



Introduction to The Internet

ISP/IXP Workshops

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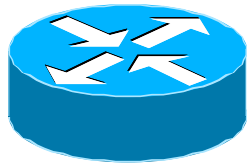
- Topologies and Definitions
- IP Addressing
- Internet Hierarchy
- Gluing it all together



Topologies and Definitions

What does all the jargon mean?

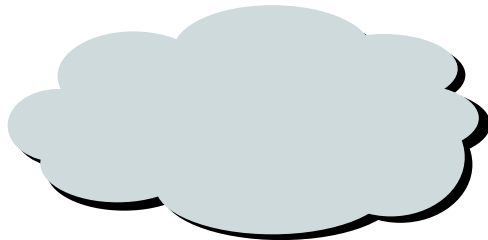
Some Icons...



Router
(layer 3, IP datagram forwarding)



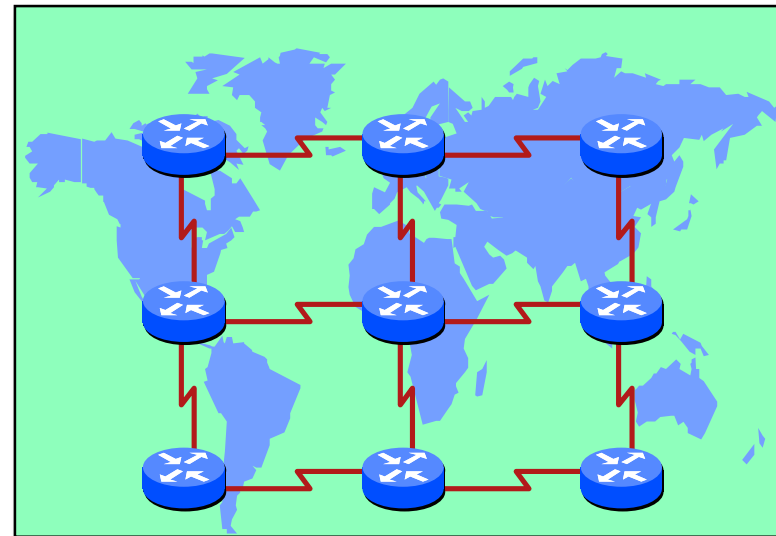
Ethernet switch
(layer 2, packet forwarding)



Network Cloud

Routed Backbone

- Routers are the infrastructure
- Physical circuits run between routers
- Easy routing configuration, operation and troubleshooting
- The dominant topology used in the Internet today
- Multi Protocol Label Switching (MPLS) built on top of router infrastructure
 - Used by some ISPs & Telcos to replace old ATM technology



Points of Presence

- PoP – Point of Presence

Physical location of ISP's equipment

Sometimes called a “node”

