Internet Exchange Points

ISP/IXP Workshops

IXP Design

- Why set up an IXP?
- Layer 2 Exchange Point
- Layer 3 Exchange Point
- Design Considerations

Internet Exchange Points

- **Layer 2 exchange point**

  Ethernet (1000/100Mbps)

  Older technologies include ATM, Frame Relay, SRP, FDDI and SMDS

- **Layer 3 exchange point**

  router based

  central or distributed

Why an Internet Exchange Point?

Saving money, improving QoS,

Generating a local Internet economy

Internet Exchange Point
Why peer?

- Consider a region with one ISP
  - They provide internet connectivity to their customers
  - They have one or two international connections
- Internet grows, another ISP sets up in competition
  - They provide internet connectivity to their customers
  - They have one or two international connections
- How does traffic from customer of one ISP get to customer of the other ISP?
  - Via the international connections

Internet Exchange Point
Why peer?

- **Yes, International Connections…**
  - **If satellite, RTT is around 550ms per hop**
  - **So local traffic takes over 1s round trip**
- **International bandwidth**
  - **Costs significantly more than domestic bandwidth**
  - **Congested with local traffic**
  - **Wastes money, harms performance**

Internet Exchange Point
Why peer?

- **Solution:**

  Two competing ISPs peer with each other

- **Result:**

  Both save money

  Local traffic stays local

  Better network performance, better QoS,…

  More international bandwidth for expensive international traffic

  Everyone is happy

Internet Exchange Point
Why peer?

- **A third ISP enters the equation**
  - **Becomes a significant player in the region**
  - **Local and international traffic goes over their international connections**
- **They agree to peer with the two other ISPs**
  - **To save money**
  - **To keep local traffic local**
  - **To improve network performance, QoS,…**

Internet Exchange Point
Why peer?

- **Peering means that the three ISPs have to buy circuits between each other**

  Works for three ISPs, but adding a fourth or a fifth means this does not scale

- **Solution:**

  Internet Exchange Point

Internet Exchange Point

- **Every participant has to buy just one whole circuit**
  - **From their premises to the IXP**
- **Rather than N-1 half circuits to connect to the N-1 other ISPs**
  - **5 ISPs have to buy 4 half circuits = 2 whole circuits → already twice the cost of the IXP connection**

