

# Internet Routing

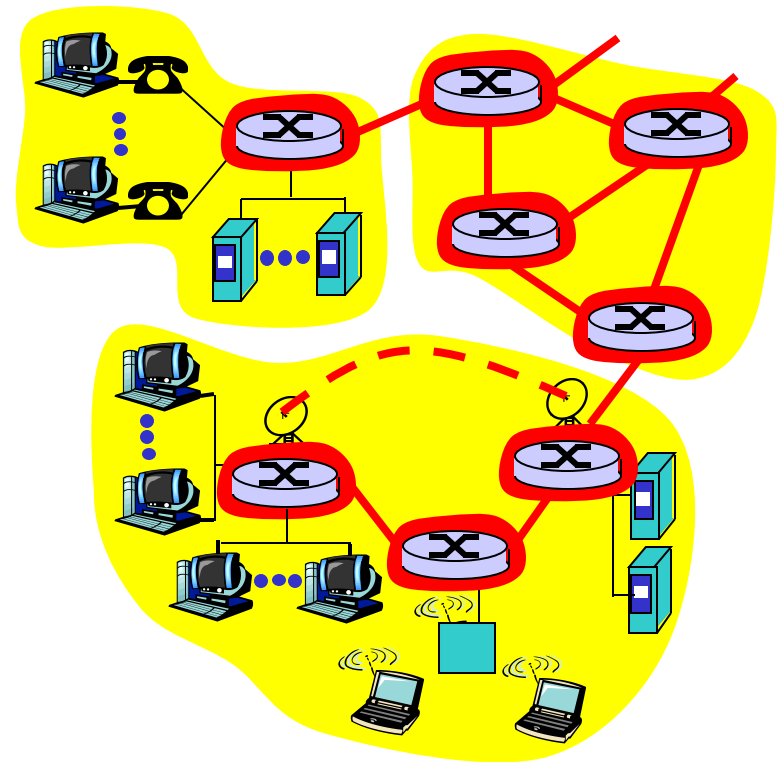
Review of Networking Principles

# 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**

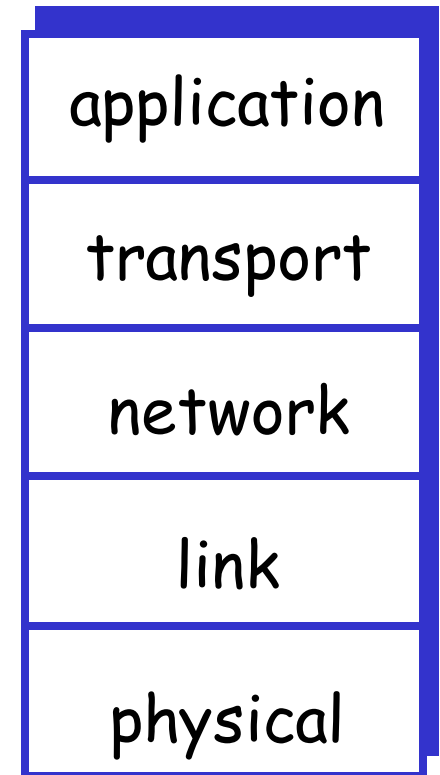
- *Destination address* determines next hop
- Routes may change during session

## □ **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

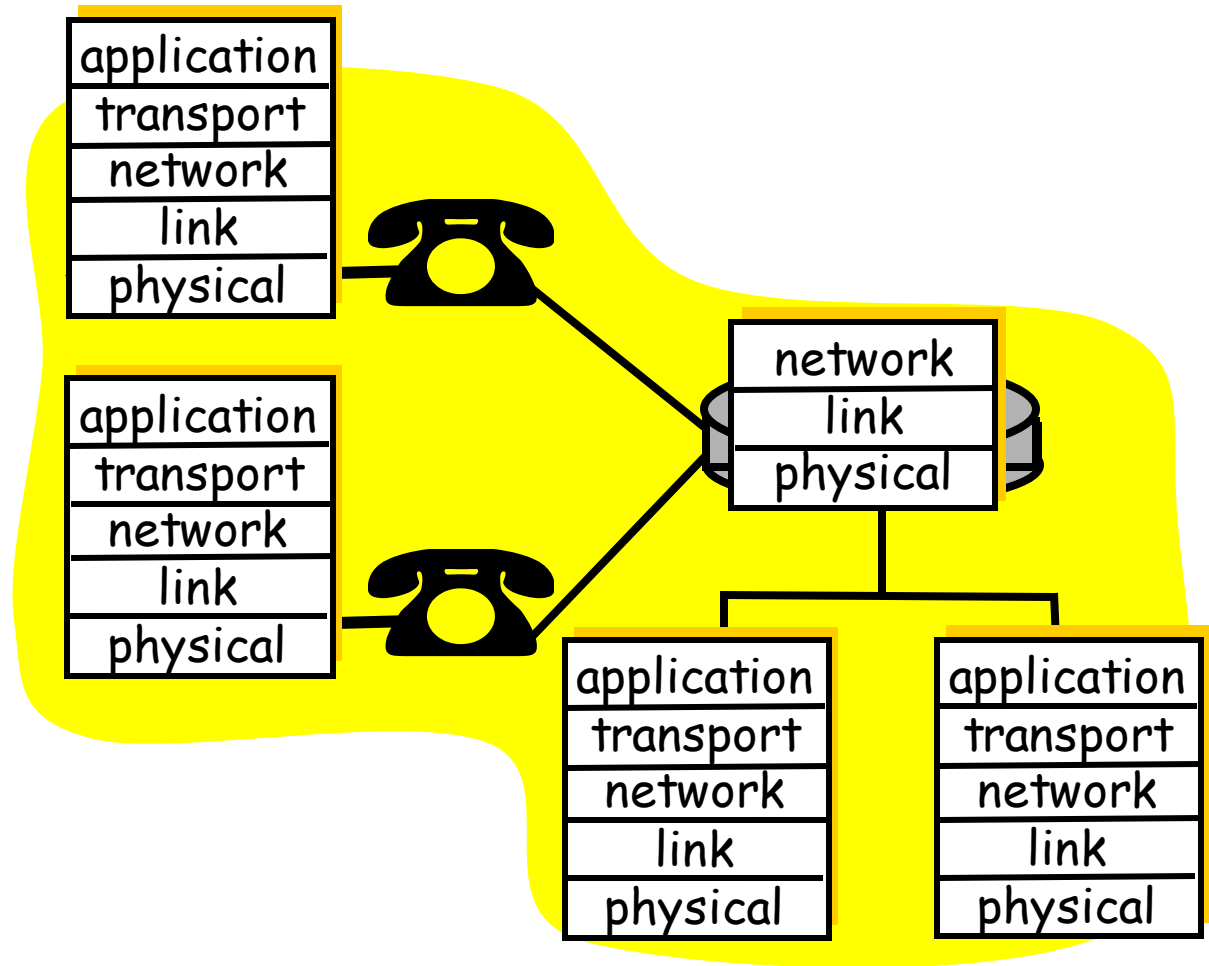
- ❑ **Application:** supporting network applications
- ❑ **Transport:** host-host data transfer
- ❑ **Network:** uniform format of packets, routing of datagrams from source to destination
- ❑ **Link:** data transfer between neighboring network elements
- ❑ **Physical:** bits “on the wire”