- vPoP – virtual PoP

To the end user, it looks like an ISP location

In reality a back hauled access point

Used mainly for consumer access networks

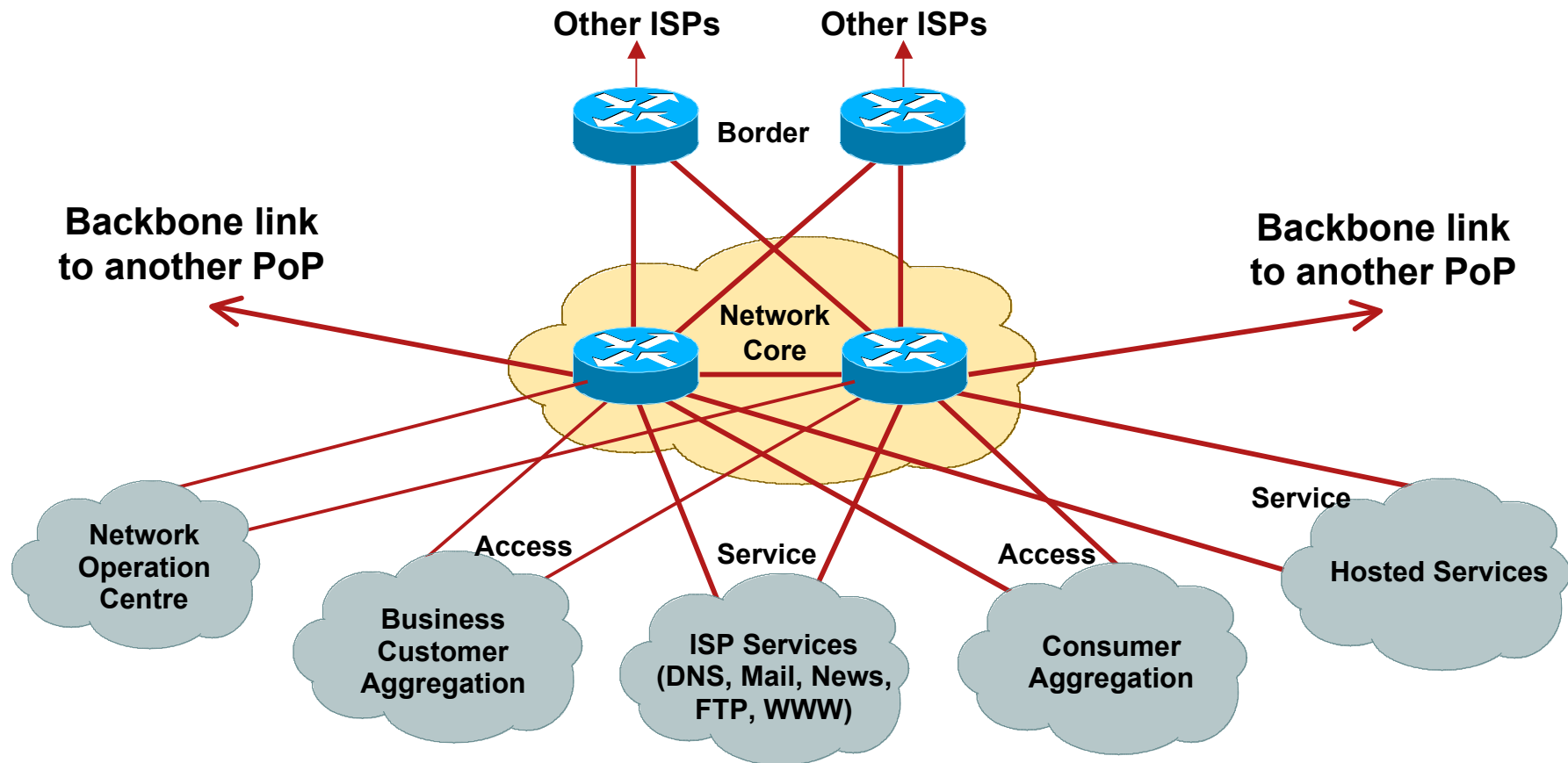
- Hub/SuperPoP – large central PoP

Links to many PoPs

PoP Topologies

- **Core** routers
high speed trunk connections
- **Distribution** routers
higher port density, aggregating network edge to the network core
- **Access** routers
high port density, connecting the end users to the network
- **Border** routers
connections to other providers
- **Service** routers
hosting and servers
- Some functions might be handled by a single router

