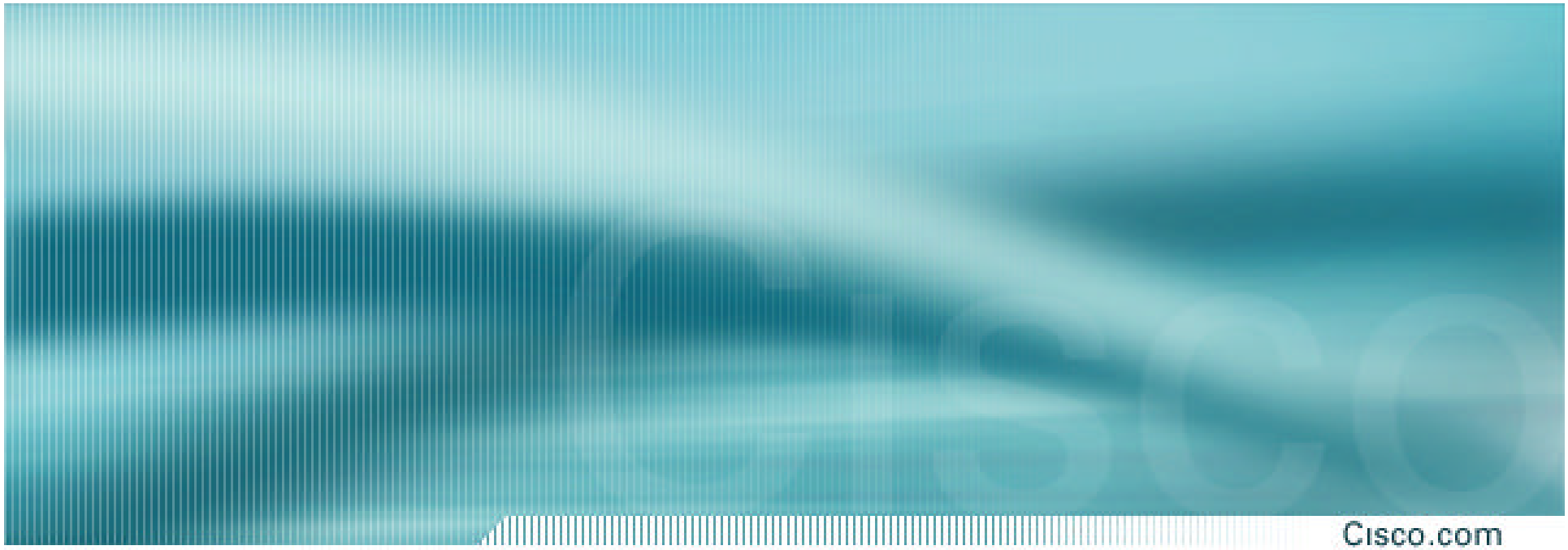

Networking 101

ISP/IXP Workshops

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Network Topology and Definitions

Cisco.com

- Definitions and icons
- Network topologies
- PoP topologies
- Interconnections and IXPs
- IP Addressing
- Gluing it all together

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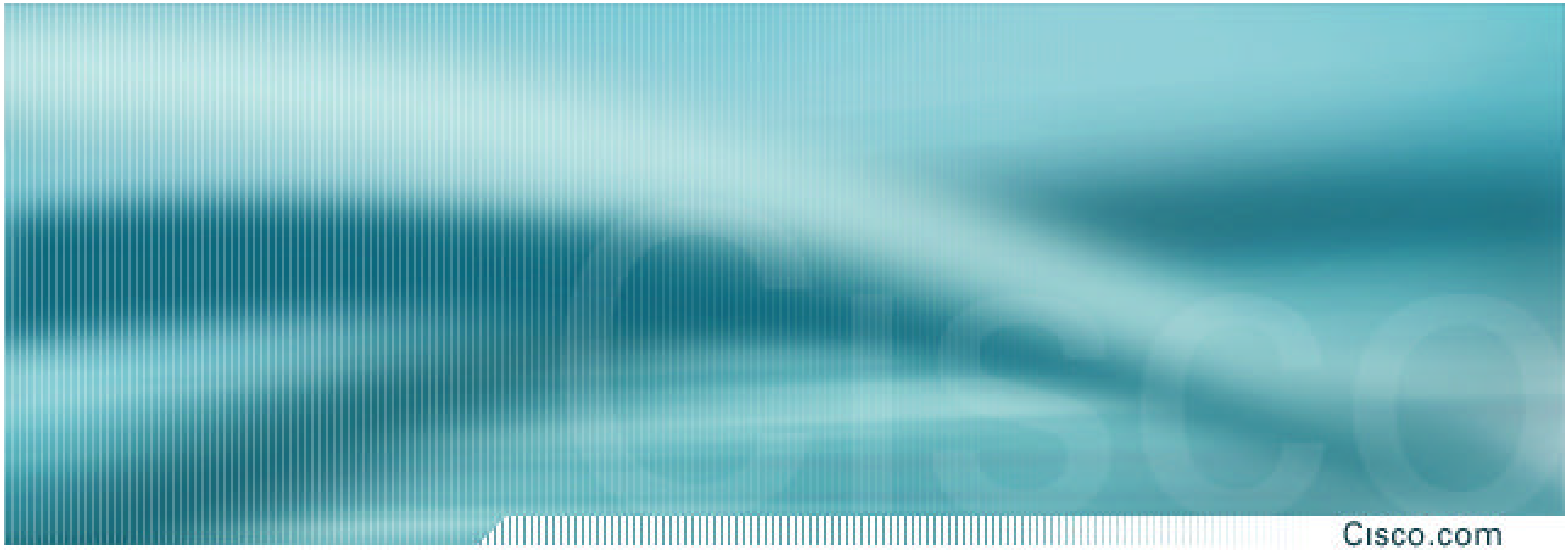

Topologies and Definitions

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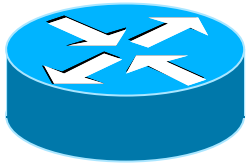
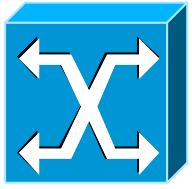
Some Icons

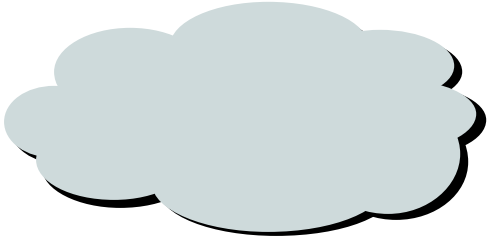


Router
(layer 3, IP datagram forwarding)



ATM or Frame Relay switch
(layer 2, frame or cell forwarding)

Ethernet switch
(layer 2, packet forwarding)



