

Internet Routing

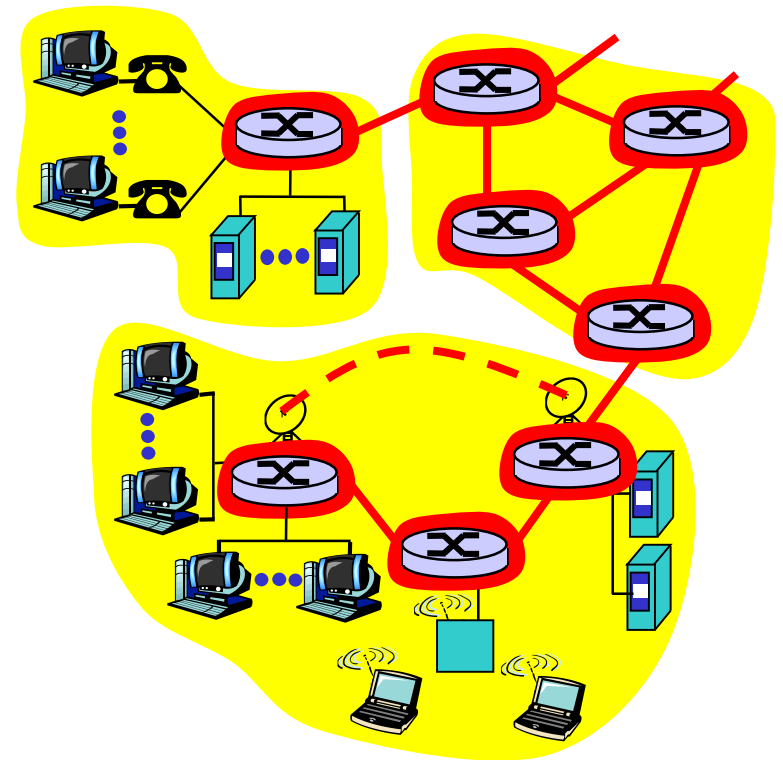
Review of Networking Principles

Principles of the Internet

- ❑ Edge vs. core (end-systems vs. routers)
 - Dumb network
 - Intelligence at the end-systems
- ❑ Different communication paradigms
 - Connection oriented vs. connection less
 - Packet vs. circuit switching
- ❑ Layered System
- ❑ Network of collaborating networks

The network core

- ❑ Mesh of interconnected routers
- ❑ ***The fundamental question:***
How is data transferred through net?
 - **Circuit switching:**
Dedicated circuit per call: telephone net
 - **Packet switching:** Data sent through net in discrete “chunks”



Routing

□ Goal

Move pkts among routers from src to dst

□ Datagram network

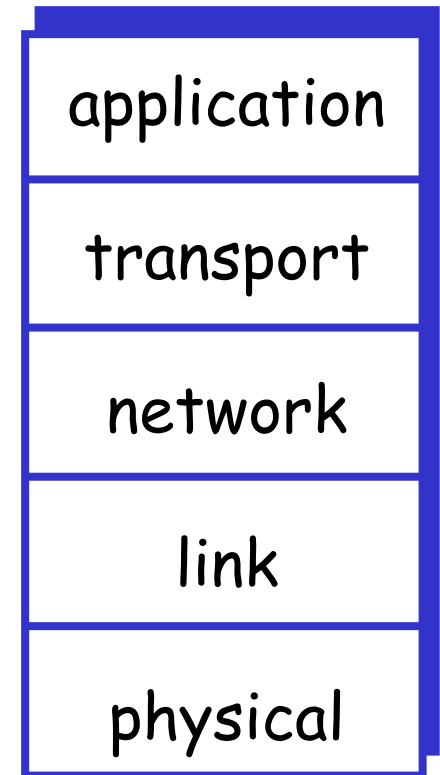
- *Destination address* determines next hop
- Routes may change during session

□ Virtual circuit network

- Each packet carries tag (virtual circuit ID), tag determines next hop
- Fixed path determined at *call setup time*, remains fixed through call
- Routers maintain per-call state

