Introduction to The Internet

ISP/IXP Workshops

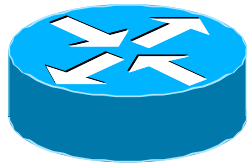# Introduction to the Internet

- Topologies and Definitions

- IP Addressing

- Internet Hierarchy

- Gluing it all together

Topologies and Definitions
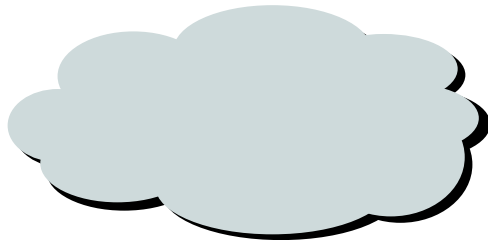
What does all the jargon mean?

Some Icons…

Router
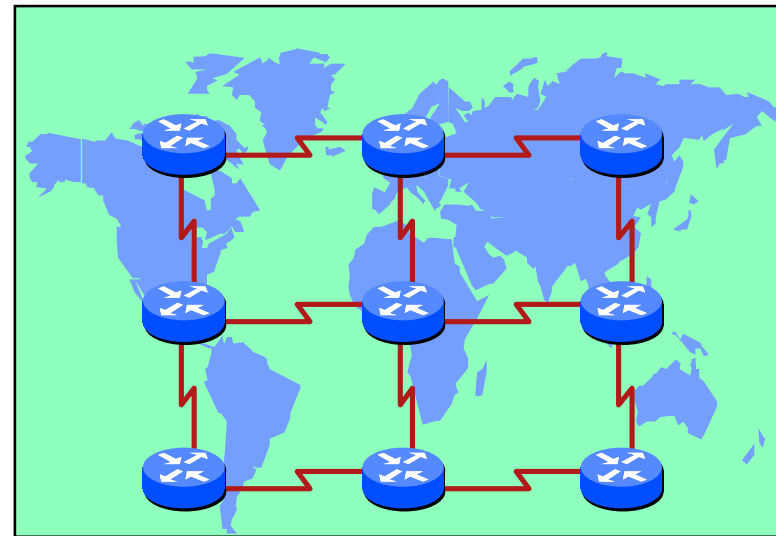(layer 3, IP datagram forwarding)