Network Cloud

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Definitions

- **PoP – Point of Presence**

  physical location of ISP's equipment

- **vPoP – virtual PoP**

  apparent ISP location

  in reality a back hauled access point

  used mainly for dial access networks

- **Hub – large central PoP**

  links to many PoPs

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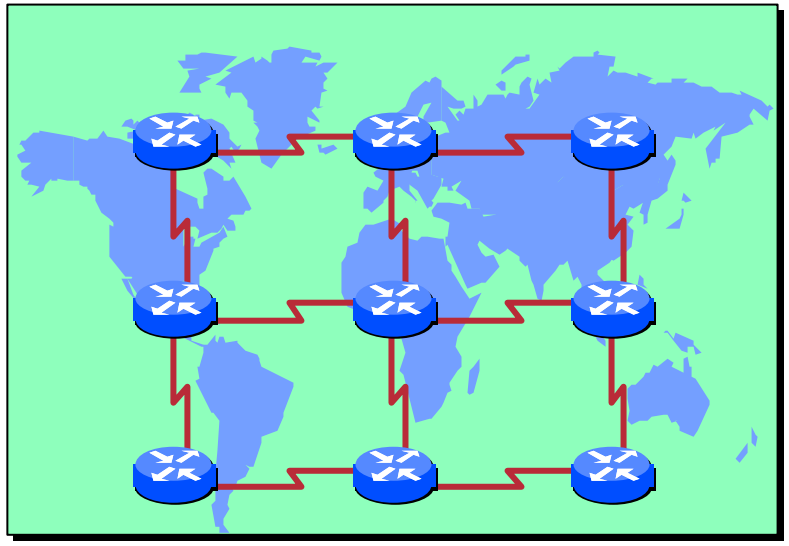
Network Topologies

Routed backbone

- Routers are the infrastructure
- HDLC or PPP links between routers
- Easier routing configuration and debugging



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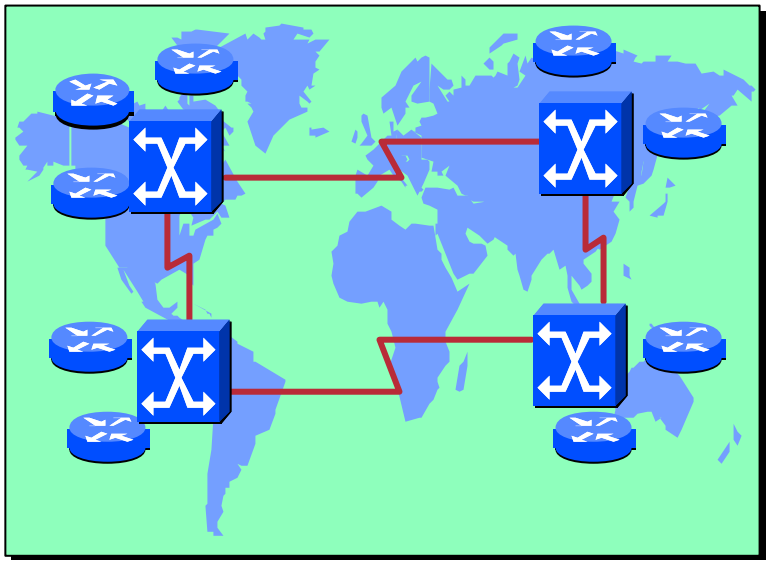
Network Topologies

Switched backbone

- frame relay or ATM
  - switches in the core
  - surrounded by routers
- more complex routing and debugging
- traffic management



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PoP Topologies

- **Core routers – high speed trunk connections**
- **Distribution routers and Access routers – high port density**
- **Border routers – connections to other providers**
- **Service routers – hosting and servers**
- **Some functions might be handled by a single router**

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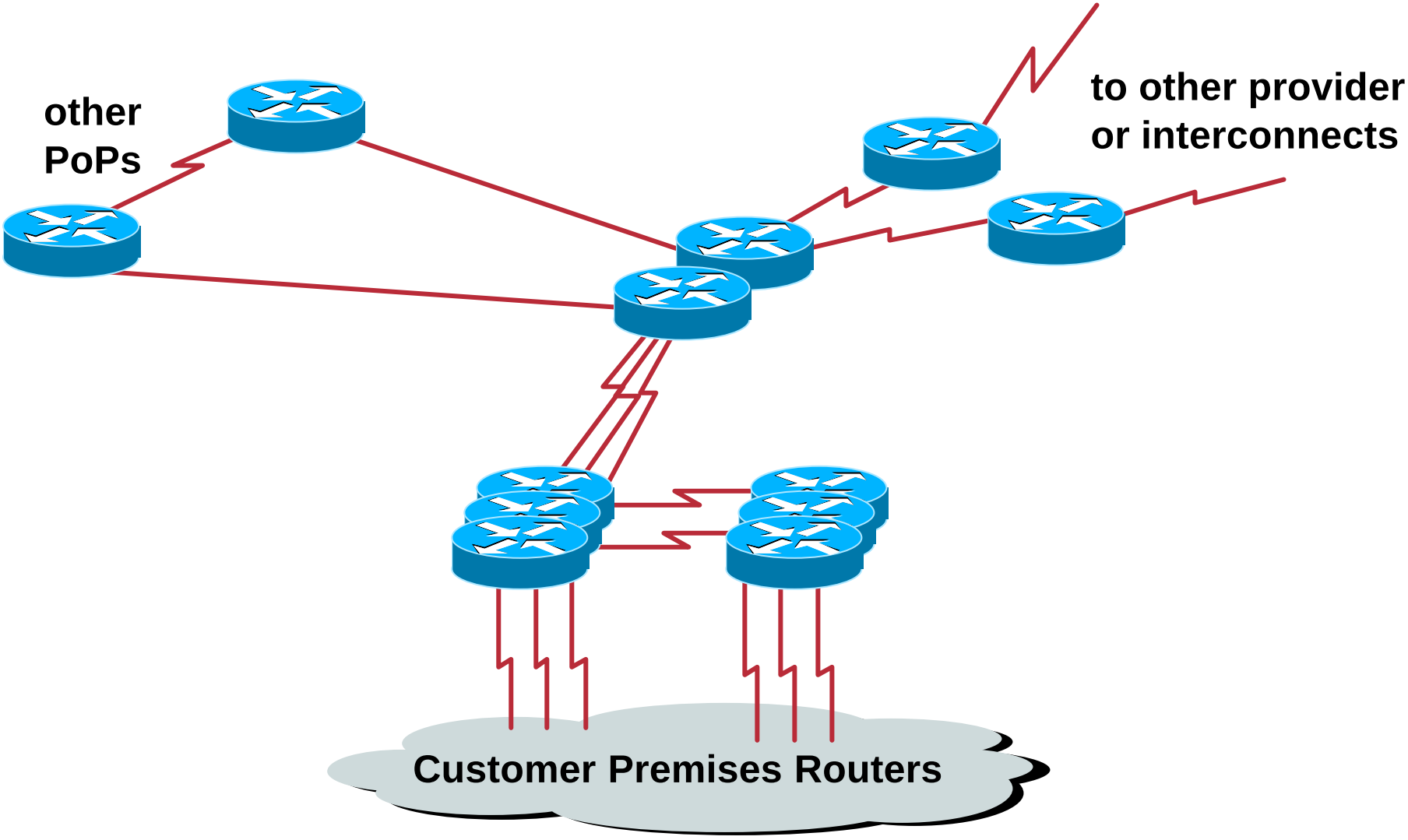
Pure routed PoPs