Typical PoP Design



More Definitions

- **Transit**

Carrying traffic across a network

Usually **for a fee**

- **Peering**

Exchanging routing information and traffic

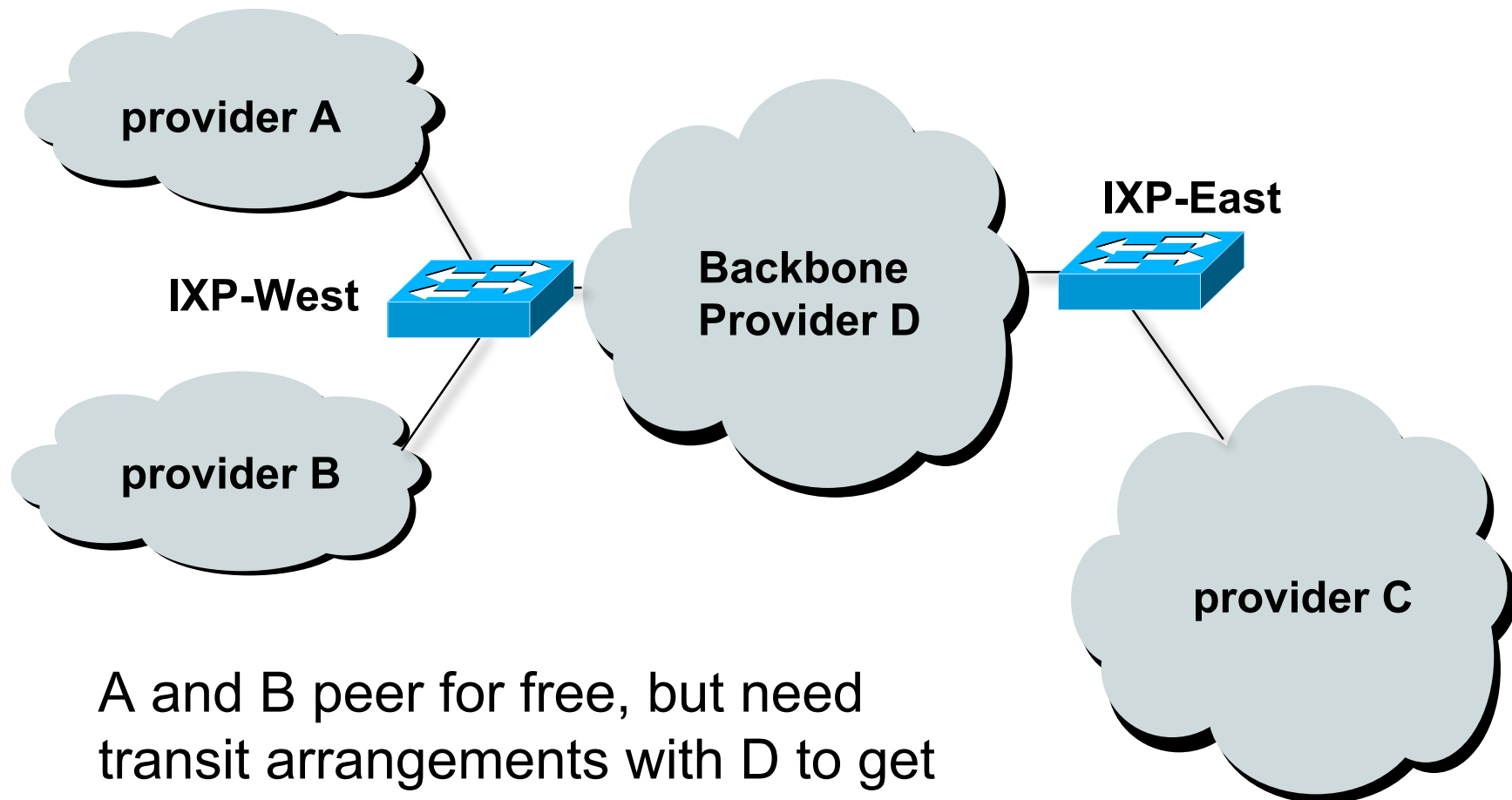