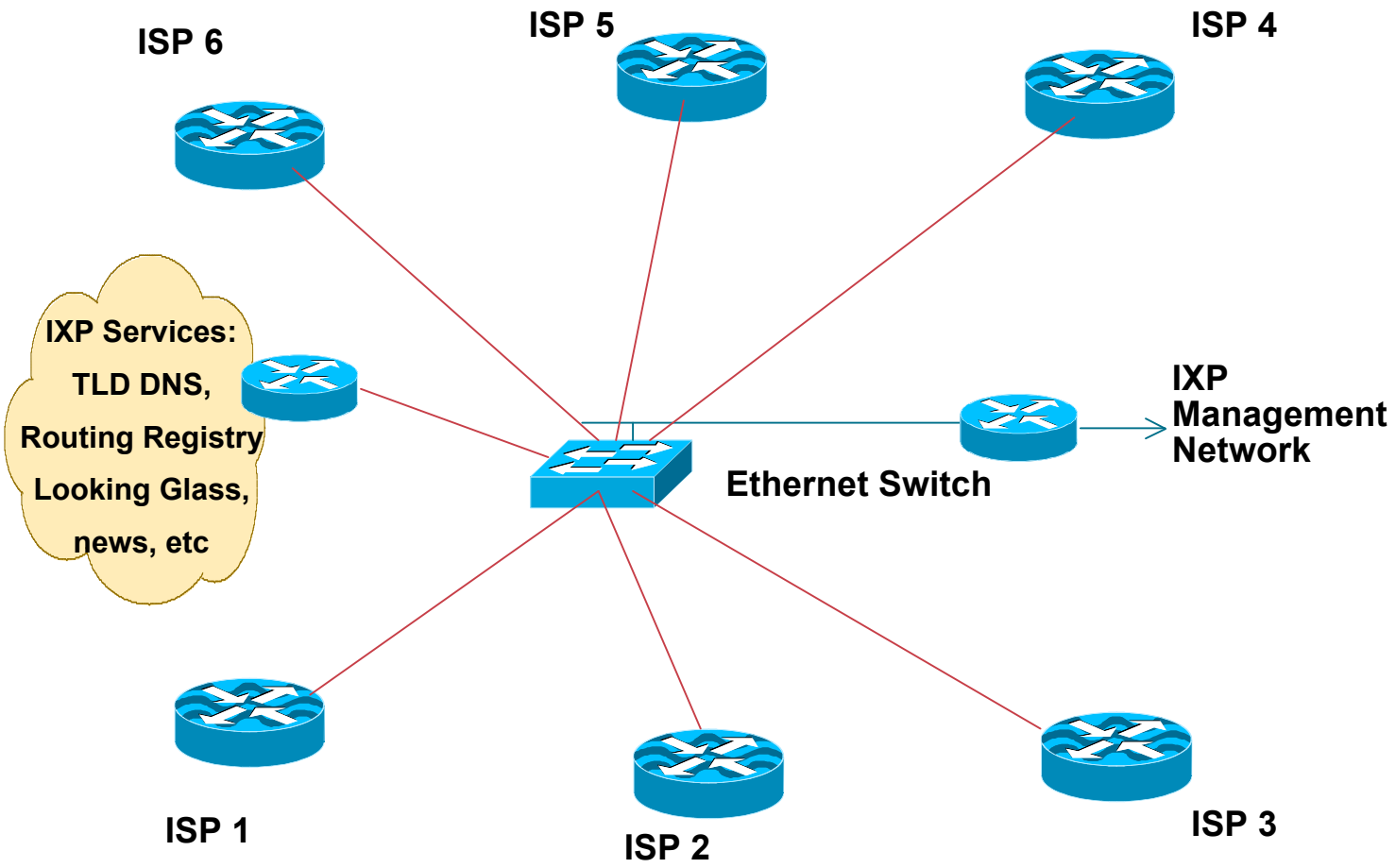
Internet Exchange Point

- **Solution**
  - **Every ISP participates in the IXP**
  - **Cost is minimal – one local circuit covers all domestic traffic**
  - **International circuits are used for just international traffic – and backing up domestic links in case the IXP fails**
- **Result:**
  - **Local traffic stays local**
  - **QoS considerations for local traffic is not an issue**
  - **RTTs are typically sub 10ms**
  - **Customers enjoy the Internet experience**
  - **Local Internet economy grows rapidly**