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Definitions

- **Transit – carrying traffic across a network, usually for a fee**
- **Peering – exchanging routing information and traffic**
- **Default – where to send traffic when there is no explicit match is in the routing table**

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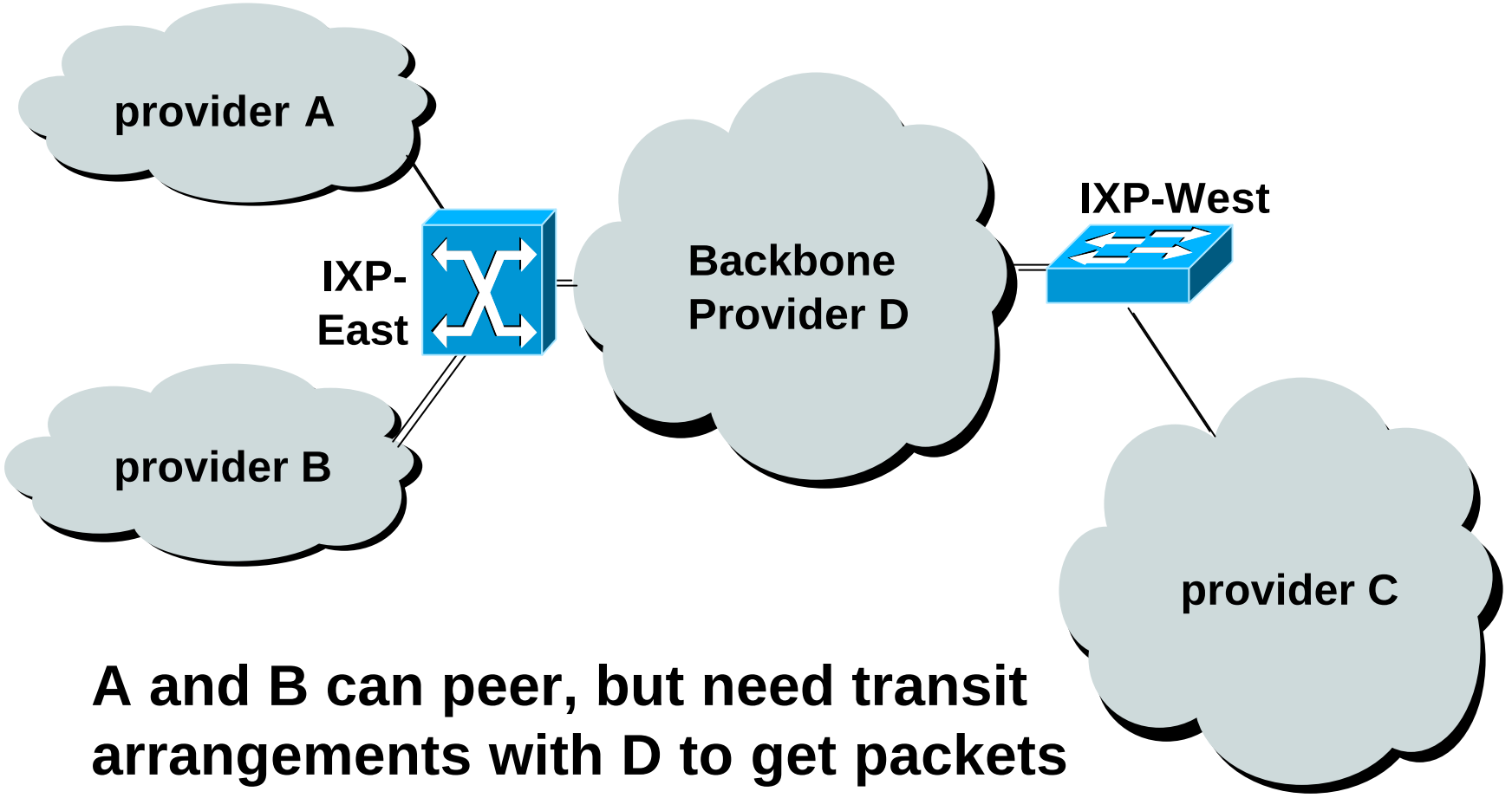
Peering and Transit example



A and B can peer, but need transit arrangements with D to get packets to/from C

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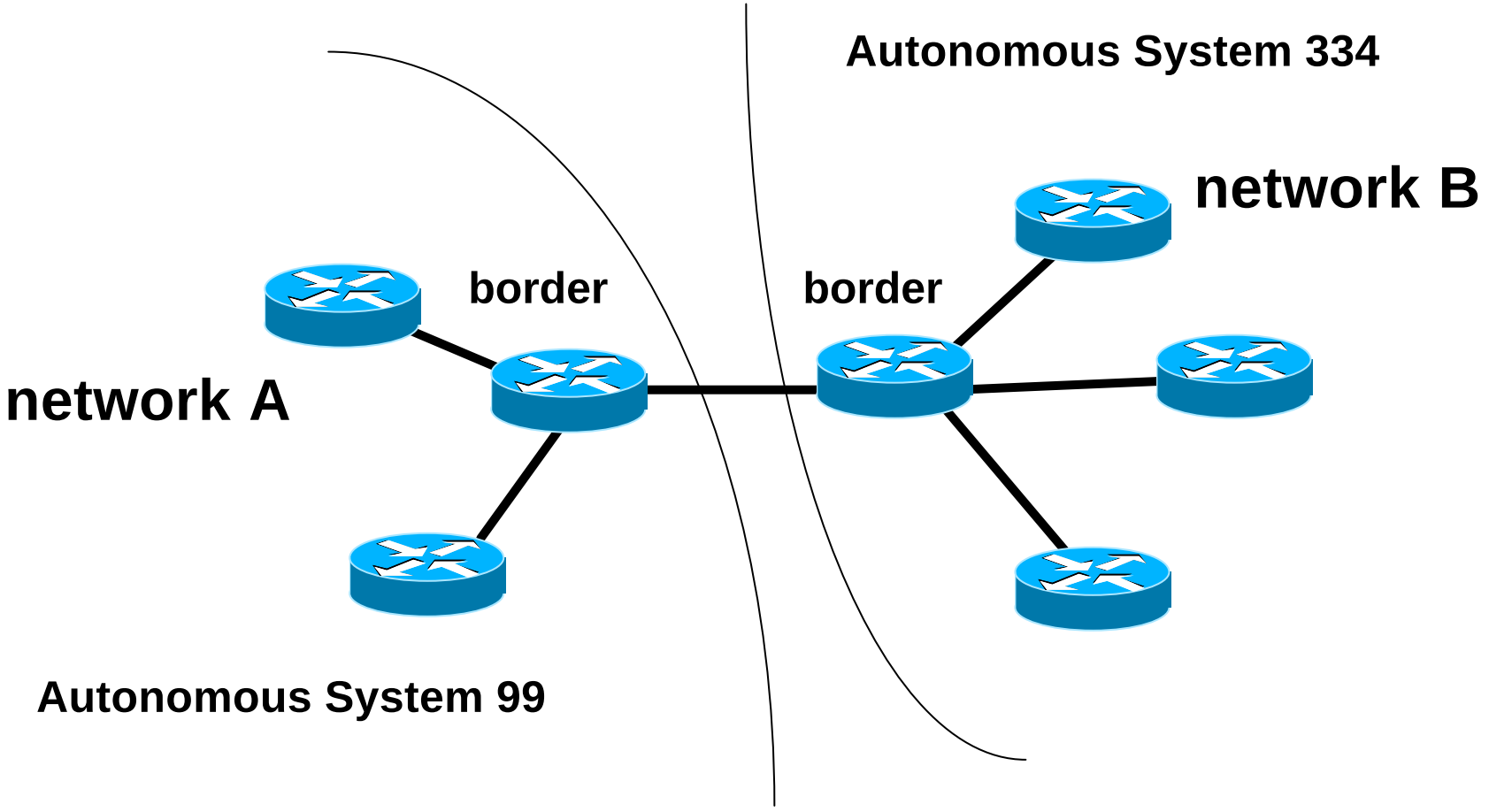
Private Interconnect