Usually **for no fee**

Sometimes called **settlement free peering**

- **Default**

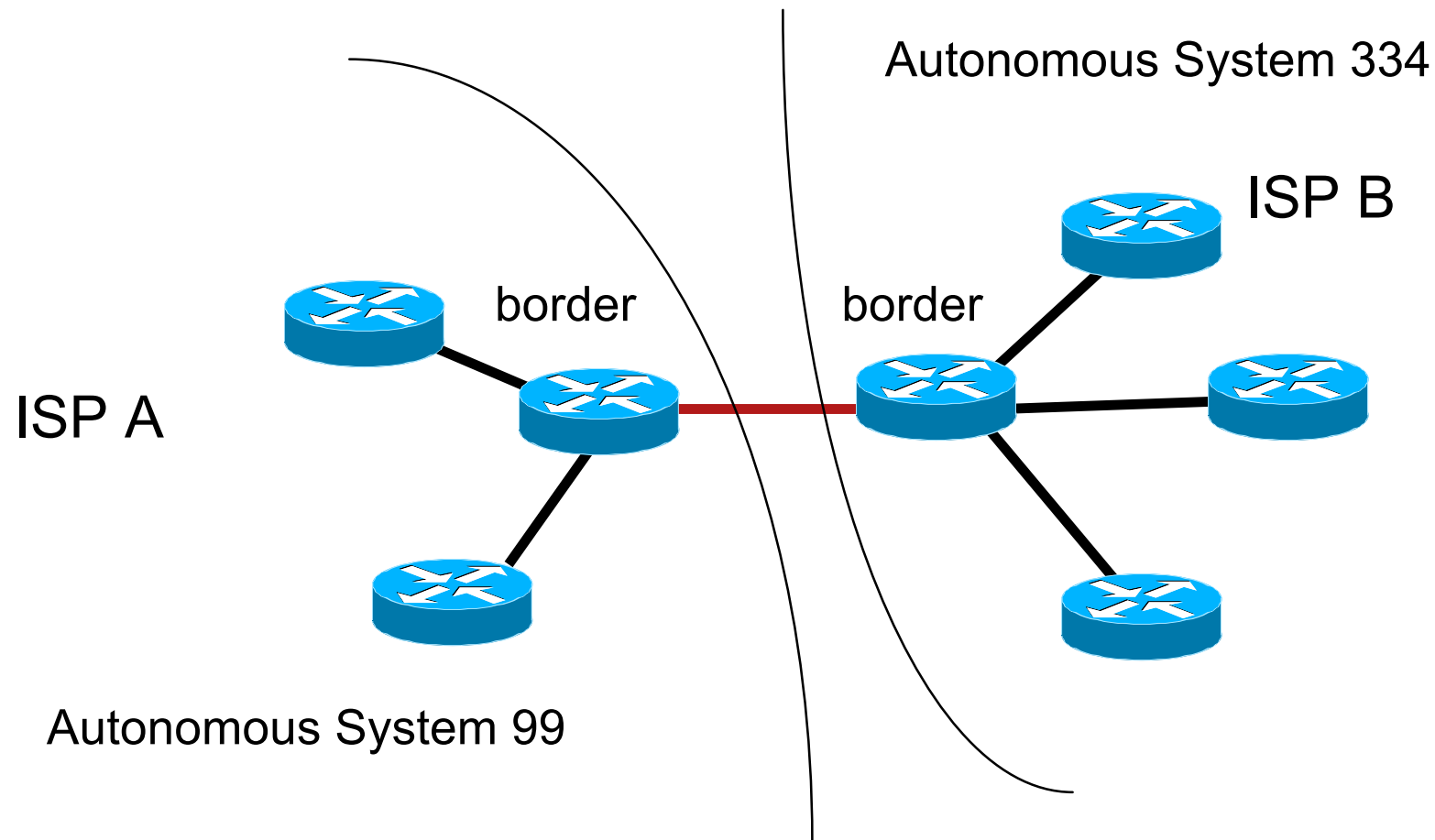
Where to send traffic when there is no explicit match in the routing table