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

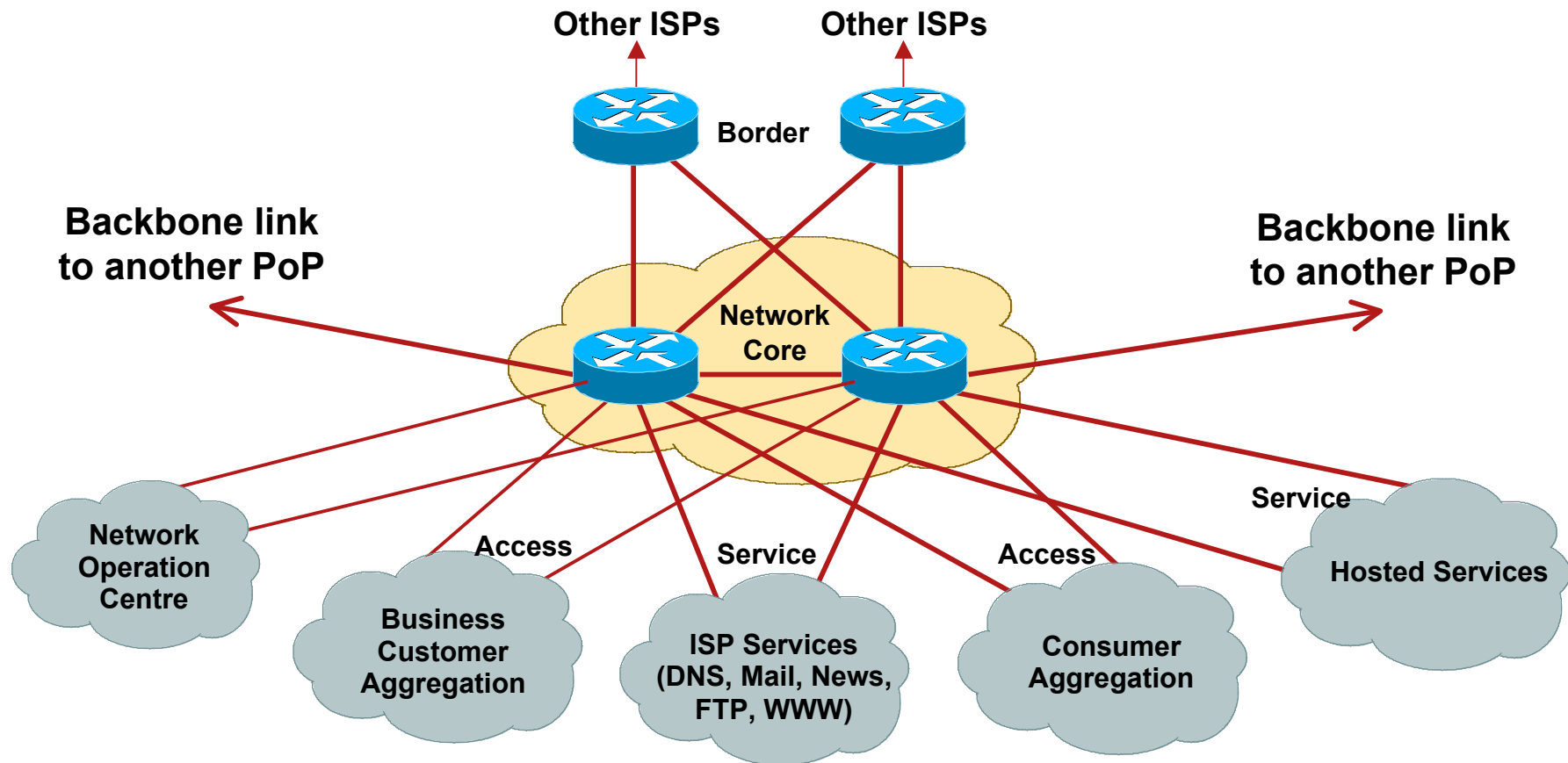 Used mainly for consumer access networks

- 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

Other ISPs

Other ISPs

Border

Backbone link
to another PoP

Backbone link
to another PoP

Network
Core

Network
Operation
Centre

Access

Service

Access

Service

Hosted Services

Business
Customer
Aggregation

ISP Services
(DNS, Mail, News,
FTP, WWW)