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Public Interconnect Points

- **IXP – Internet eXchange Point**
- **NAP – Network Access Point**
- **local IXPs**

  peering point for a group of local/regional providers
- **transit IXPs**

  connects local providers to backbone (transit) providers
- **hybrid IXPs**

  combines the function of local and transit

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Public Interconnect Point

- Centralised (in one facility)
- Distributed (connected via WAN links)
- Shared, switched or routed interconnect
  - Router, FDDI, Ethernet, ATM, Frame relay, SMDS, etc.
- Each provider establishes relationship with other provider at IXP
  - ISP border router peers with all other provider border routers

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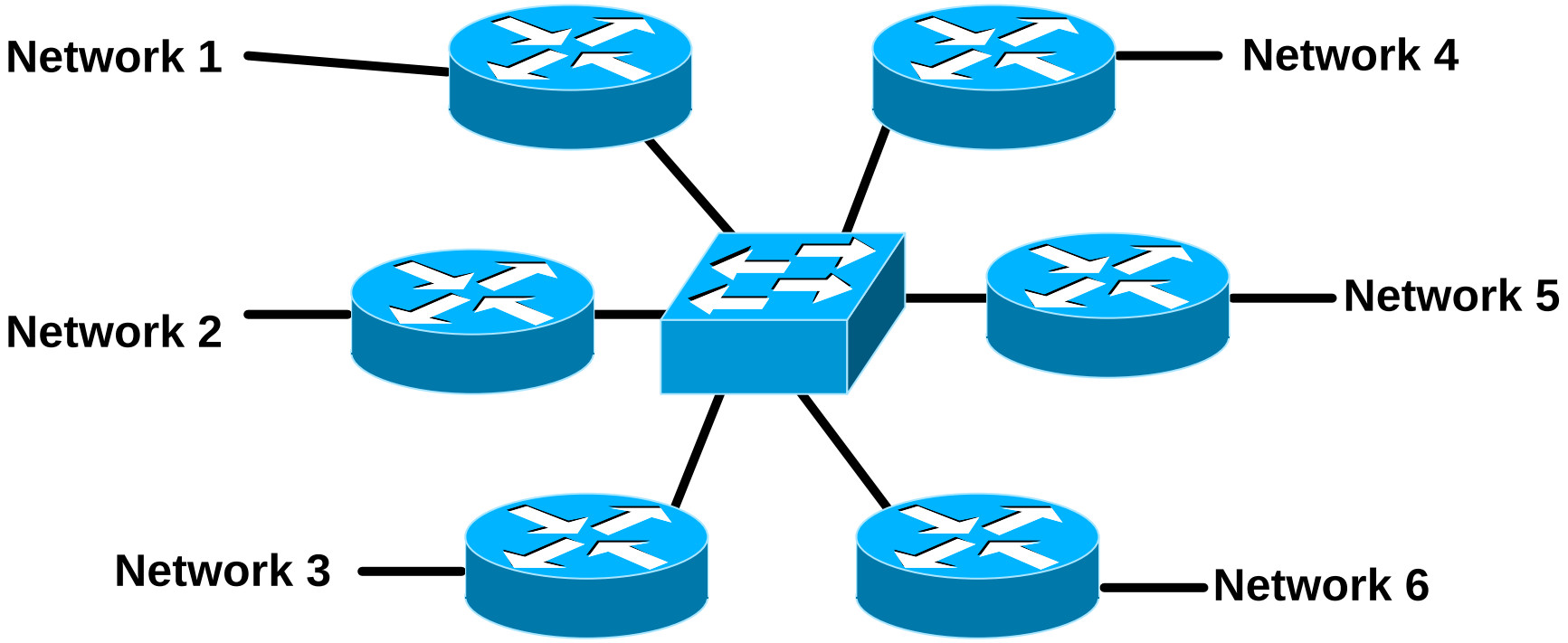
Public Interconnect



each of these represents a border router in a different autonomous system

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Route Server

- **Advantages:**

  reduces resource burden on border routers (CPU, memory, configuration complexity)

  reduces administrative burden on providers

- **Disadvantages:**

  must rely on a third party (for management, configuration, software updates, maintenance, etc)