Peering and Transit example



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

Private Interconnect



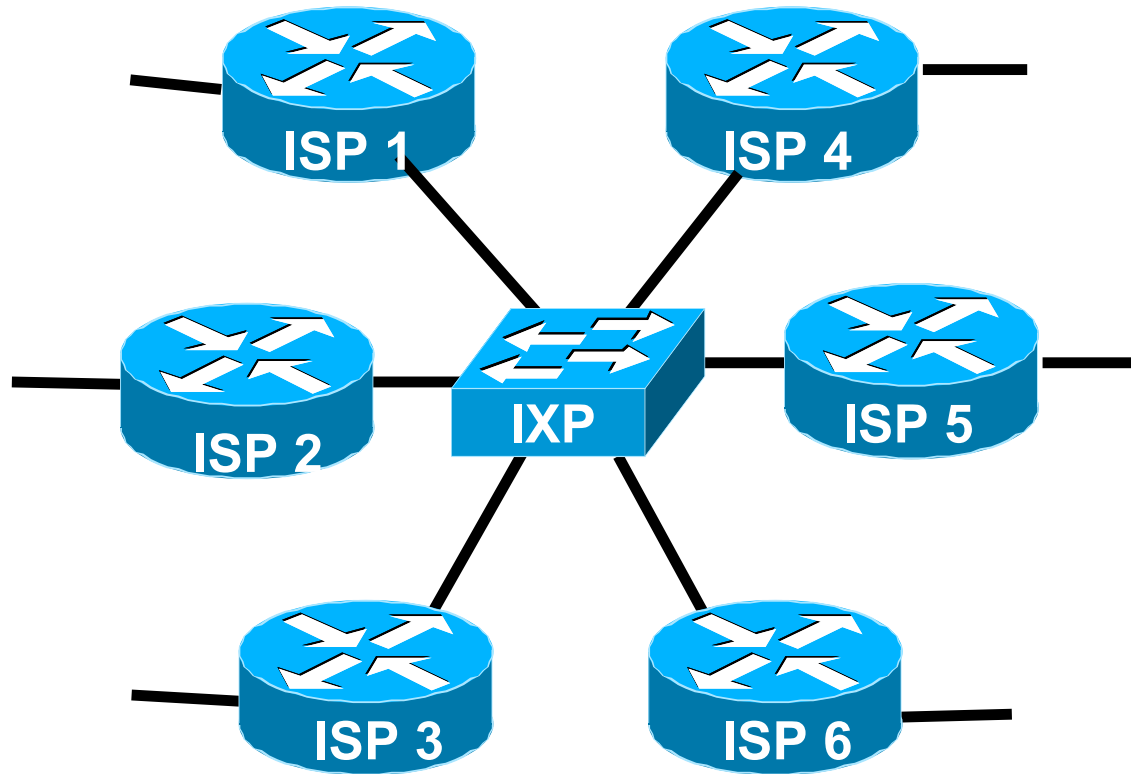
Public Interconnect

- A location or facility where several ISPs are present and connect to each other over a common shared media
- Why?
 - To save money, reduce latency, improve performance
- IXP – Internet eXchange Point
- NAP – Network Access Point

Public Interconnect

- Centralised (in one facility)
- Distributed (connected via WAN links)
- Switched interconnect
 - Ethernet (Layer 2)
 - Technologies such as SRP, FDDI, ATM, Frame Relay, SMDS and even routers have been used in the past
- Each provider establishes **peering** relationship with other providers at IXP
 - ISP border router peers with all other provider border routers