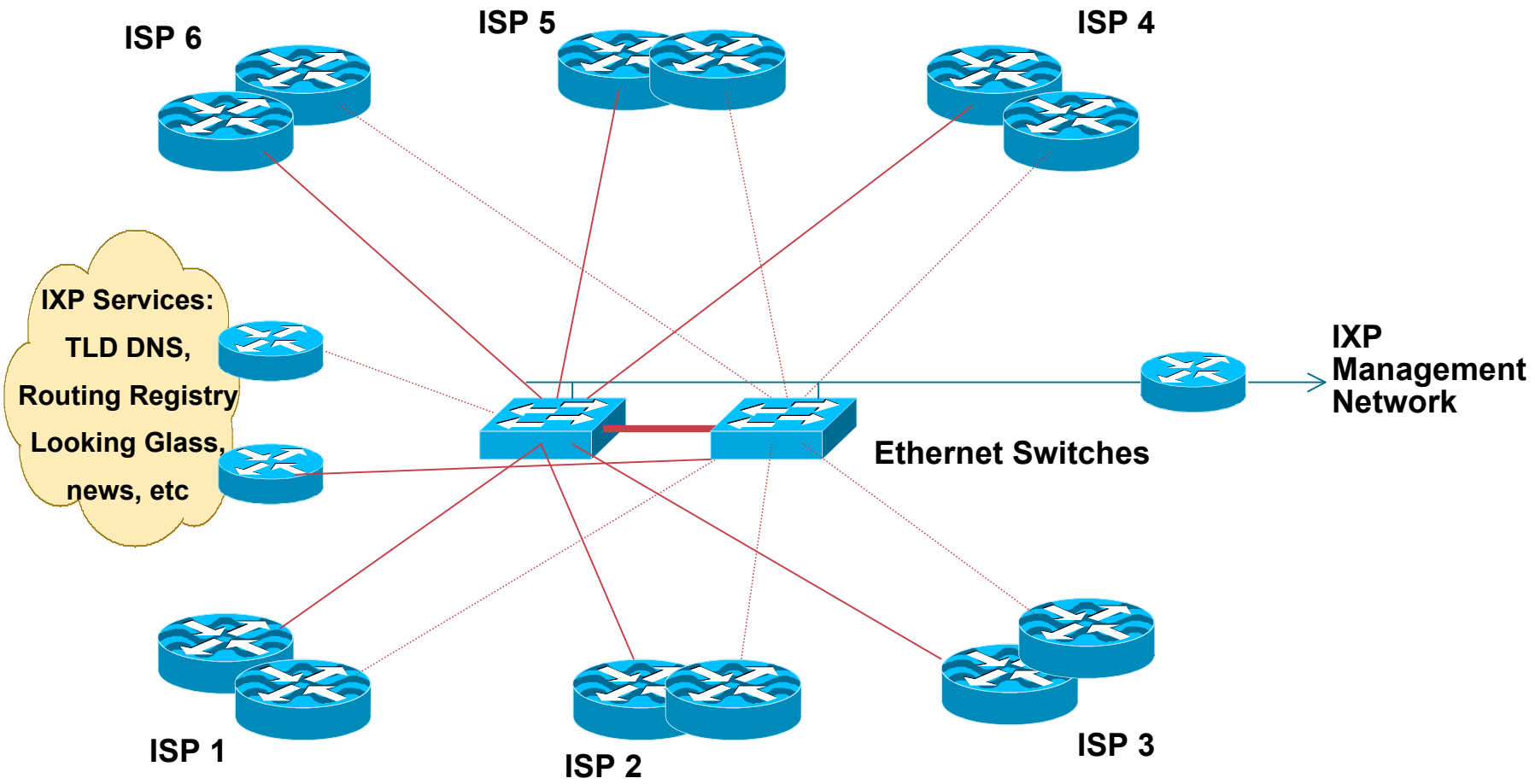
Layer 2 Exchange

The traditional IXP

Layer 2 Exchange



Layer 2 Exchange



Layer 2 Exchange

- Two switches for redundancy
- ISPs use dual routers for redundancy or loadsharing
- Offer services for the “common good”
  - Internet portals and search engines
  - DNS TLD, News, NTP servers
  - Routing Registry and Looking Glass

Layer 2 Exchange

- **Requires neutral IXP management**
  - **usually funded equally by IXP participants**
  - **24x7 cover, support, value add services**
- **Secure and neutral location**
- **Configuration**
  - **private address space if non-transit and no value add services**
  - **ISPs require AS, basic IXP does not**