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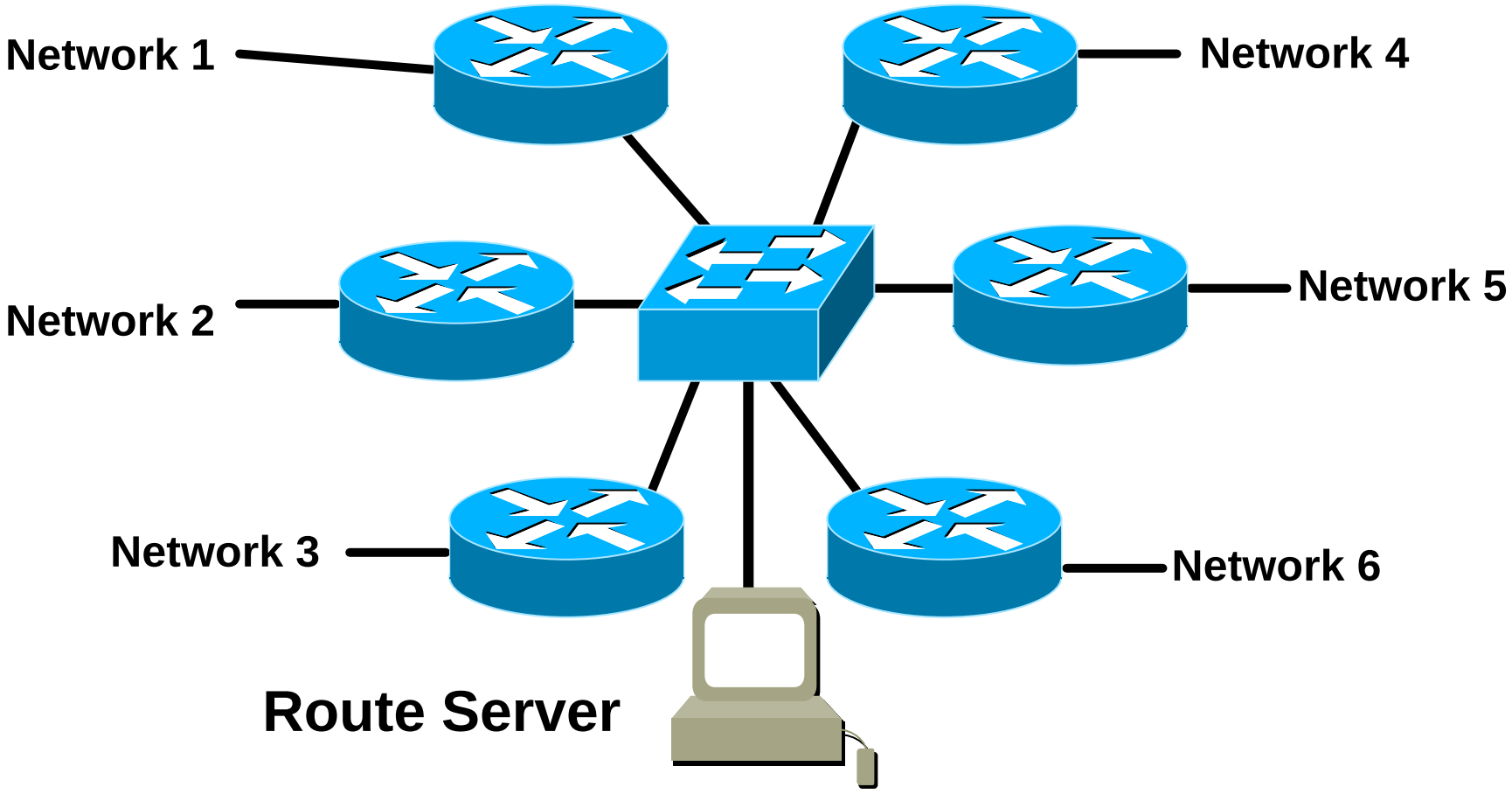
Route Server



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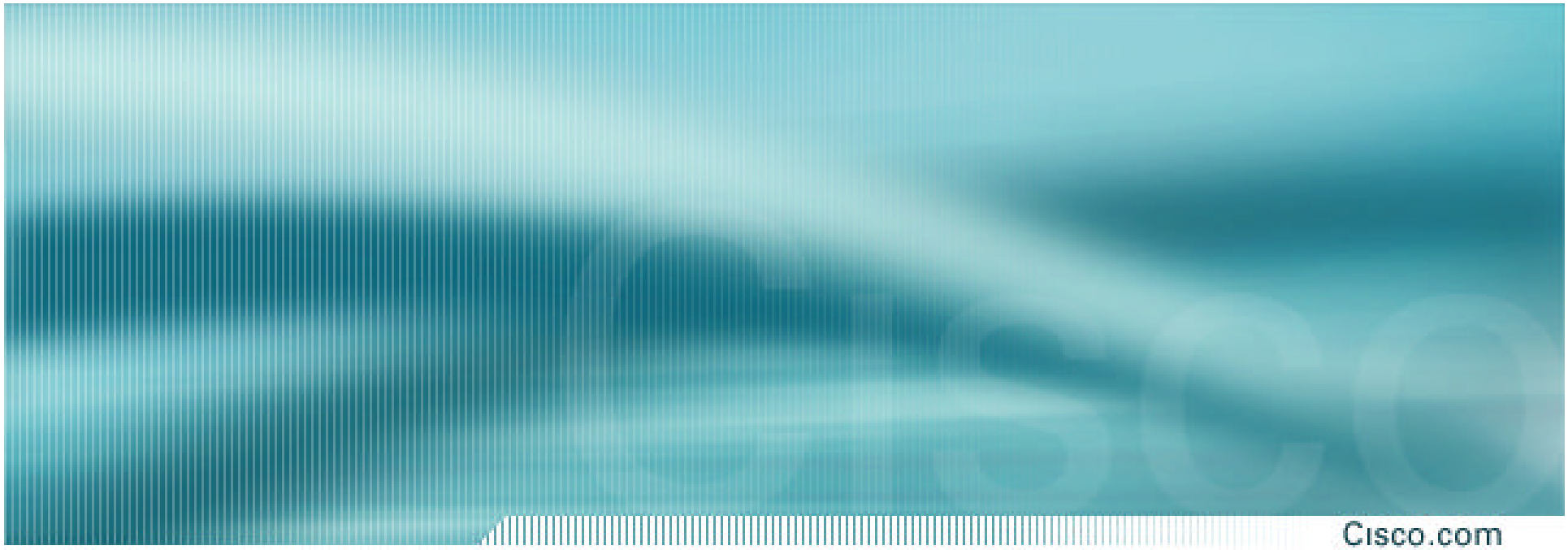

IP Addressing

Where to get address space and who from

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IP Addressing

- Internet is classless
- Concept of Class A, class B or class C is no more

  engineers talk in terms of prefix length, for example the class B 158.43 is now called 158.43/16.

- All routers must be CIDR capable

  Classless InterDomain Routing

  RFC1812 – Router Requirements

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IP Addressing

- **Pre-CIDR (<1994)**

  big networks got a class A

  medium networks got a class B

  small networks got a class C

- **Nowadays**

  allocations/assignments made according to demonstrated need – CLASSLESS

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IP Addressing

- IPv4 Address space is a resource shared amongst all Internet users
  - Regional Internet Registries delegated allocation responsibility by the IANA
  - APNIC, ARIN, LACNIC & RIPE NCC are the four RIRs
  - RIRs allocate address space to ISPs and Local Internet Registries
  - ISPs/LIRs assign address space to end customers or other ISPs
- 55% of available IPv4 address space used

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Definitions

- **Non-portable – ‘provider aggregatable’ (PA)**
  - **Customer uses RIR member’s address space while connected to Internet**
  - **Customer has to renumber to change ISP**
  - **Aids control of size of Internet routing table**
  - **May fragment provider block when multihoming**
- **PA space is allocated to the RIR member with the requirement that all assignments made by the RIR member to end sites are announced as an aggregate to the rest of the Internet**

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Definitions

- **Portable – ‘provider independent’ (PI)**
  - **Customer gets or has address space independent of ISP**
  - **Customer keeps addresses when changing ISP**
  - **Bad for size of Internet routing table**
  - **PI space is rarely distributed by the RIRs**