Consumer
Aggregation

More Definitions

- Transit

  Carrying traffic across a network

  Usually **for a fee**

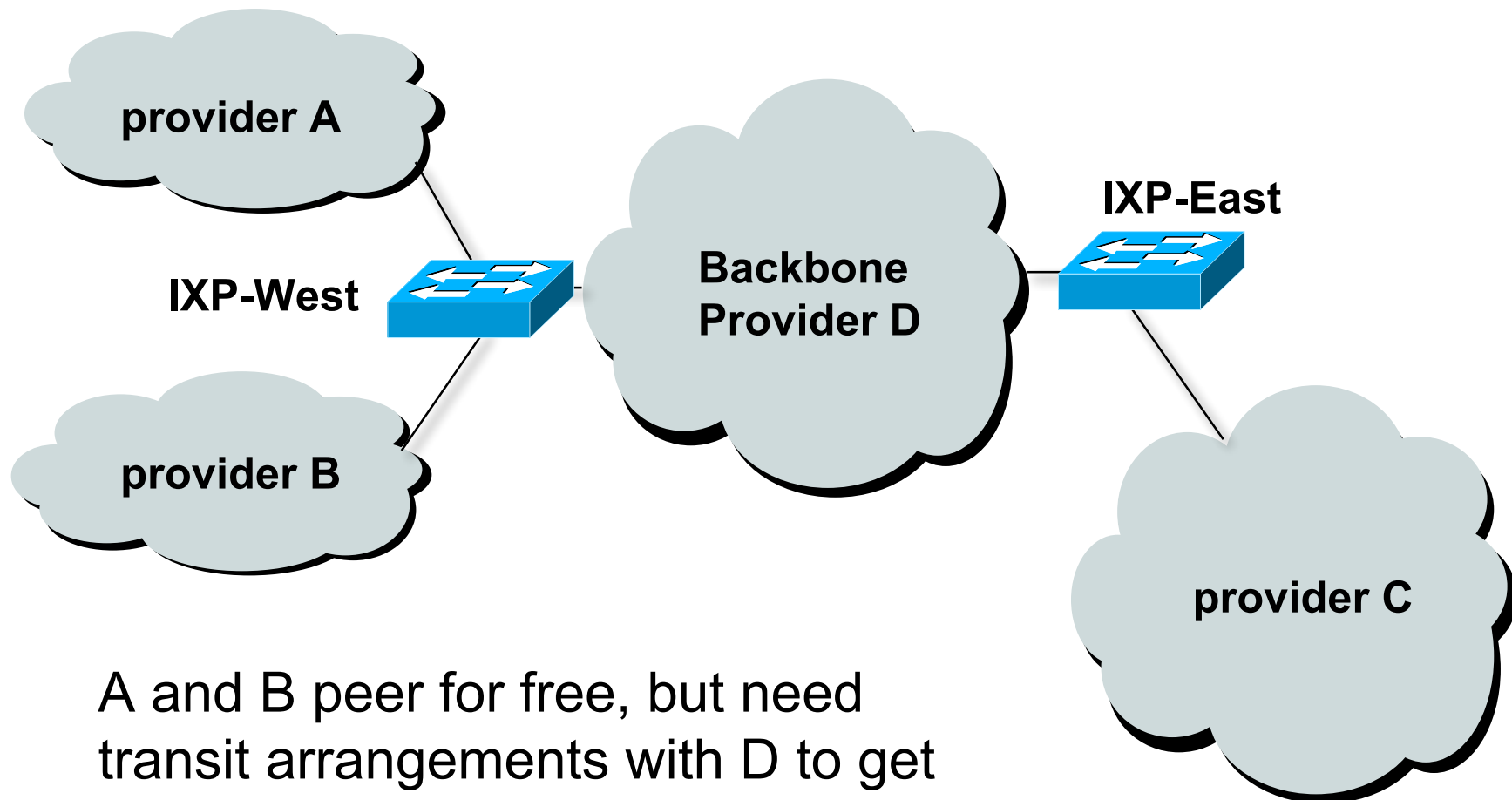- Peering