Internet protocol stack

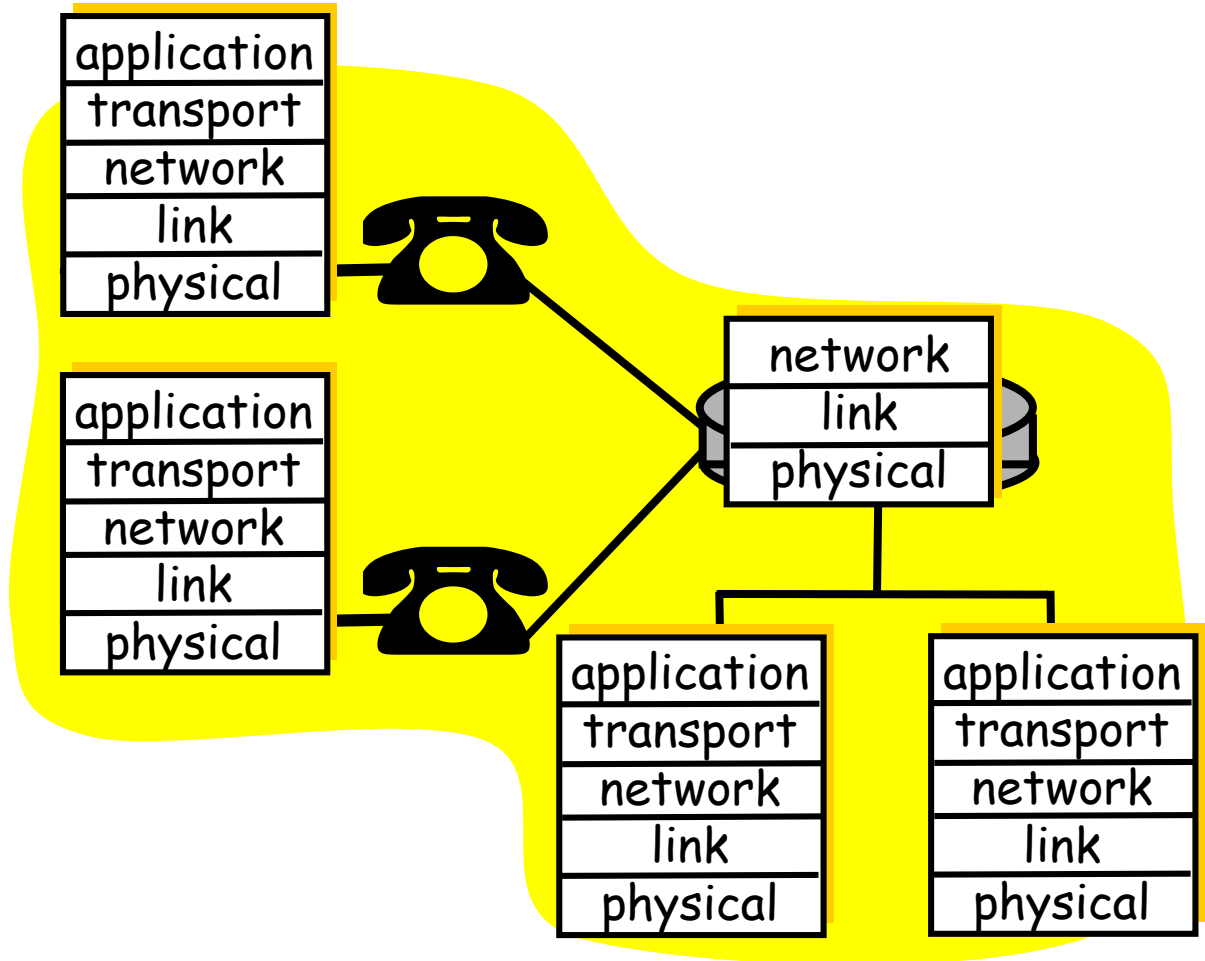
- ❑ **Application:** supporting network applications
- ❑ **Transport:** host-host data transfer
- ❑ **Network:** uniform format of packets, routing of datagrams from source to destination
- ❑ **Link:** data transfer between neighboring network elements
- ❑ **Physical:** bits “on the wire”