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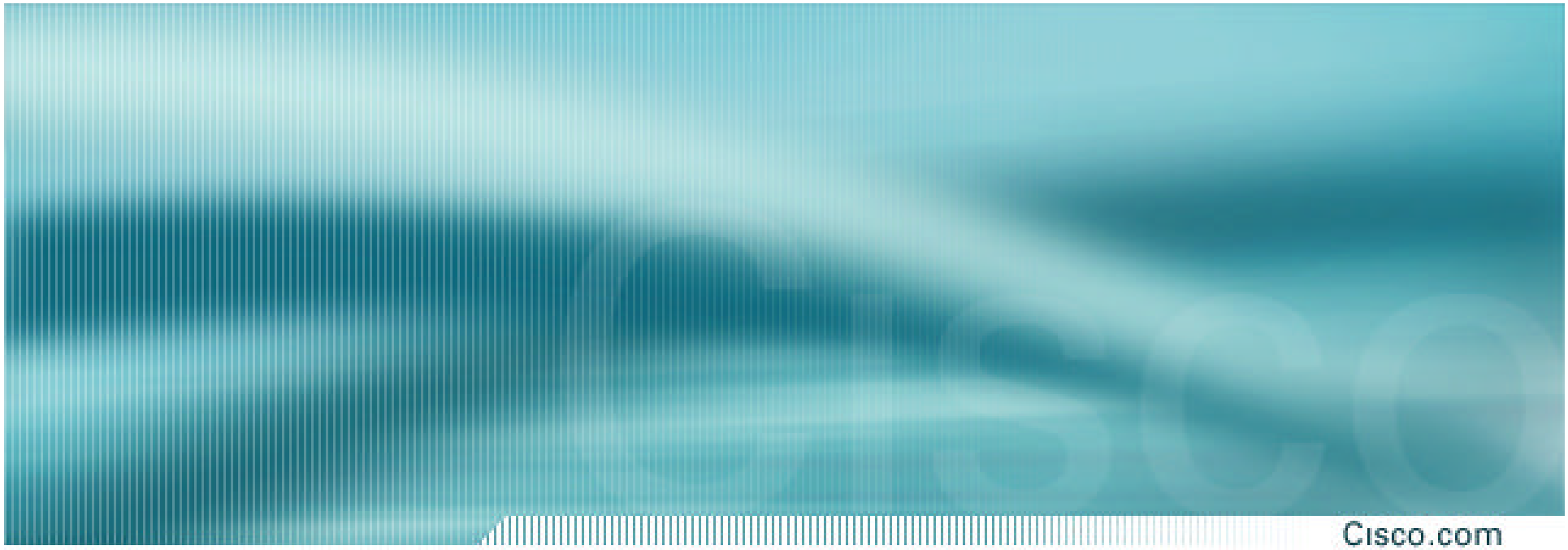

Internet Hierarchy

The pecking order

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Default Free Zone

The default free zone is made up of Internet routers which have explicit routing information about the rest of the Internet, and therefore do not need to use a default route.

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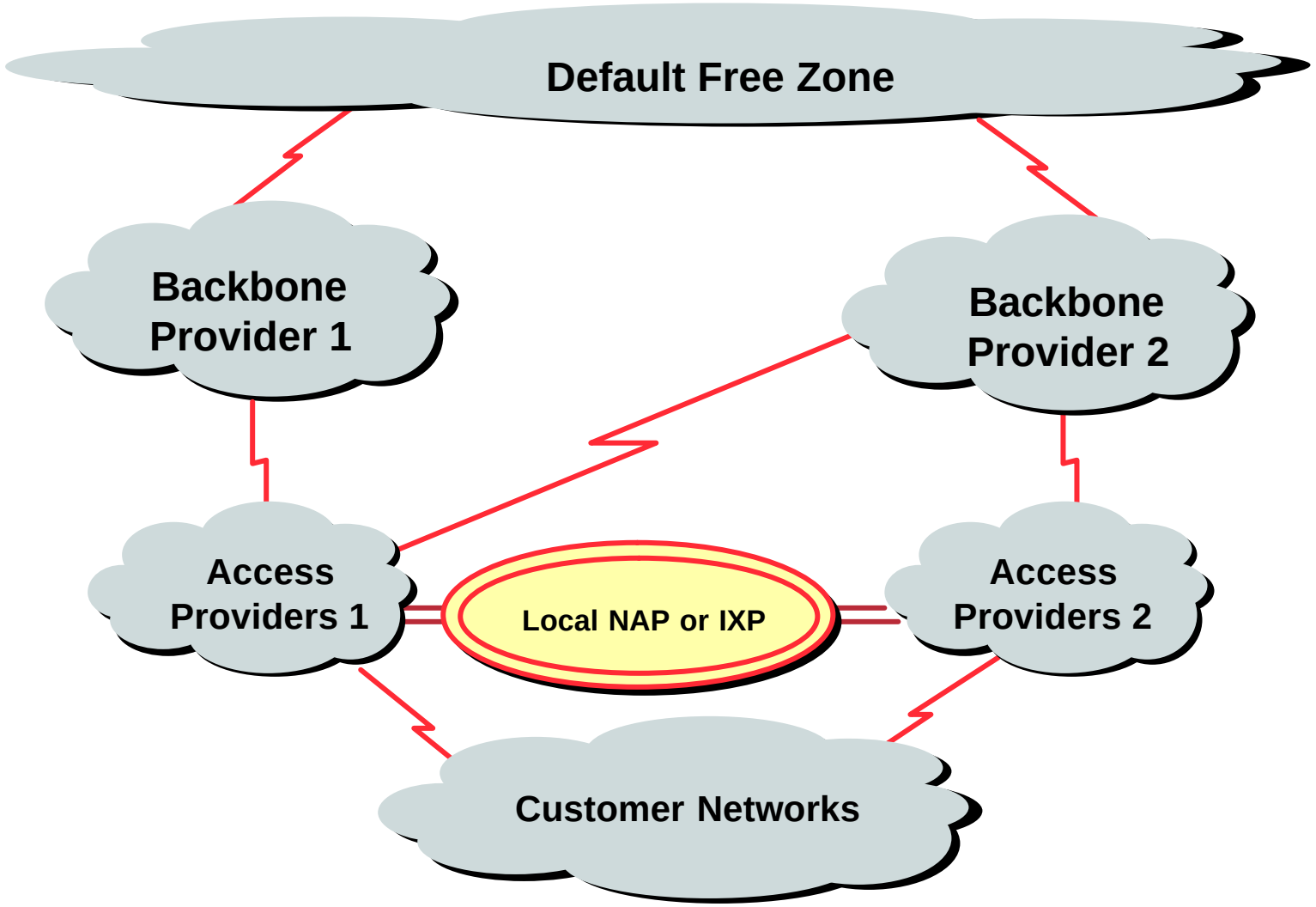
High Level View of the Global Internet



