth of routing table
- Use subnetting technique also in the Internet !
  - Do hierarchical IP address assignment !
  - Aggregation = "Supernetting"
    (Smaller netmask than natural netmask)

Classful Routing Update



Now Classless and Supernetting



CIDR

- September 1993, RFC 1519: Classless Inter-Domain Routing (CIDR)
- Requires classless routing protocols
  - BGP-3 upgraded to BGP-4
  - New BGP-4 capabilities were drawn on a napkin, with all implementors of significant routing protocols present (legend)
  - RFC 1654

Address Management

- ISPs assign
  contiguous blocks of
  contiguous blocks of
  contiguous blocks ...
  of addresses to their customers
- Aggregation at borders possible !
- Tier I providers filter routes with prefix lengths larger than /19
  - But more and more exceptions today...

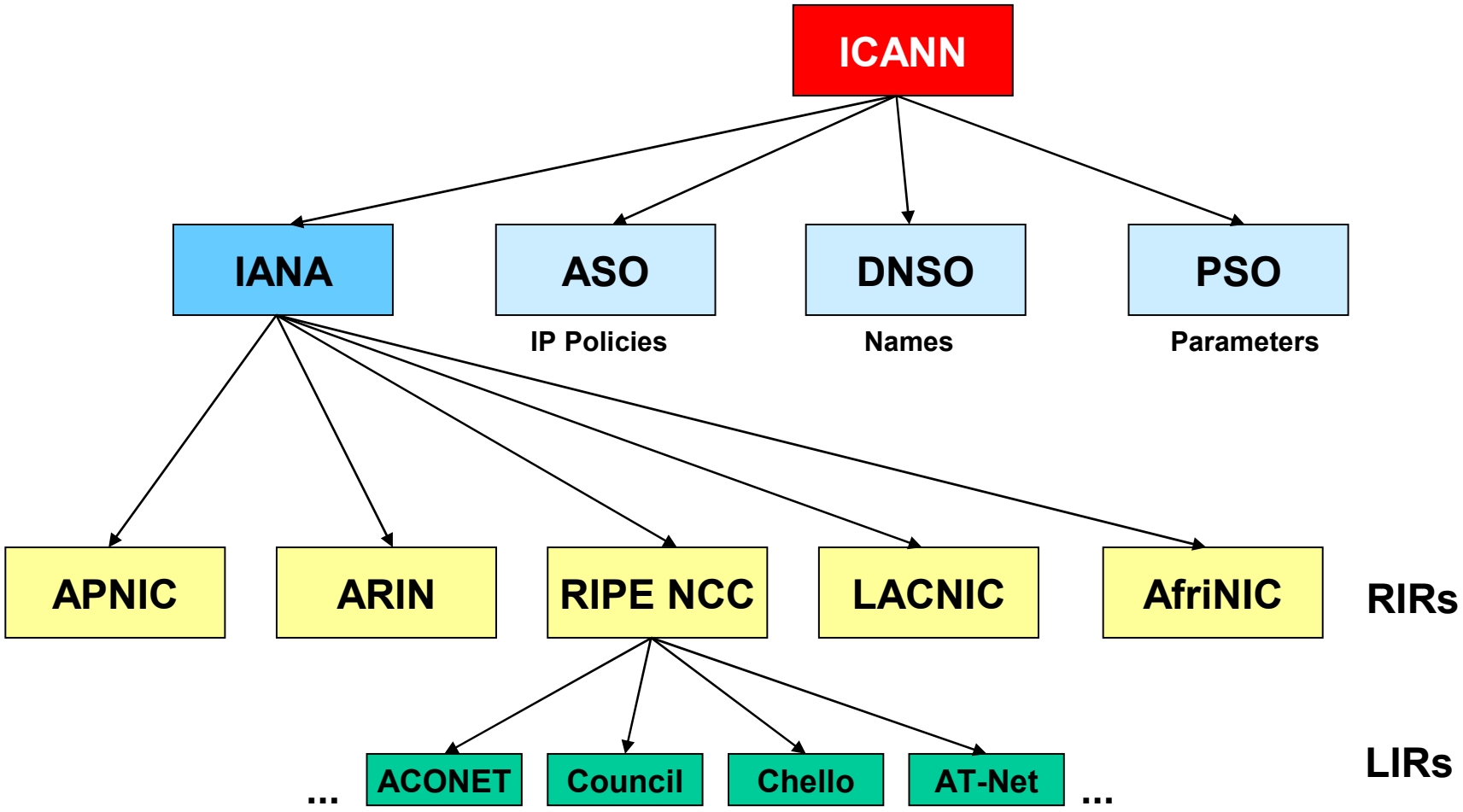
International Address Assignment

- August 1990, RFC 1174 (by IAB) proposed regionally distributed registry model
  - Regionally means continental ;-)
- Regional Internet Registries (RIRs)
  - RIPE NCC
  - APNIC
  - ARIN

RIRs

- RIPE NCC (1992)
  - Réseaux IP Européens (RIPE) founded the Network Coordination Centre (NCC)
- APNIC (1993)
  - Asia Pacific Information Centre
- ARIN (1997)
  - American Registry for Internet Numbers
- AfriNIC
  - Africa
- LACNIC
  - Latin America and Caribbean

ICANN, RIRs, and LIRs



CIDR Concepts Summary

- Coordinated address allocation
- Classless routing
- Supernetting

RFC 1366 Address Blocks

- 192.0.0.0 - 193.255.255.255 ... Multiregional
- 194.0.0.0 - 195.255.255.255 ... Europe
- 198.0.0.0 - 199.255.255.255 ... North America
- 200.0.0.0 - 201.255.255.255 ... Central/South America
- 202.0.0.0 - 203.255.255.255 ... Pacific Rim

Class A Assignment

- IANA responsibility
  - RFC 1366 states: *"There are only approximately 77 Class A network numbers which are unassigned, and these 77 network numbers represent about 30% of the total network number space."*
- 64.0.0.0 – 127.0.0.0 were reserved for the end of (IPv4) days ?
  - Recent assignments (check IANA website)

Class B Assignment

- IANA and RIRs requirements
  - Subnetting plan which documents more than 32 subnets within its organizational network
  - More than 4096 hosts
- RFC 1366 recommends to use multiple Class Cs wherever possible