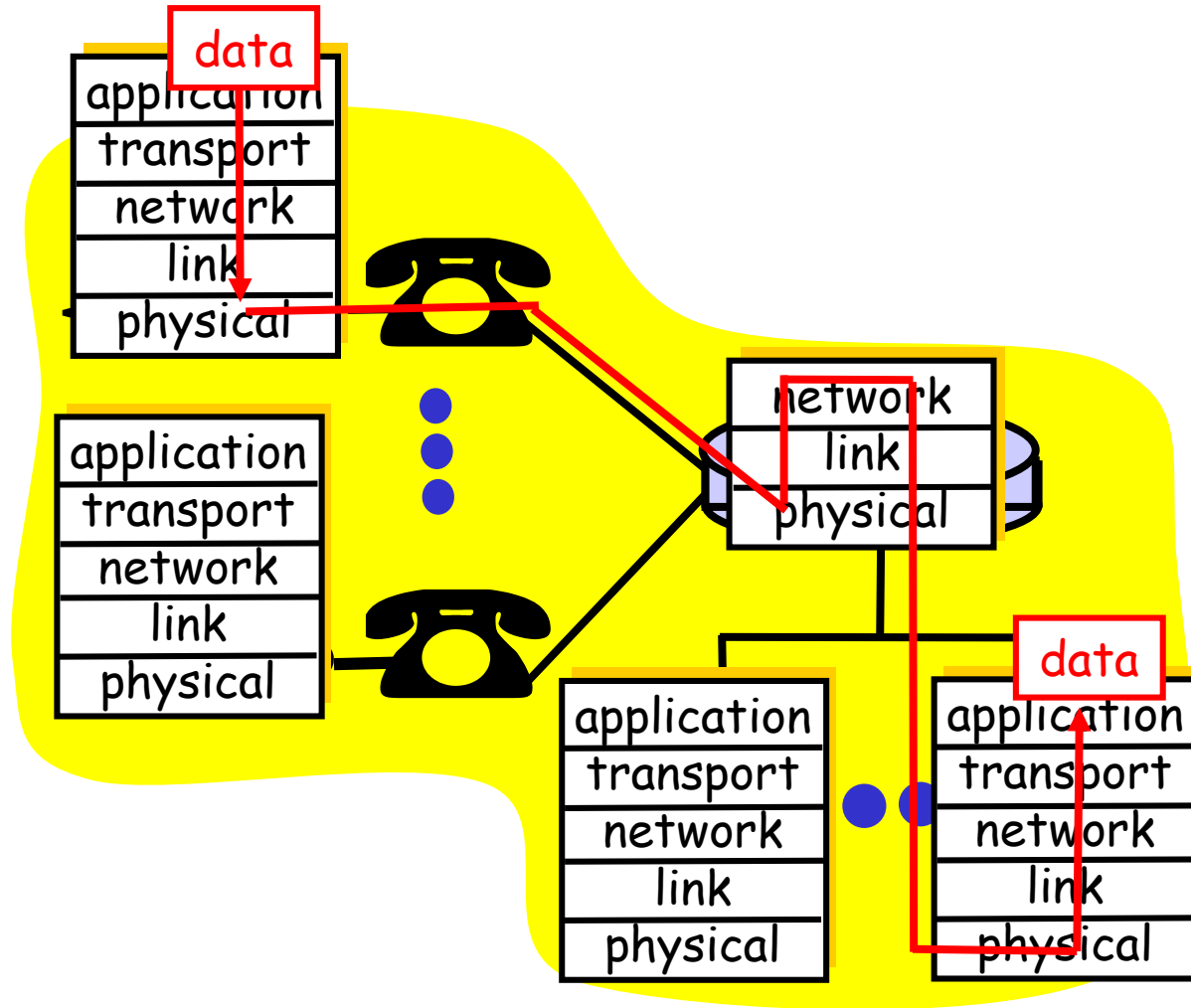
Layering: Logical communication

Each layer:

- ❑ Distributed
- ❑ “Entities” implement layer functions at each node
- ❑ Entities perform actions, exchange messages with peers