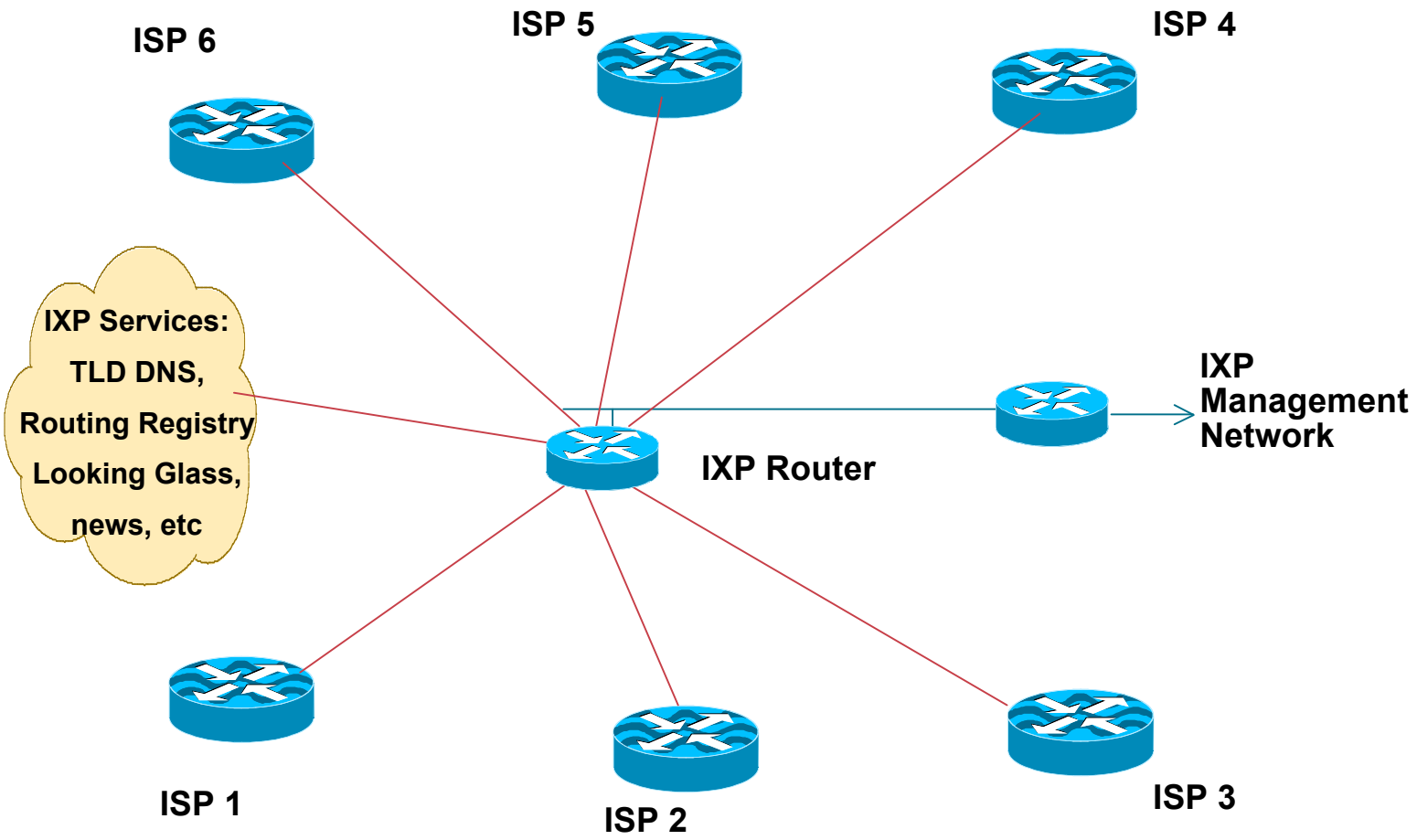
Layer 2 Exchange

- **Network Security Considerations**
  - **LAN switch needs to be securely configured**
  - **Management routers require TACACS+ authentication, vty security**
  - **IXP services must be behind router(s) with strong filters**