  Exchanging routing information and traffic

  Usually **for no fee**
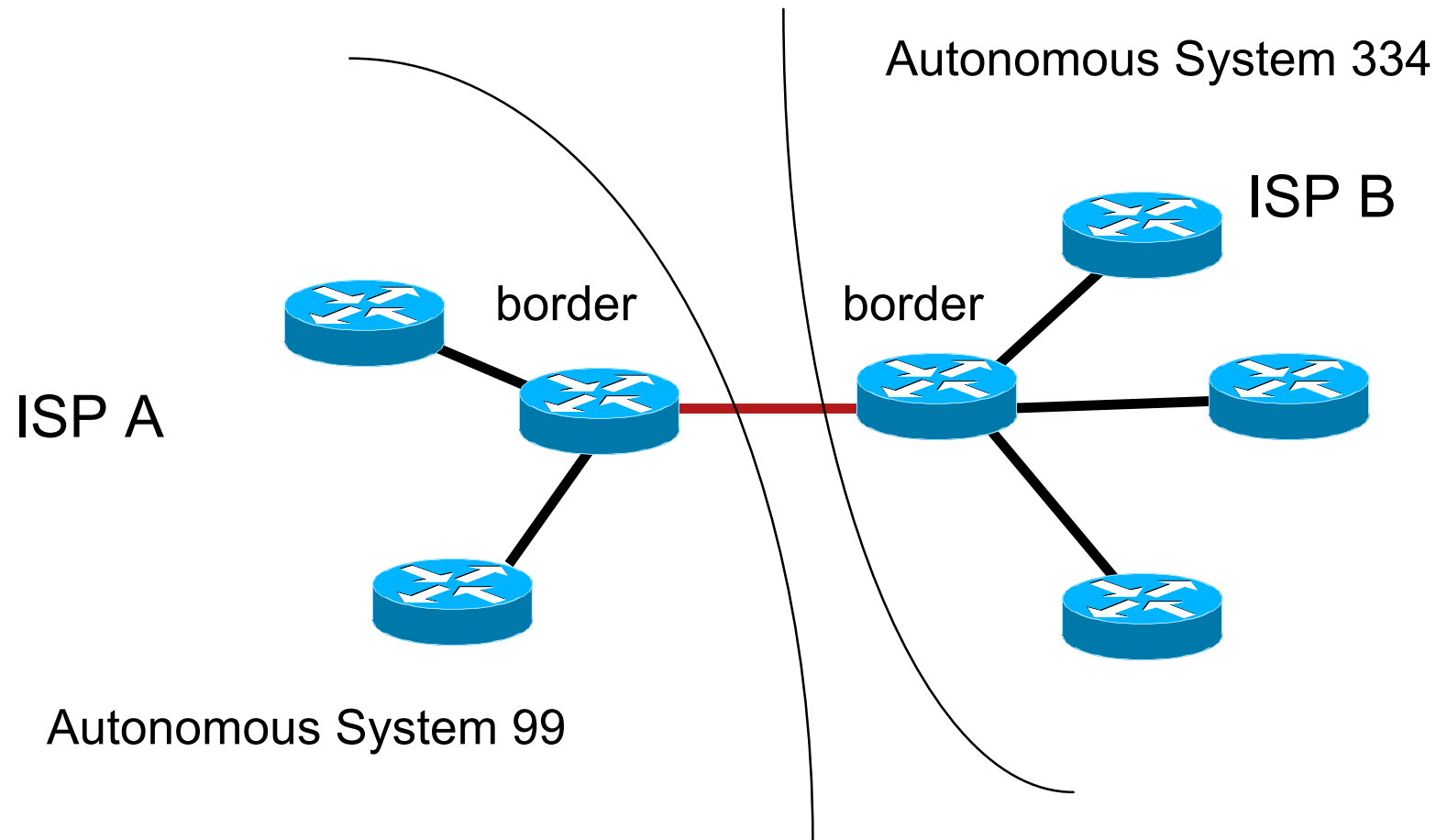
  Sometimes called **settlement free peering**