Public Interconnect

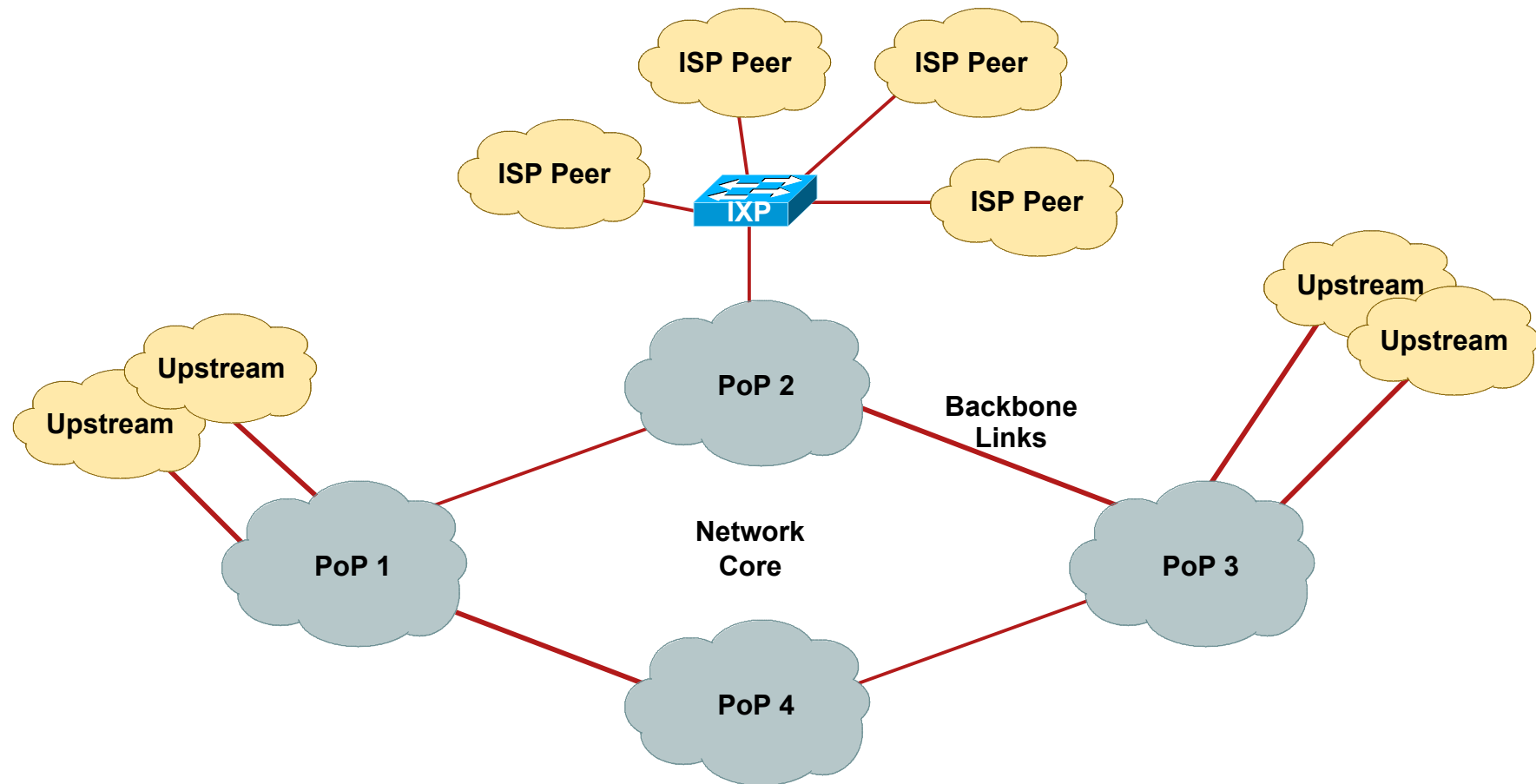


Each of these represents a border router in a different autonomous system

ISPs participating in Internet

- Bringing all pieces together, ISPs:
 - Build multiple PoPs in a distributed network
 - Build redundant backbones
 - Have redundant external connectivity
 - Obtain transit from upstream providers
 - Get free peering from local providers at IXPs

Example ISP Backbone Design





IP Addressing

Where to get address space and who from

IP Addressing

- Internet uses **classless** routing
- Concept of IPv4 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 **I**nter**D**omain **R**outing
RFC1812 – Router Requirements

IP Addressing

- Pre-CIDR (<1994)

 - big networks got a class A

 - medium networks got a class B

 - small networks got a class C

- Nowadays

 - Sizes of IPv4 allocations/assignments made according to demonstrated need – **CLASSLESS**

IP Addressing

- IPv4 Address space is a resource **shared** amongst **all** Internet users
 - Regional Internet Registries delegated allocation responsibility by the IANA
 - AfriNIC, APNIC, ARIN, LACNIC & RIPE NCC are the five RIRs
 - RIRs **allocate** address space to ISPs and Local Internet Registries
 - ISPs/LIRs **assign** address space to end customers or other ISPs
- 97% of usable IPv4 address space has been allocated (January 2011)
 - Only 7 /8 blocks remain
 - The time for IPv6 is now**

Non-portable Address Space

- “Provider Aggregatable” or “PA Space”

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

Need to fragment provider block when multihoming

- PA space is allocated to the RIR member

All assignments made by the RIR member to end sites are announced as an aggregate to the rest of the Internet

Portable Address Space

- “Provider Independent” or “PI Space”