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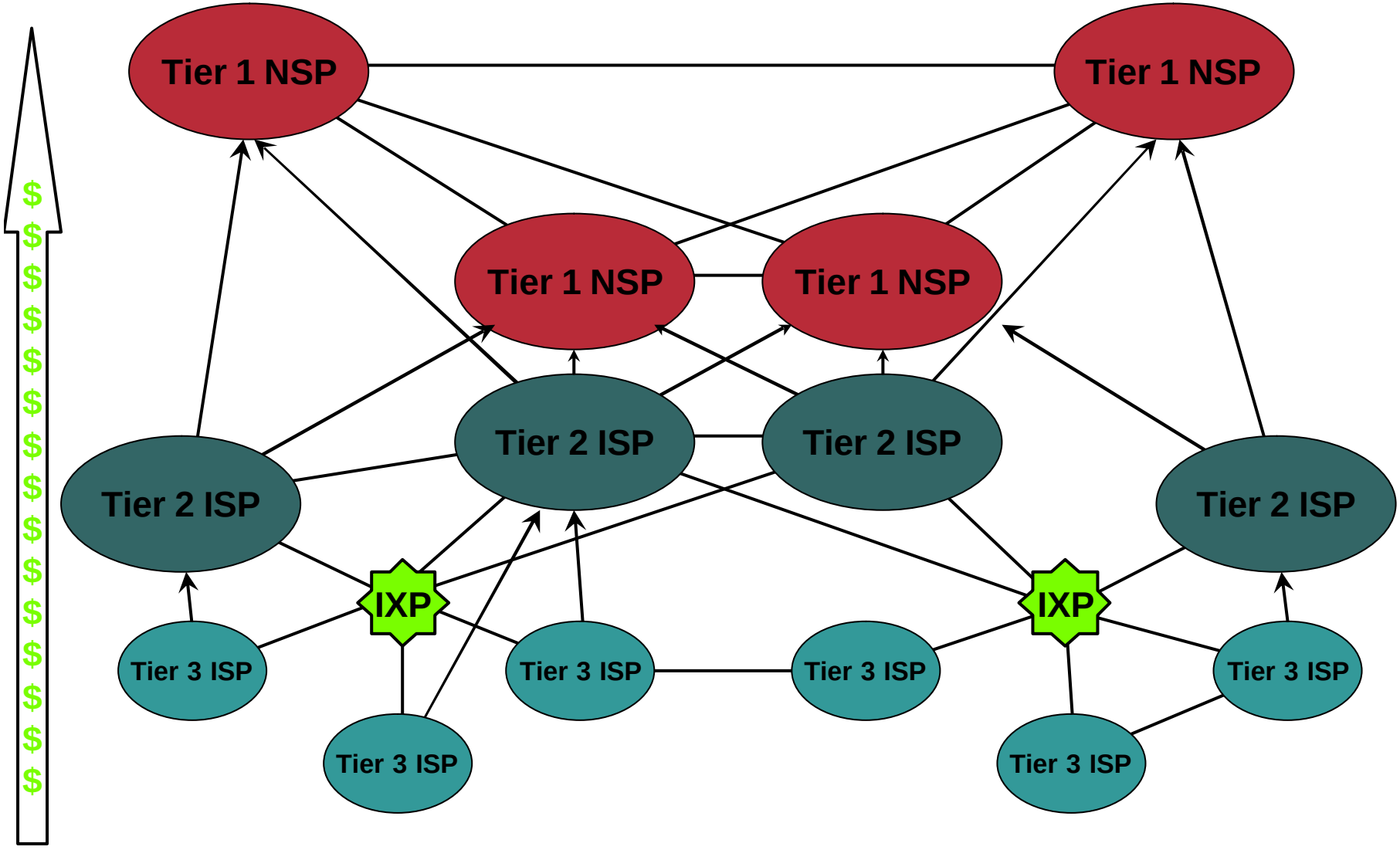
Categorising ISPs



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Inter-provider relationships

- **Peering between equivalent sizes of service providers (e.g. Tier 2 to Tier 2)**
  - **shared cost private interconnection, equal traffic flows**
  - **“no cost peering”**
- **Peering across exchange points**
  - **if convenient, of mutual benefit, technically feasible**
- **Fee based peering**
  - **unequal traffic flows, “market position”**

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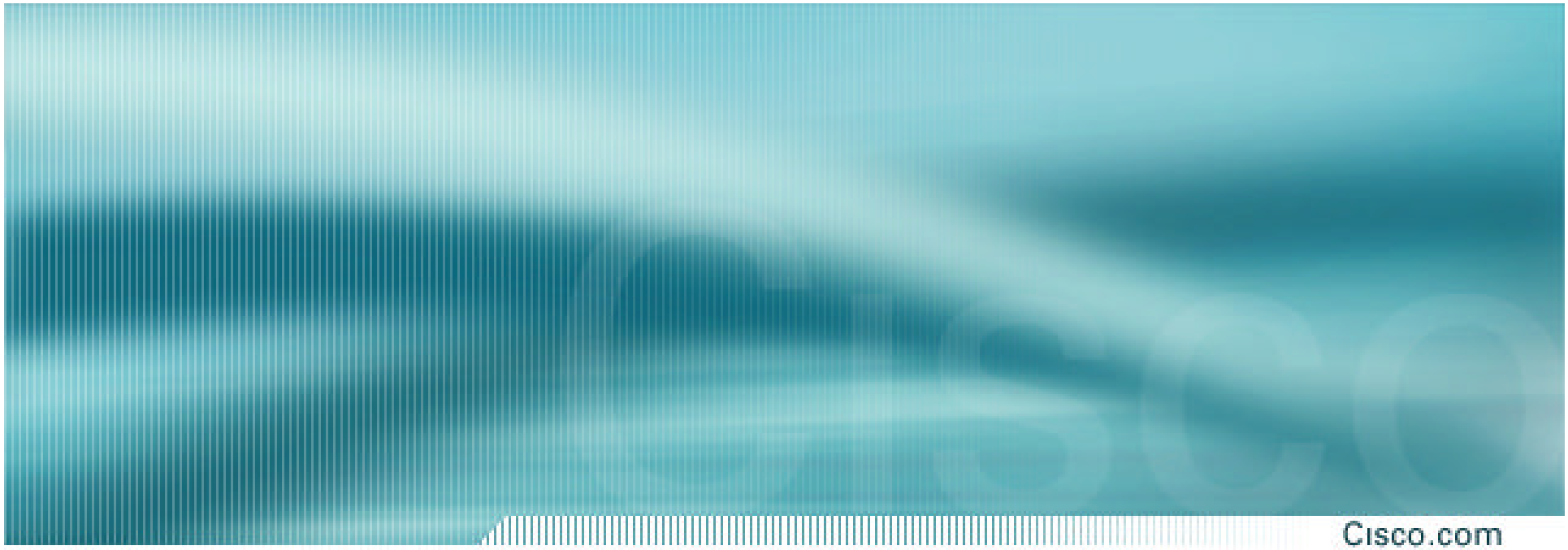

Gluing it together

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Gluing it together

- **Who runs the Internet?**
  - **No one**
- **How does it keep working?**
  - **It just does – inter provider business relationships and the need for customer reachability ensures that the Internet by and large functions for the common good**
- **Any facilities to help keep it working**
  - **Internet Routing Registry (?)**
  - **Engineers keep talking to each other!**

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Engineers keep talking to each other...