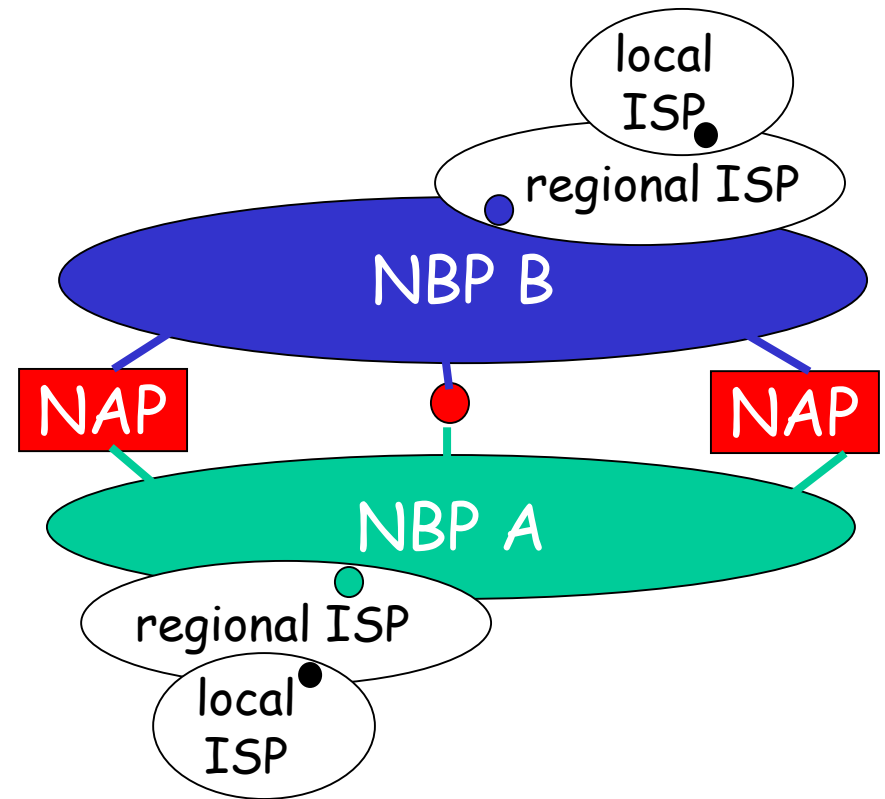


Layering: Physical communication



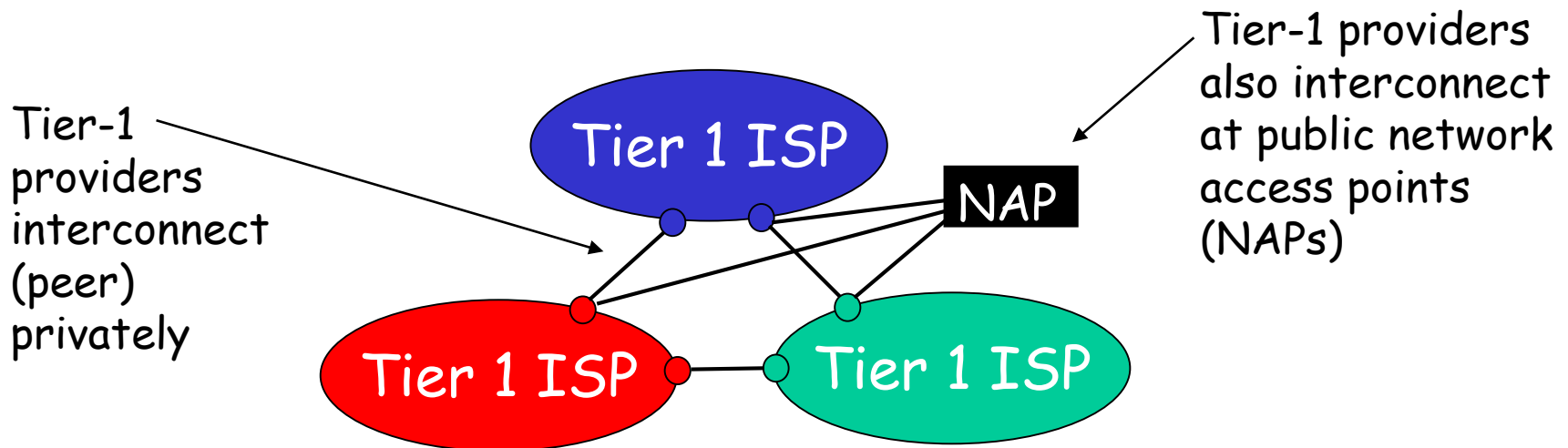
Internet structure: Network of networks

- ❑ Roughly hierarchical
- ❑ **National/international backbone providers (NBP)**
 - E.g., BBN/GTE, Sprint, AT&T, IBM, UUNet
 - Interconnect (peer) with each other privately, or at public Network Access Point (NAPs)
- ❑ **Regional ISPs**
 - Connect into NBPs
- ❑ **Local ISP**, company
 - Connect into regional ISPs



Internet structure: Network of networks

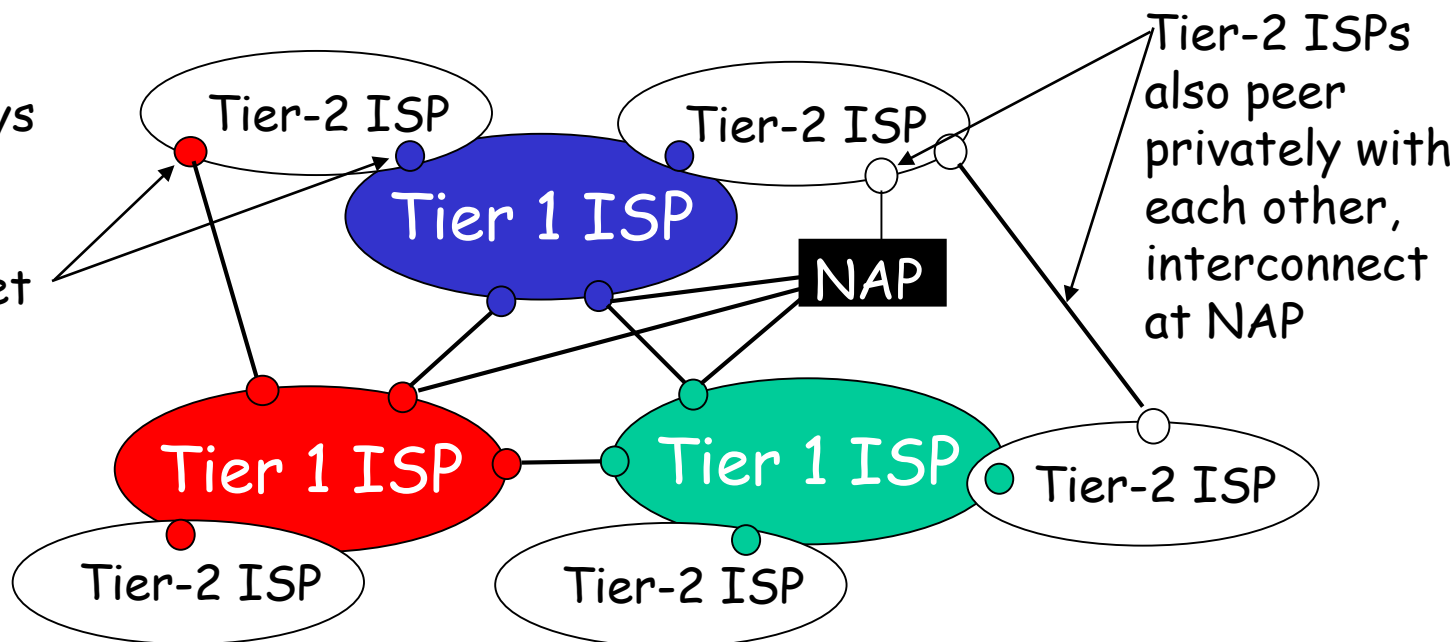
- Roughly hierarchical
- At center: “tier-1” ISPs (e.g., UUNet, BBN/Genuity, Sprint, AT&T), national/international coverage
 - Treat each other as equals