Class C Assignment

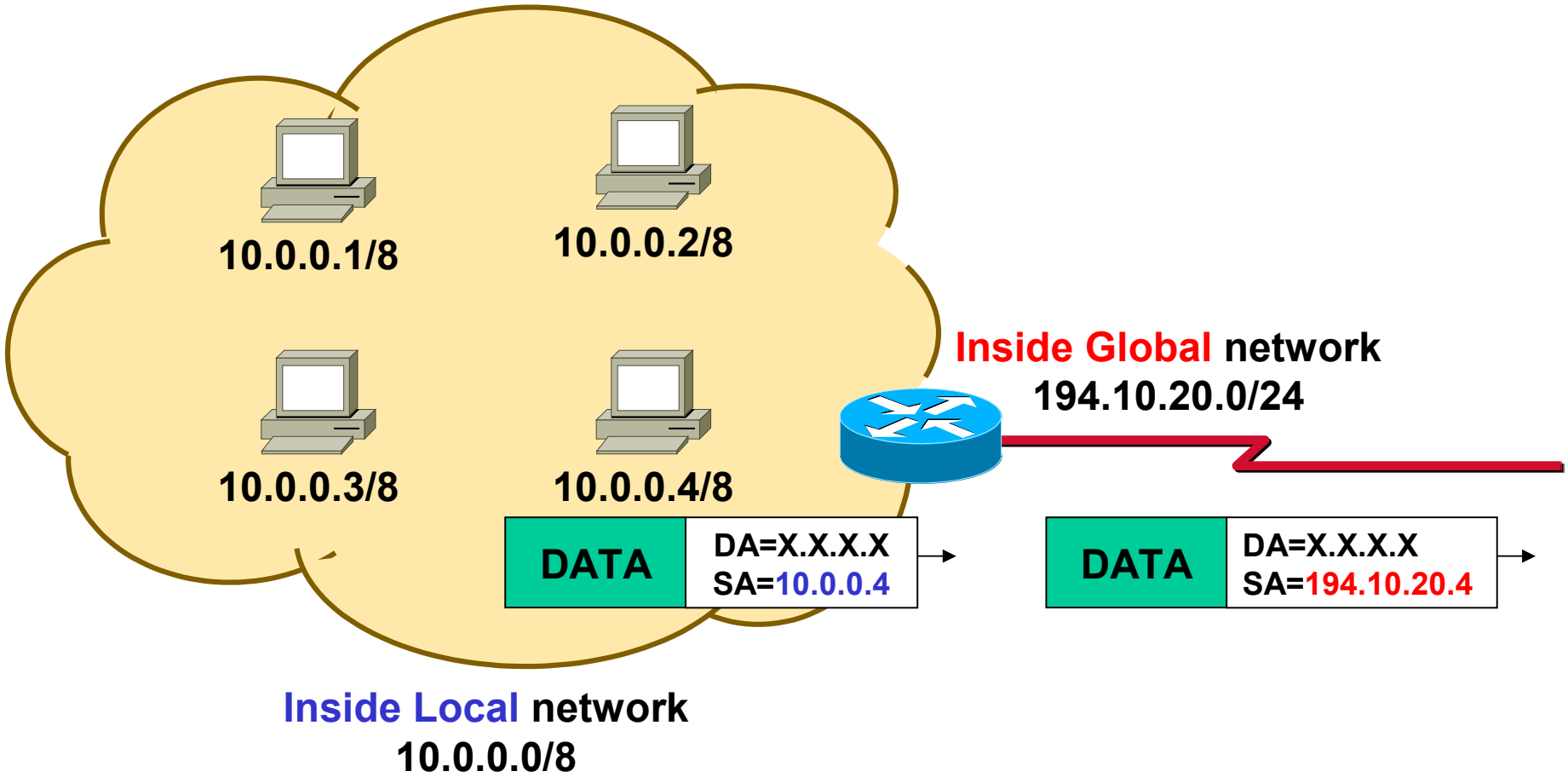
- If an organization requires more than a single Class C, it will be assigned a bit-wise contiguous block from the Class C space
- Up to 16 contiguous Class C networks per subscriber (= one prefix, 12 bit length)

Organization	Assignment
1) requires fewer than 256 addresses	1 class C network
2) requires fewer than 512 addresses	2 contiguous class C networks
3) requires fewer than 1024 addresses	4 contiguous class C networks
4) requires fewer than 2048 addresses	8 contiguous class C networks
5) requires fewer than 4096 addresses	16 contiguous class C networks