- Default

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

Peering and Transit example

provider A

IXP-West

Backbone
Provider D

IXP-East

provider B

provider C

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

Private Interconnect

Autonomous System 334

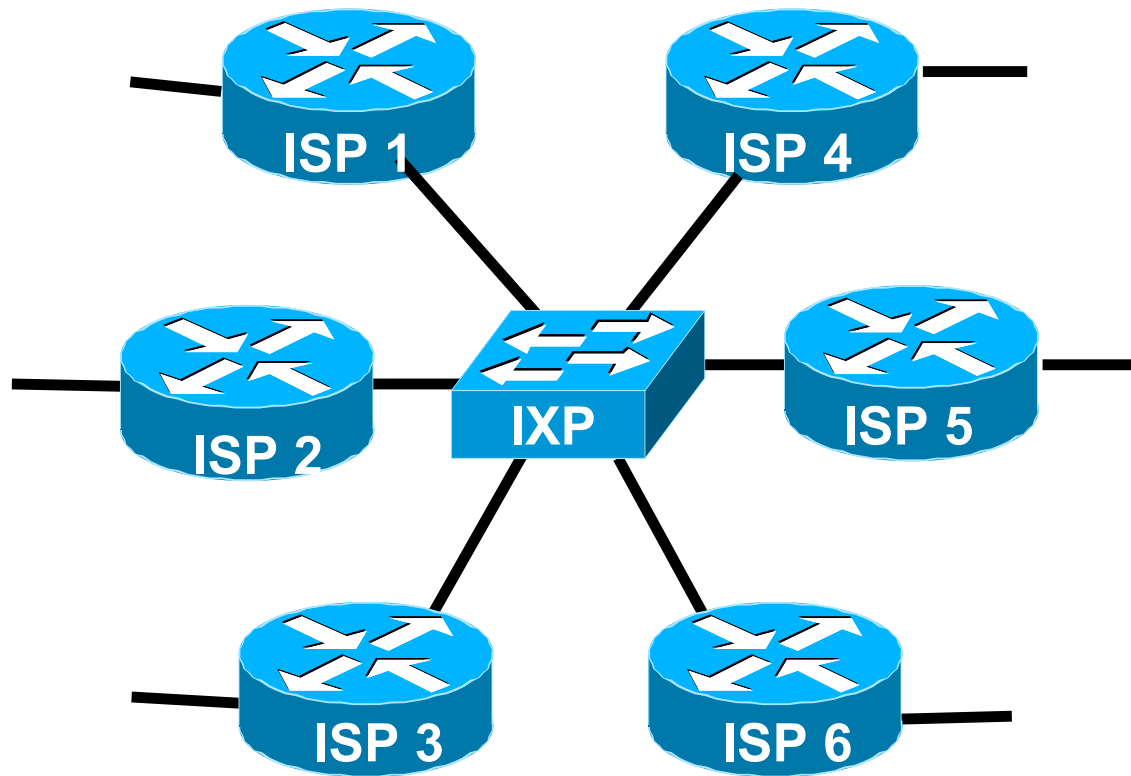ISP B

border

border

ISP A

Autonomous System 99

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
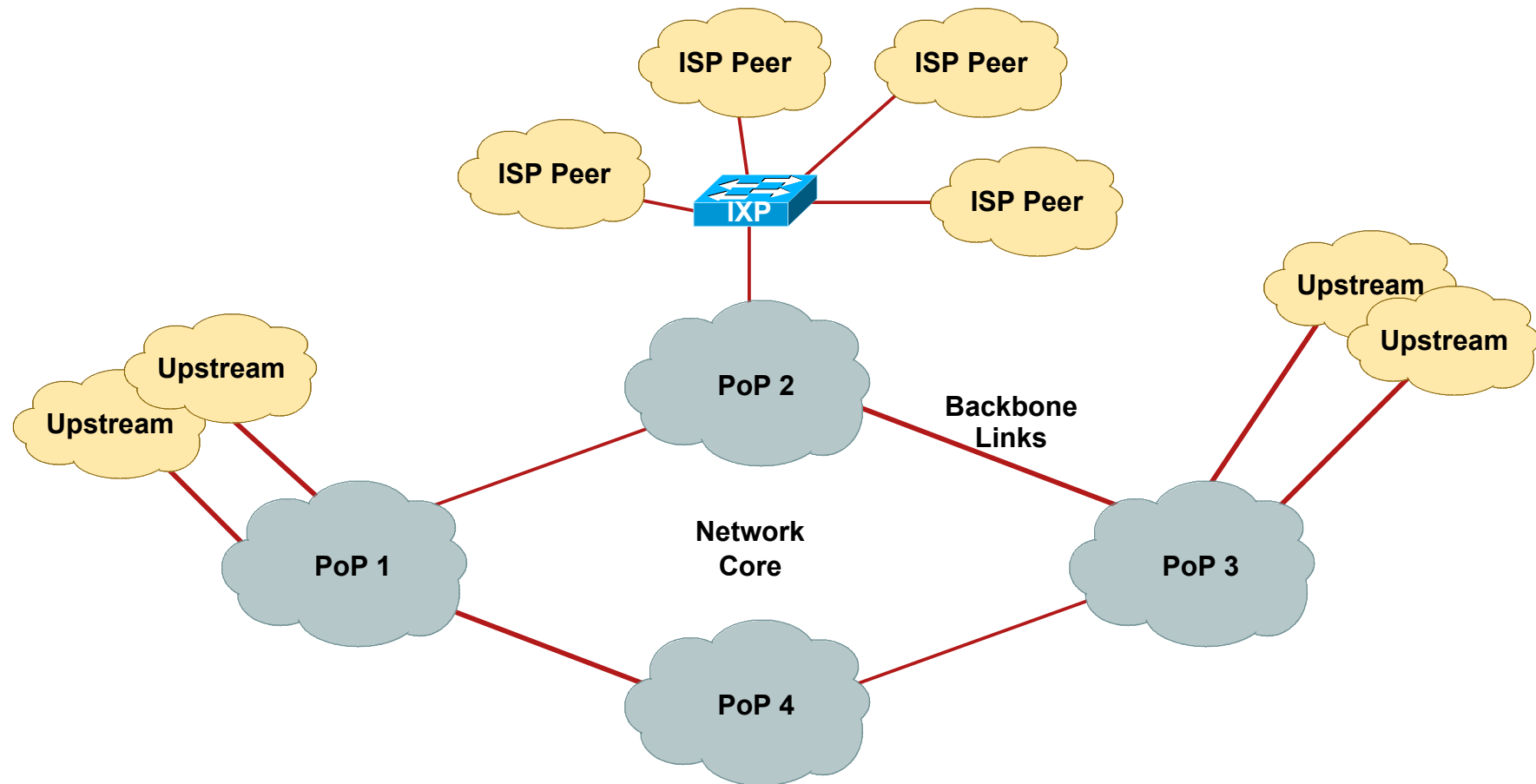
Public Interconnect