Internet structure: Network of networks

- “Tier-2” ISPs: smaller (often regional) ISPs
 - Connect to one or more tier-1 ISPs, possibly other tier-2 ISPs

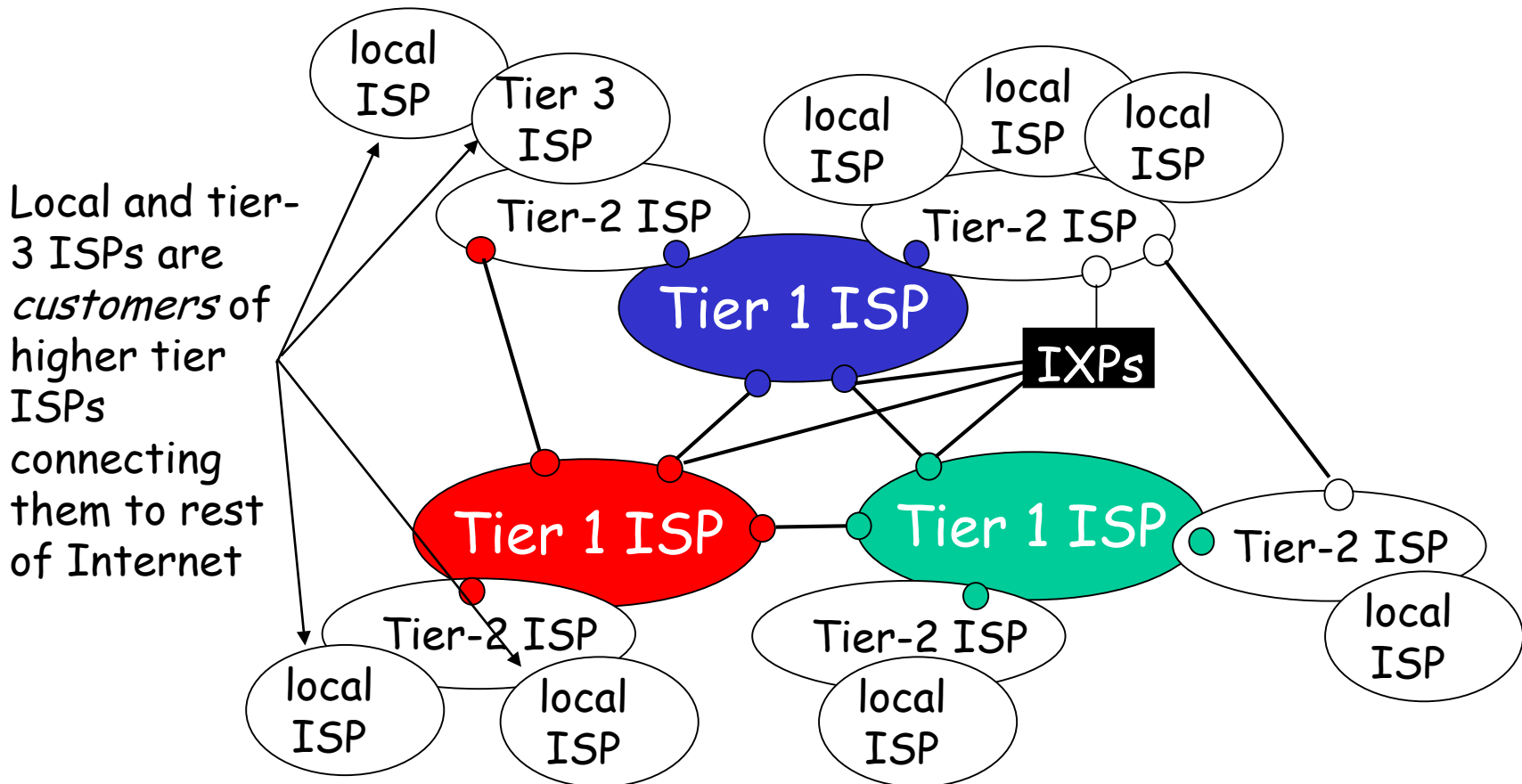
- Tier-2 ISP pays tier-1 ISP for connectivity to rest of Internet
- tier-2 ISP is *customer* of tier-1 provider