Customer gets or has address space independent of ISP

Customer keeps addresses when changing ISP

Is very bad for size of Internet routing table

Is very bad for scalability of the routing system

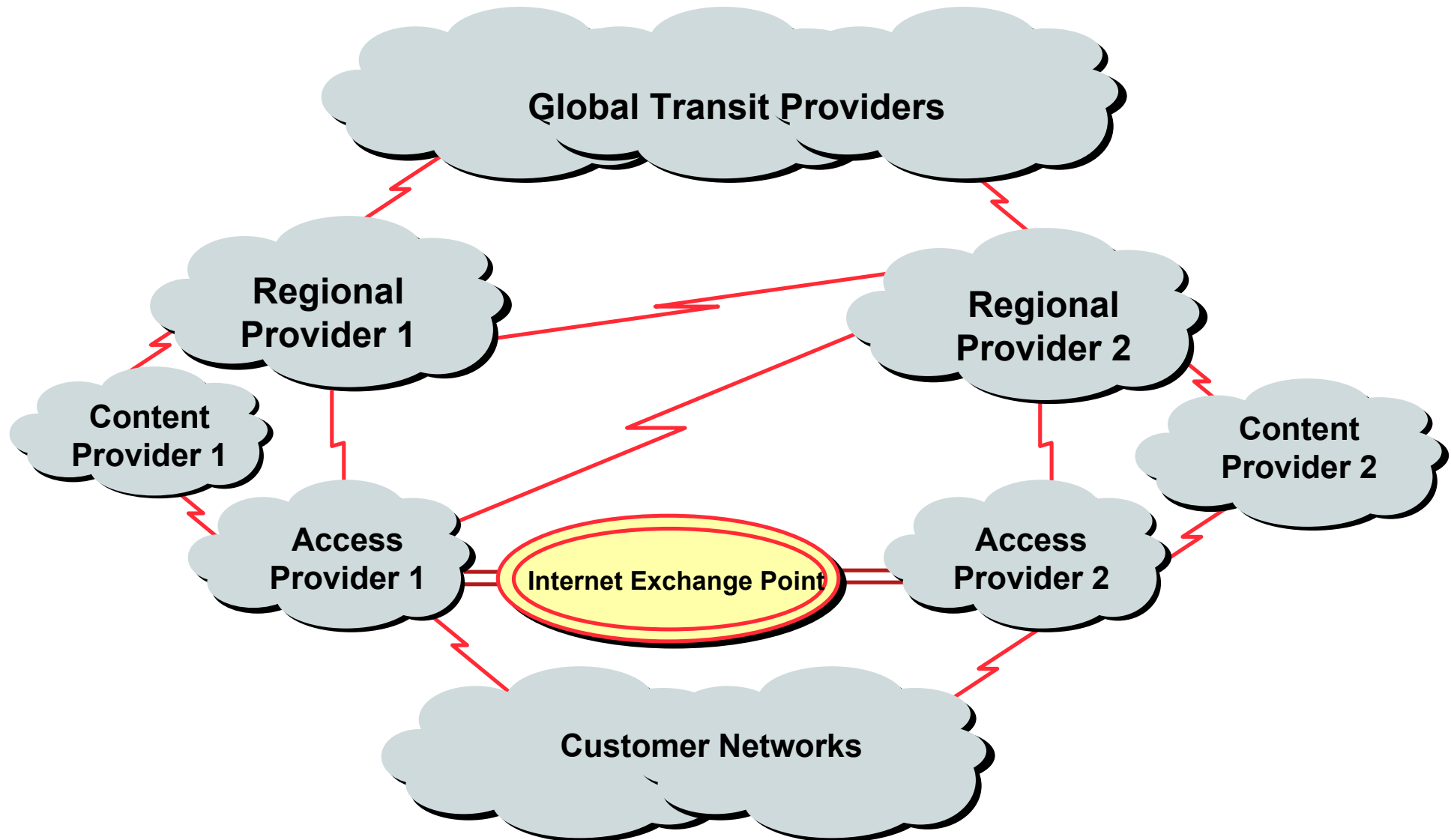
→ PI space is rarely distributed by the RIRs