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 InterDomain Routing

  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

- 94% of usable IPv4 address space has been allocated

  - 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
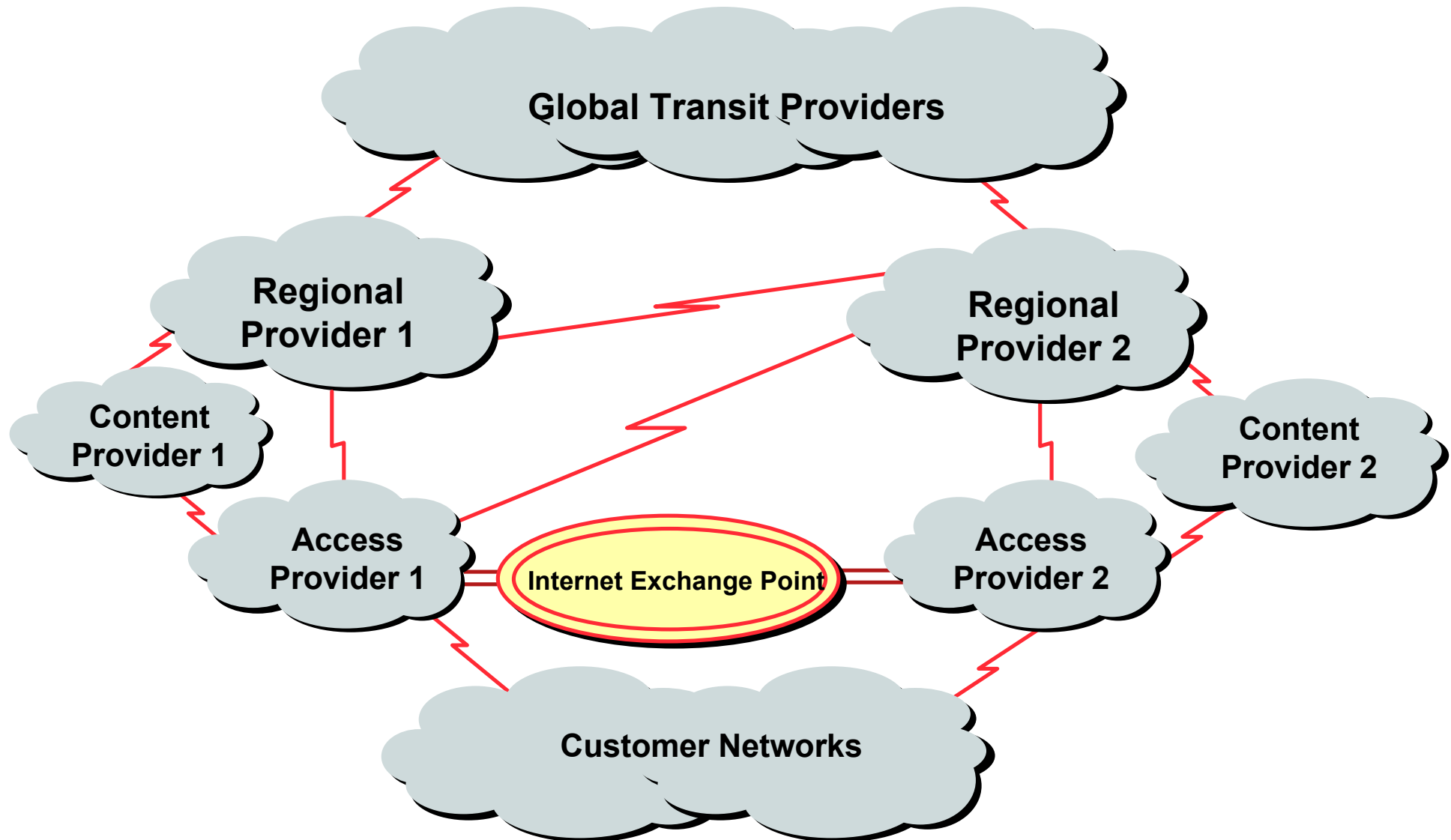
  Is very bad for scalability of the routing system