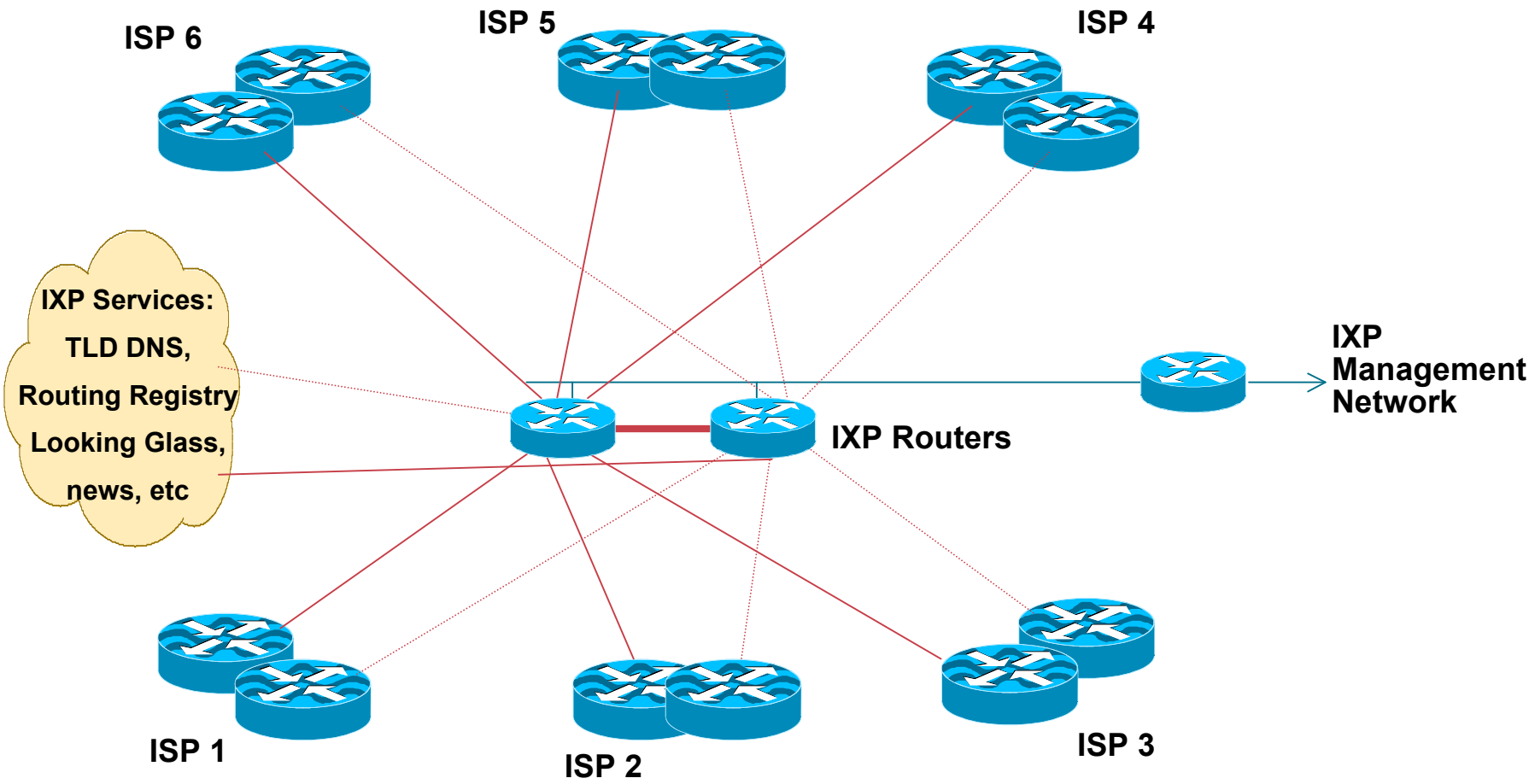
Layer 3 Exchange

The wholesale transit ISP

Layer 3 Exchange



Layer 3 Exchange



Layer 3 Exchange

- Two routers for redundancy
- ISPs use dual routers for redundancy or loadsharing
- Offer services for the “common good”
  - Internet portals and search engines
  - DNS TLD, News, NTP servers
  - Routing Registry and Looking Glass

Layer 3 Exchange

- **Requires neutral IXP management**
  - **usually funded equally by IXP participants**
  - **24x7 cover, support, value add services**
  - **BGP configuration skills essential**
- **Secure and neutral location**
- **Configuration**
  - **private address space if non-transit and no value add services**
  - **ISPs and IXP require AS**

Layer 3 Exchange

- **Network Security Considerations**

  Core IXP router(s) require strong security, preferably with BGP neighbour authentication