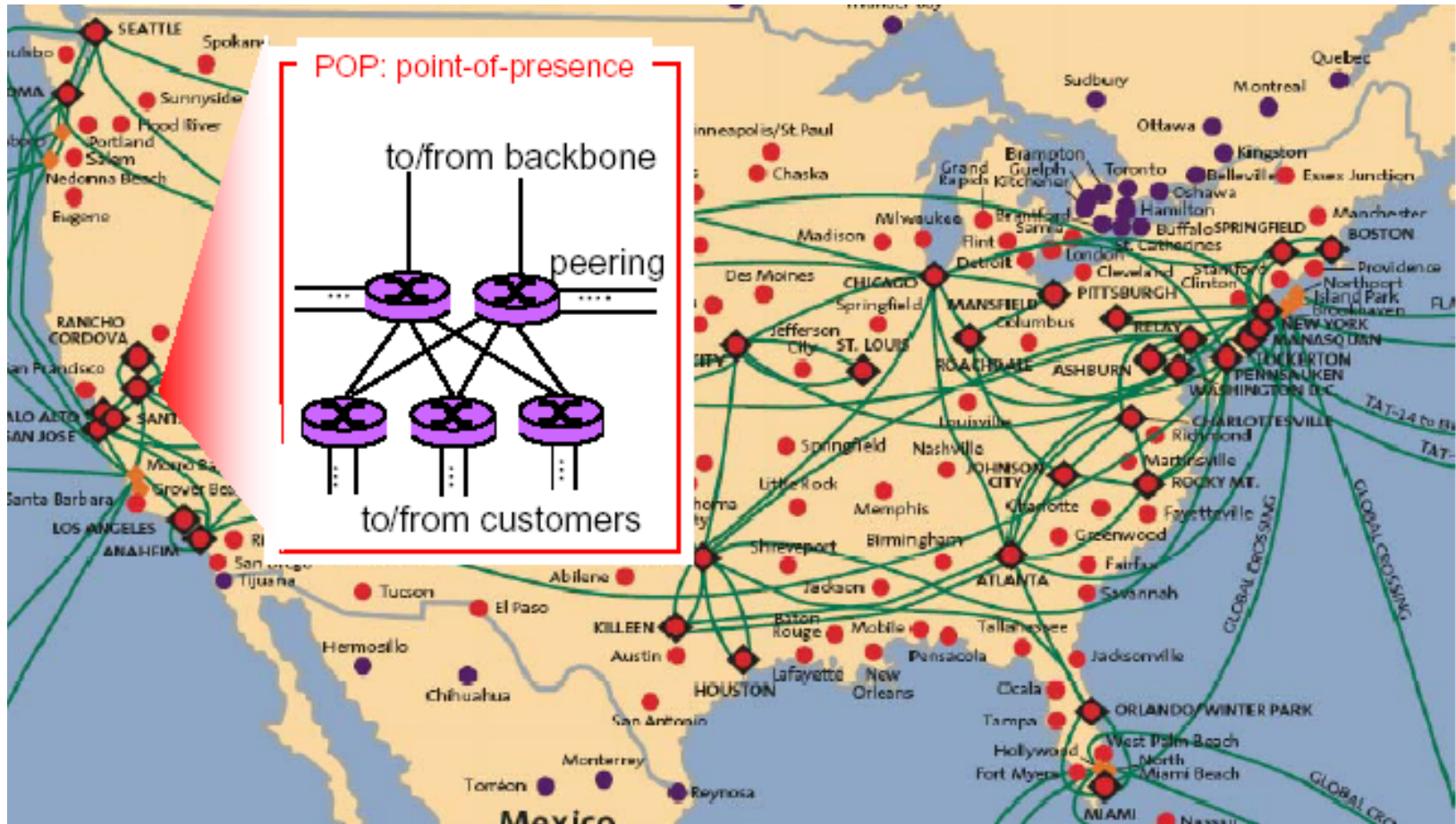
Internet structure: Network of networks

□ “Tier-3” ISPs and local ISPs

- Last hop (“access”) network (closest to end systems)