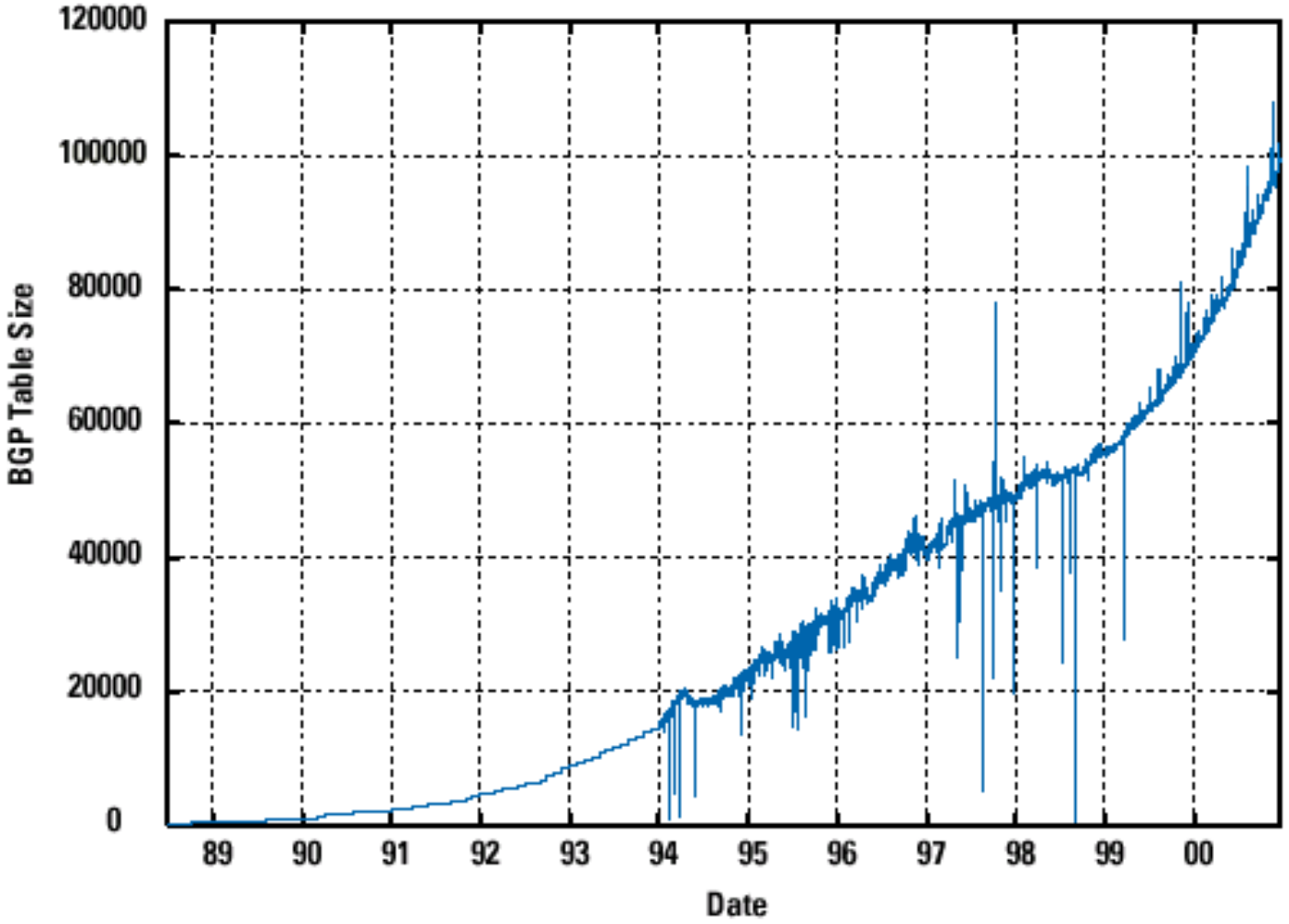
RFC 1918 – Private Addresses

- In order to prevent address space depletion, RFC 1918 defined three private address blocks
  - 10.0.0.0 - 10.255.255.255 (prefix: 10/8)
  - 172.16.0.0 - 172.31.255.255 (prefix: 172.16/12)
  - 192.168.0.0 - 192.168.255.255 (prefix: 192.168/16)
- Connectivity to global space via Network Address Translation (NAT)

NAT Example


10.0.0.1/8
10.0.0.2/8
10.0.0.3/8
10.0.0.4/8
Inside Local network
10.0.0.0/8
Inside Global network
194.10.20.0/24
DATA
DA=X.X.X.X
SA=10.0.0.4
DATA
DA=X.X.X.X
SA=194.10.20.4

But...



Source: www.cisco.com