Internet Hierarchy

The pecking order

High Level View of the Global Internet



Detailed View of the Global Internet

- Global Transit Providers

 - Connect to each other

 - Provide connectivity to Regional Transit Providers

- Regional Transit Providers

 - Connect to each other

 - Provide connectivity to Content Providers

 - Provide connectivity to Access Providers

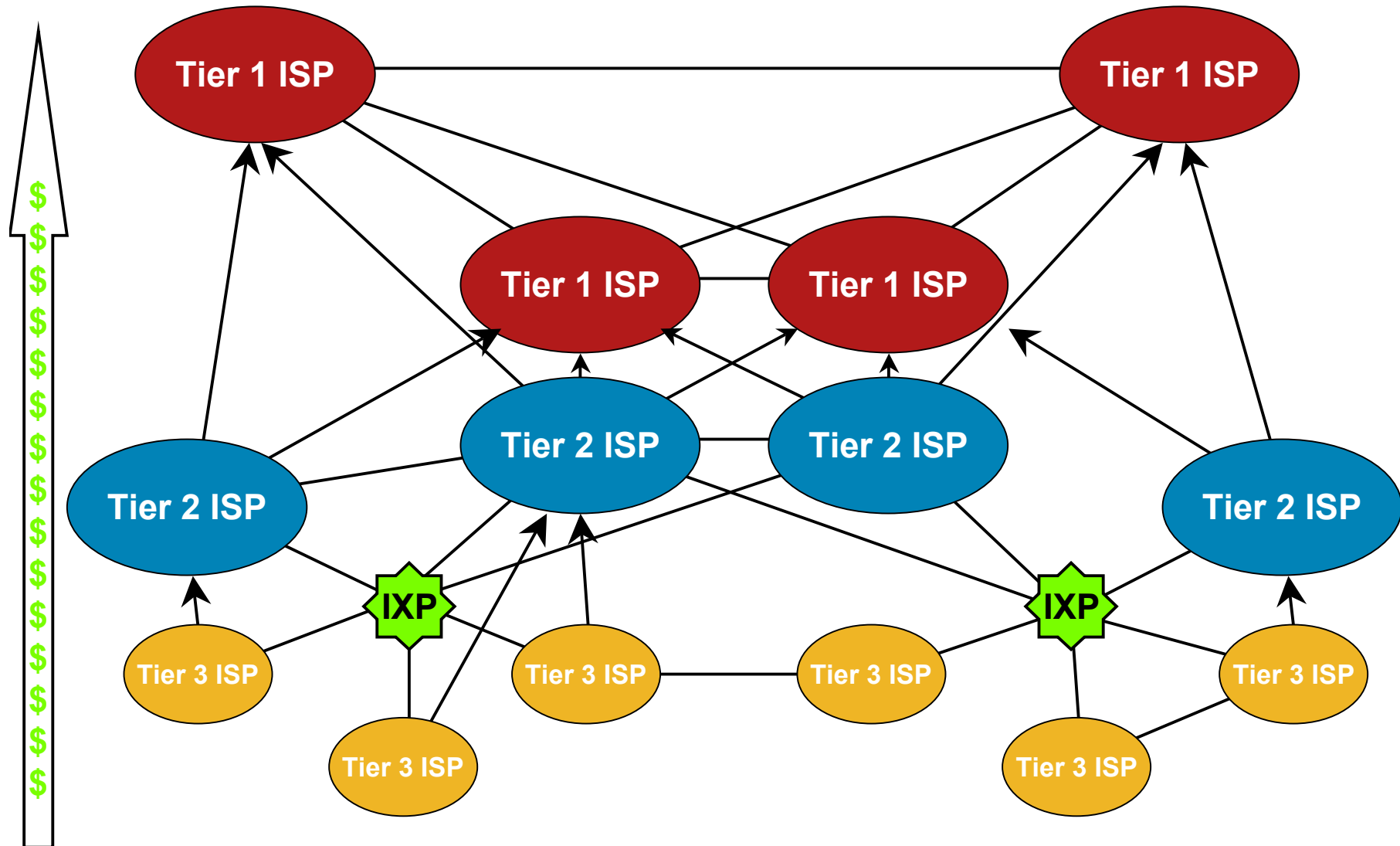
- Access Providers

 - Connect to each other across IXPs (free peering)

 - Provide access to the end user

 - Provide access for Content Providers

Categorising ISPs



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”

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

NB: is not related to where an ISP is in the food chain



Gluing it together

Gluing it together

- Who runs the Internet?

No one

(Definitely not ICANN, nor the RIRs, nor the US,...)

- How does it keep working?

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?

Not really. But...

Engineers keep working together!

Engineers keep talking to each other...

- North America

NANOG (North American Network Operators Group)

NANOG meetings and mailing list

www.nanog.org

- Latin America

Foro de Redes

NAPLA

LACNOG – recently launched

- Middle East

MENOG (Middle East Network Operators Group)

www.menog.net

Engineers keep talking to each other...

- Asia & Pacific

APRICOT annual conference

www.apricot.net

APOPS & APNIC-TALK mailing lists

mailman.apnic.net/mailman/listinfo/apops

mailman.apnic.net/mailman/listinfo/apnic-talk

PacNOG (Pacific NOG)

mailman.apnic.net/mailman/listinfo/pacnog

SANOG (South Asia NOG)

E-mail to sanog-request@sanog.org

Engineers keep talking to each other...

- Europe

RIPE meetings, working groups and mailing lists

e.g. Routing WG: www.ripe.net/mailman/listinfo/routing-wg

- Africa

AfNOG meetings and mailing list

- And many in-country ISP associations and NOGs

- IETF meetings and mailing lists

www.ietf.org

Summary

- Topologies and Definitions
- IP Addressing
 - PA versus PI address space
- Internet Hierarchy
 - Local, Regional, Global Transit Providers
 - IXPs
- Gluing it all together
 - Engineers cooperate, common business interests



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