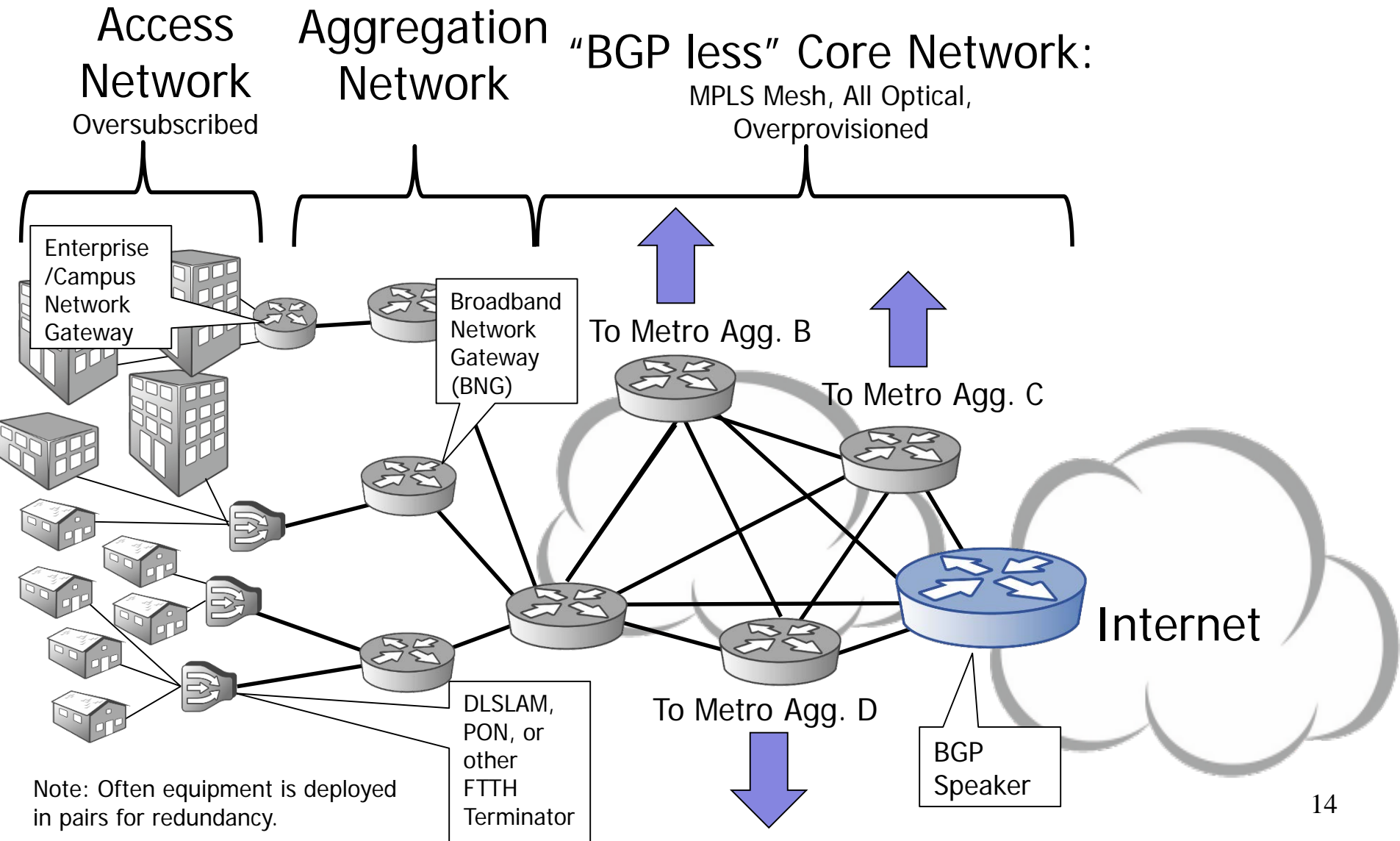
Example Tier-1 ISP: Sprint



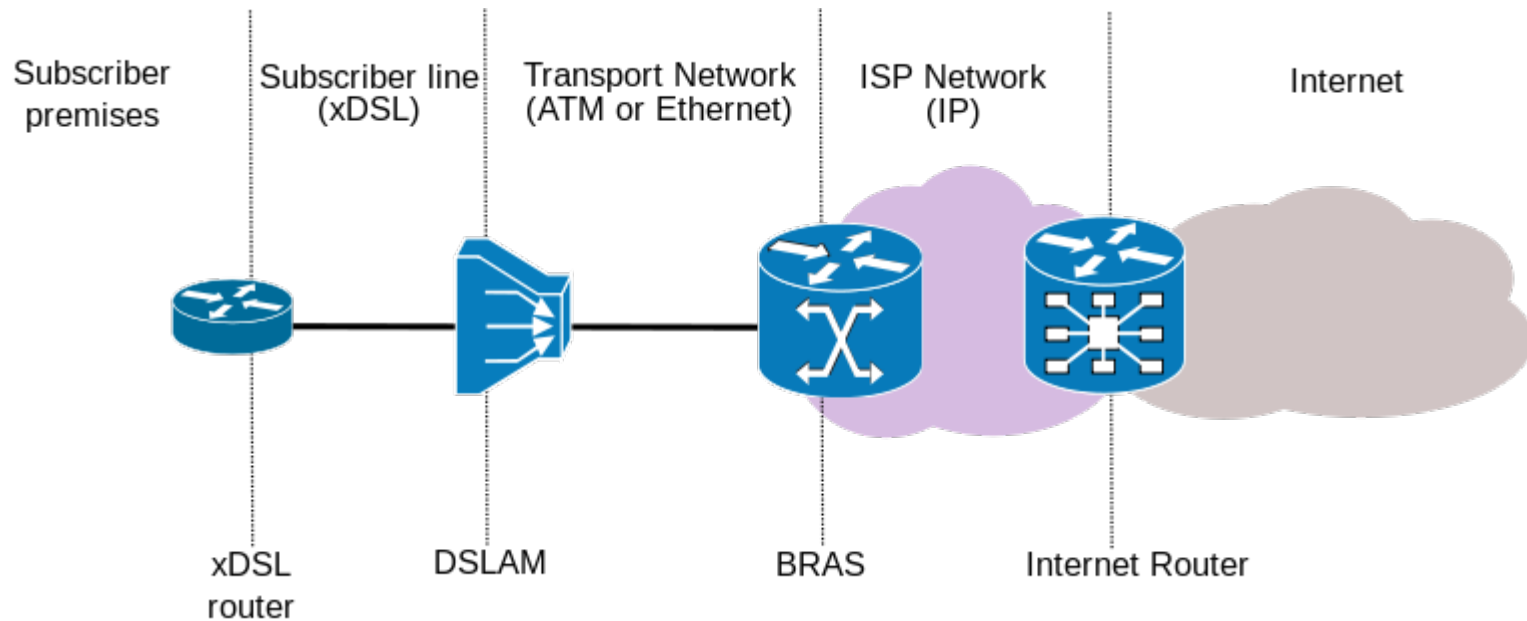
The Operator View

- ❑ Tier 1 and 2 operators divide their networks in different ways
 - Architectural – access, aggregation, core
 - Service – WAN, data center, wireless
- ❑ Helps in network management and service provisioning
 - Traffic/Routing view optimizes equipment utilization and management