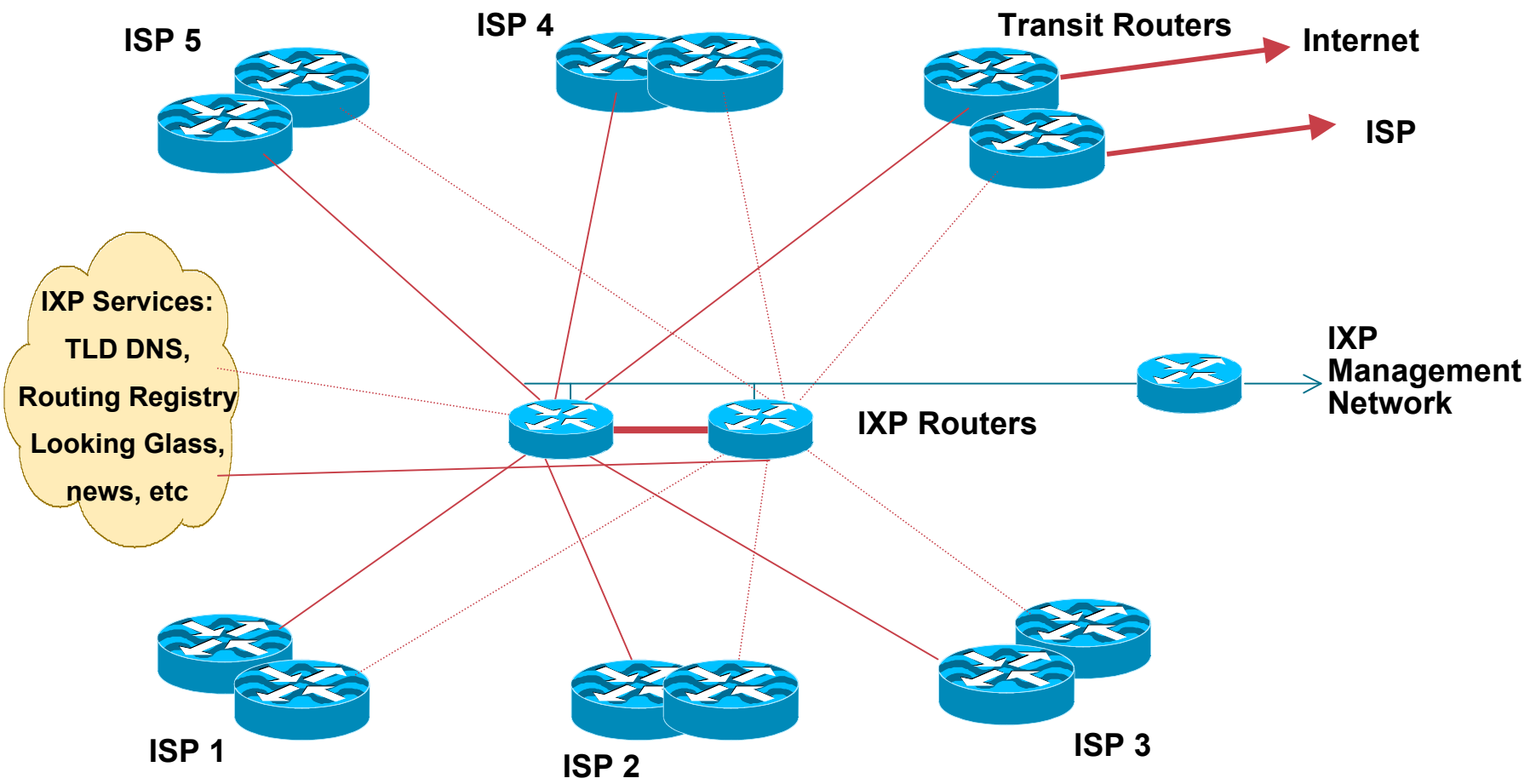
  Management routers require TACACS+ authentication, vty security

  IXP services must be behind router(s) with strong filters

Transit IXPs

- Provides local Internet exchange facility to members
- Also provides transit to Internet or upstream ISP
- Usually operated as a commercial service
- Usually layer 3 design

Layer 3 Transit Exchange



Layer 2 versus Layer 3

- **Layer 3**
  - **IXP team requires good BGP knowledge**
  - **Rely on 3rd party for BGP configuration**
  - **Less freedom on who peers with whom**
  - **Could potentially compete with IXP membership**
  - **Easier to distribute over wide area**