  → 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
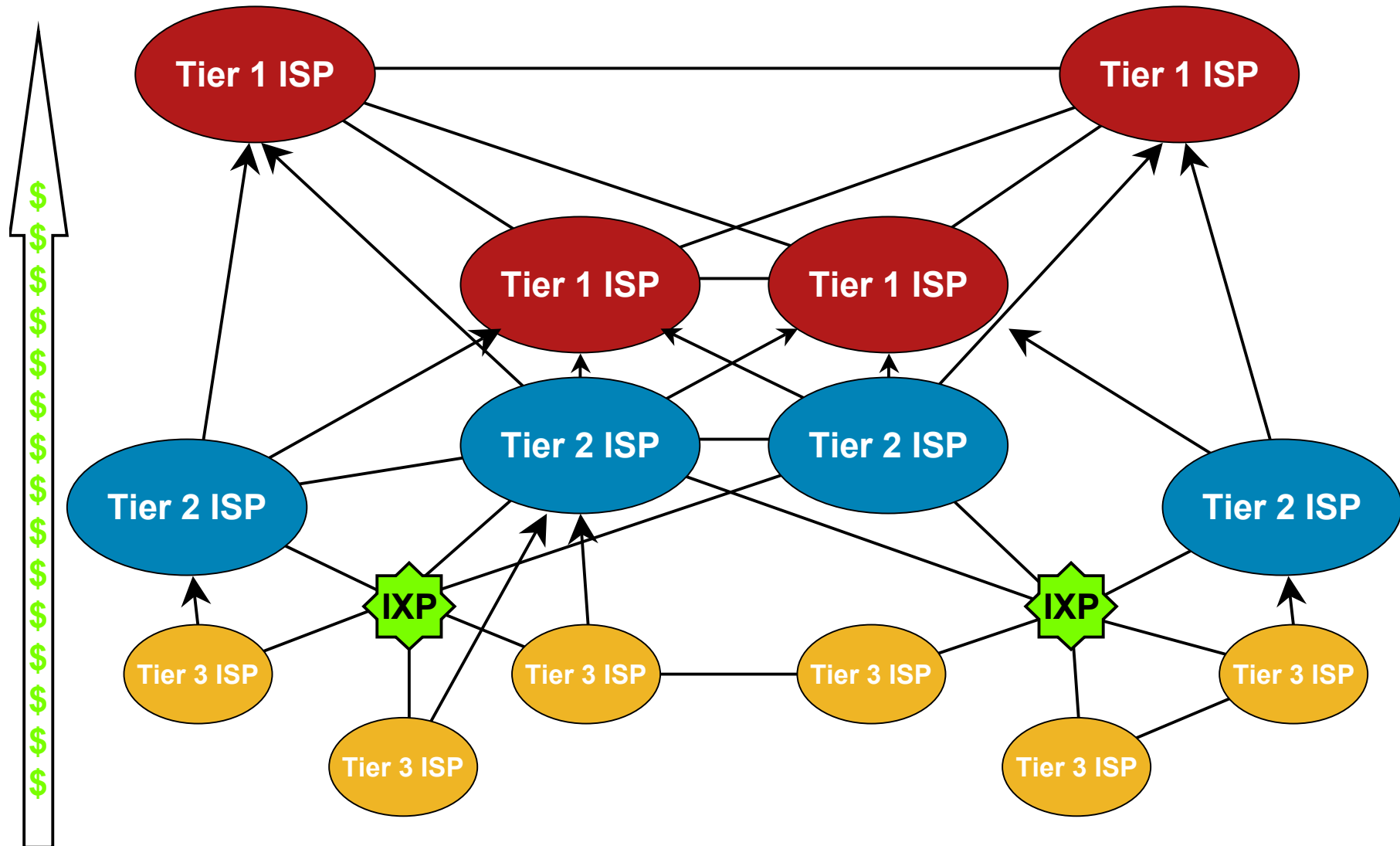
   Provide connectivity to Access Providers

- **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

Introduction to The Internet

ISP/IXP Workshops