- NANOG meetings and mail list
  - North American Network Operators Group
- RIPE meetings, working groups and mailing lists
- IETF meetings and mailing lists
- APOPS and APNIC-TALK mailing lists
  - APRICOT annual conference
- AfNOG meetings and mailing list
- And many other in-country ISP associations

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Internet Routing Registry

- **Distributed authoritative global routing policy database**
  - **databases run by three regional internet registries are part of the IRR**
  - **RADB run by Merit is part of the IRR**
  - **some SPs run their own Routing Registries, either isolated, or as part of the IRR**

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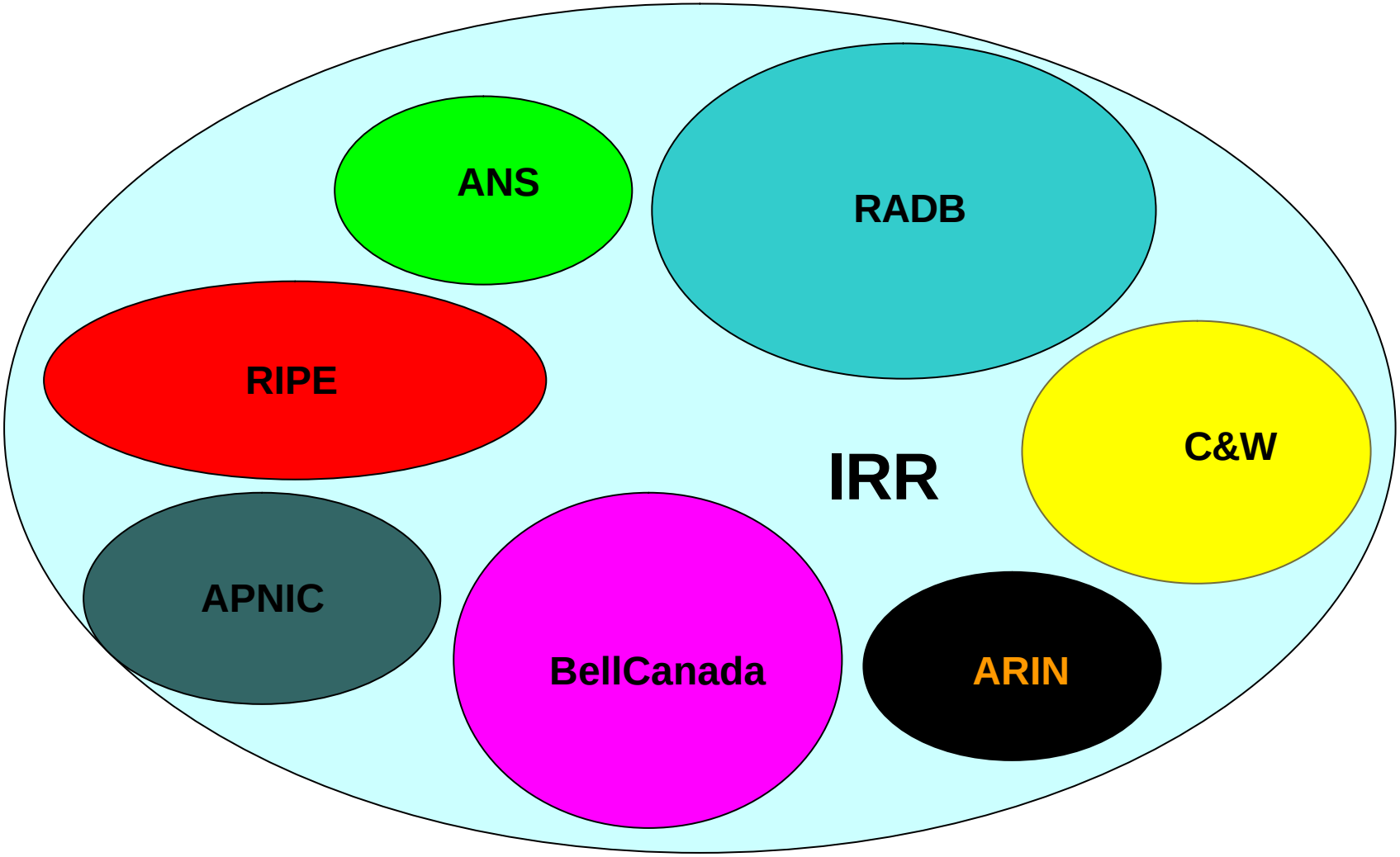
Entities of the IRR



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IRR

- Repository of routing policy information
- Used by many ISPs for configuring peering relationships with each other
  - helps with complex relationships
  - helps with debugging network problems
- Adoption is stronger in some regions (Europe) than in others

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Summary

- **Network Topologies and Definitions**
- **IP Addressing**
  - **PI versus PA address space**
- **Gluing it all together**
  - **Engineers co-operate**

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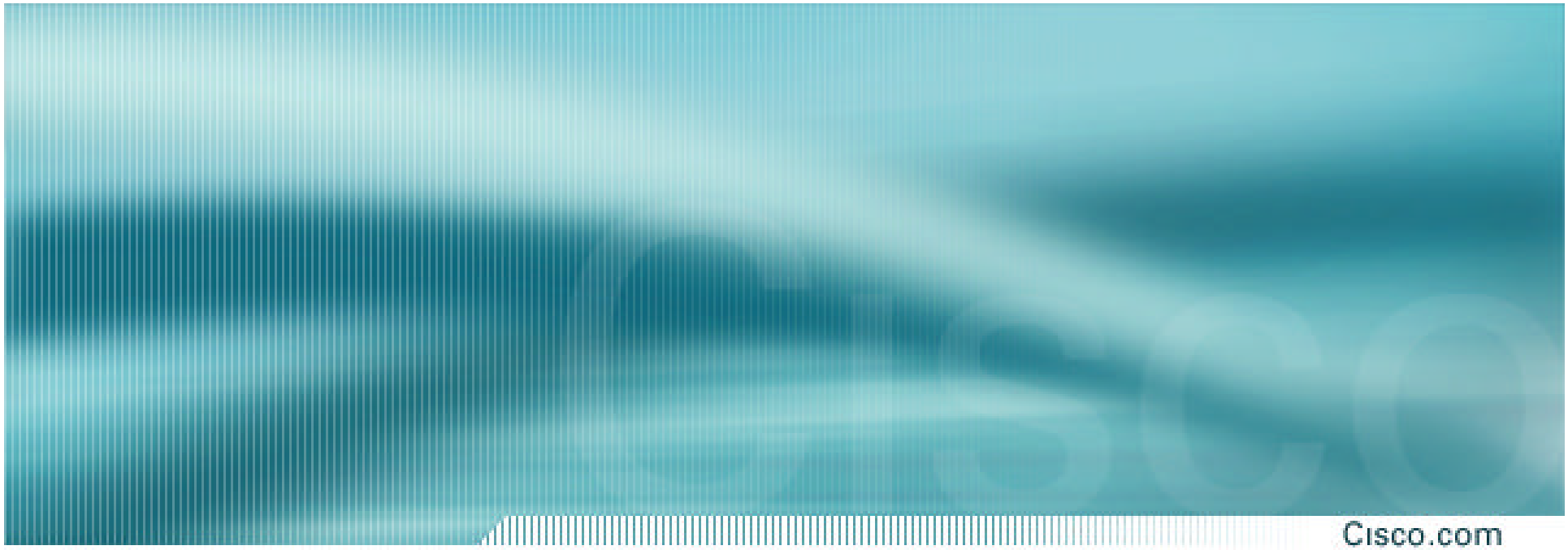

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