Layer 2 versus Layer 3

- **Layer 2**
  - **IXP team does not need routing knowledge**
  - **Easy to get started**
  - **More complicated to distribute over wide area**
  - **ISPs free to set up peering agreements with each other as they wish**

Layer 2 versus Layer 3 Summary

- Layer 2 is a REAL internet exchange point
- Layer 3 is marketing concept used by Transit ISPs

IXP Design Considerations

Routing

- ISP border routers at the IXP generally should NOT be configured with default route or carry full Internet routing table
  - Carrying default or full table means that this router and the ISP network is open to abuse by non-peering IXP members
  - Correct configuration is only to carry routes offered to IXP peers on the IXP peering router
- Note: Some ISPs offer transit across IX fabrics
  - They do so at their own risk – see above

Routing (more)

- ISP border routers at the IXP should not be configured to carry the IXP LAN network within the IGP or iBGP

  Use next-hop-self BGP concept

- Don’t generate ISP prefix aggregates on IXP peering router

  If connection from backbone to IXP router goes down, normal BGP failover will then be successful

Address Space

- **Some IXPs use private addresses for the IX LAN**
  - **Public address space means IXP network could be leaked to Internet which may be undesirable**
  - **Because most ISPs filter RFC1918 address space, this avoids the problem**
- **Some IXPs use public addresses for the IX LAN**
  - **Address space available from the RIRs**
  - **IXP terms of participation often forbid the IX LAN to be carried in the ISP member backbone**

Hardware

- **Don’t mix port speeds**

  if 10Mbps and 100Mbps connections available, terminate on different switches (L2 IXP)

- **Don’t mix transports**

  if terminating ATM PVCs and G/F/Ethernet, terminate on different devices

- **Insist that IXP participants bring their own router**

  moves buffering problem off the IXP

  security is responsibility of the ISP, not the IXP

Services Offered

- **Services offered should not compete with member ISPs (basic IXP)**
  - **e.g. web hosting at an IXP is a bad idea unless all members agree to it**
- **IXP operations should make performance and throughput statistics available to members**
  - **Use tools such as MRTG to produce IX throughput graphs for member (or public) information**

Services to Offer

- TLD DNS
  - the country IXP could host the country's top level DNS
  - e.g. "SE." TLD is hosted at Netnod IXes in Sweden
  - Offer back up of other country TLD DNS
- Root server
  - Anycast instances of l.root-servers.net, F.root-servers.net etc are present at many IXes
- Usenet News
  - Usenet News is high volume
  - could save bandwidth to all IXP members

Services to Offer

- **Route Collector**
  - **All IXP members peer with the route collector**
  - **Route collector shows the reachability information available at the exchange**
  - **Requires a simple router with large memory**
- **Looking Glass**
  - **one way of making the Route Collector routes available for global view**
  - **public or members only access**

Services to Offer
Route Server

- Reduces admin burden on IXP member routers
  - only BGP session is with Route Server
  - Route Server supplies all paths it knows to the IXP member routers – no best path selection
- Can use private AS
  - Route Server software does not prepend its AS to the AS path
- RSd (from Merit Network) has been used

Services to Offer

- **Network Time Protocol**

  Locate a stratum 1 time source (GPS receiver, atomic clock, etc) at IXP

- **Multicast**

  Provide MBONE and other multicast services for the common good

Services to Offer
Routing Registry

- Routing Registry is used to register the routing policy of the IXP membership
  - documenting peering relationships
  - auto-configuring of peer routers
- Alternative is to use the public Internet Routing Registry (IRR)

IXP Design

Summary

Summary

- L2 IXP – most commonly deployed
  - Based around ethernet switches
  - ATM and other old technologies are obsolete
- L3 IXP – nowadays generally a marketing concept used by wholesale ISPs
  - Does not offer the same flexibility as L2
  - Not recommended unless there are overriding regulatory or political reasons to do so

Internet Exchange Point Design

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