 - Service view facilitates offering customers specific kinds of services

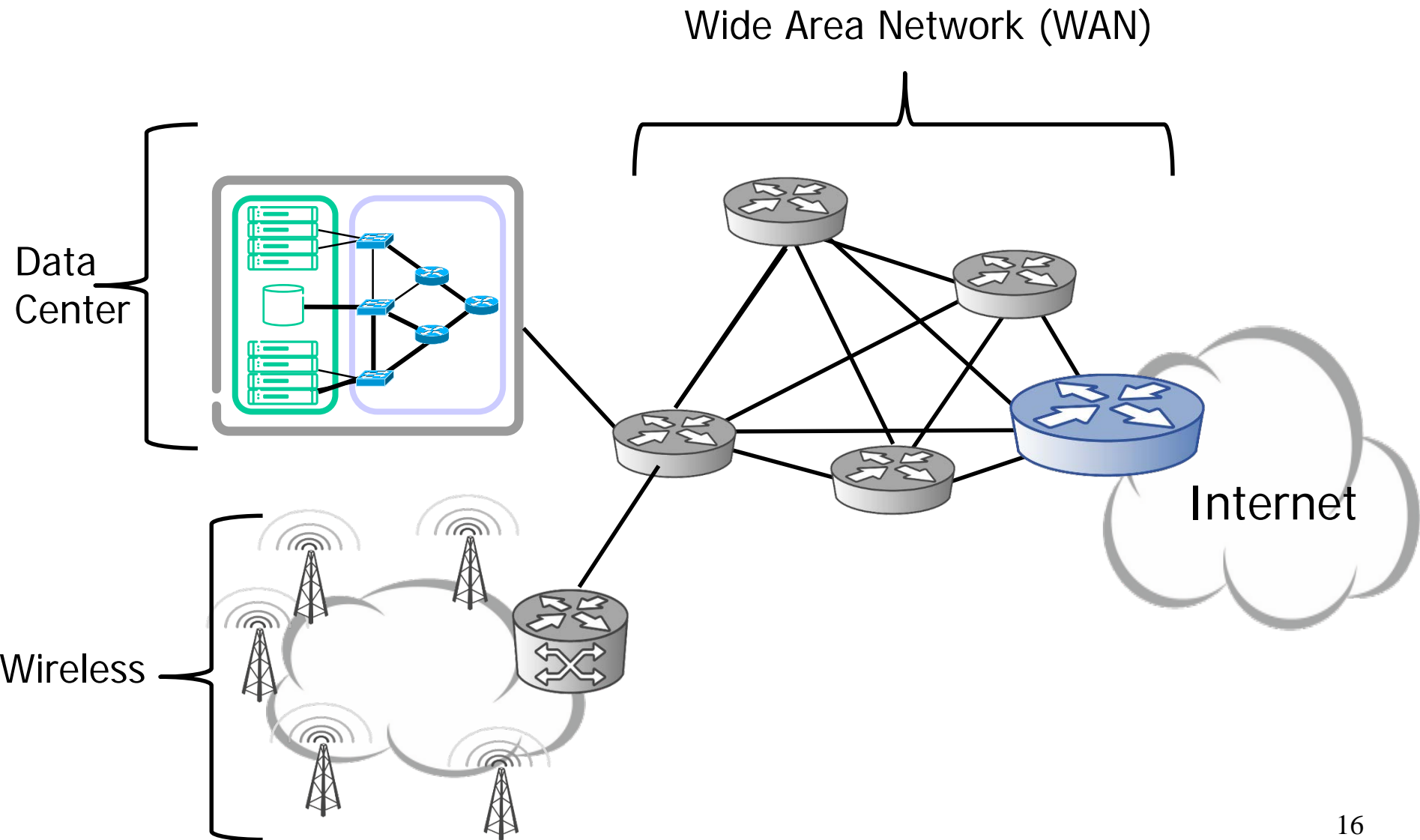
The Operator View: Architectural



The Operator View:xDSL Detail



The Operator View: Service



The Operator View: Service Offerings

❑ WAN

- L3 VPN
- L2 VPN
- Internet

❑ Data Center

- Web hosting
- Data storage

❑ Wireless

- Voice Minutes
- Data bundles
- Texts