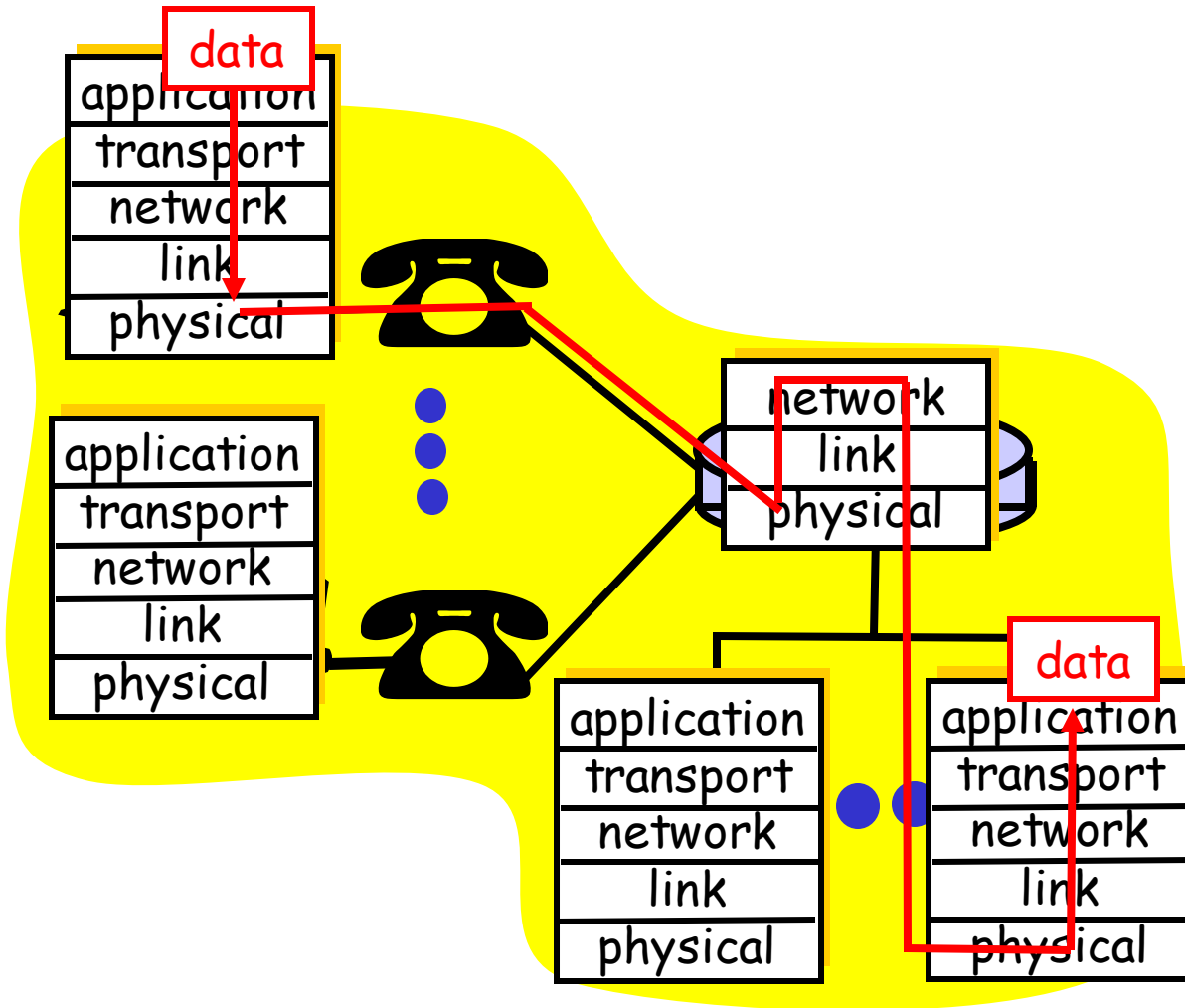
# Layering: Logical communication

Each layer:

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

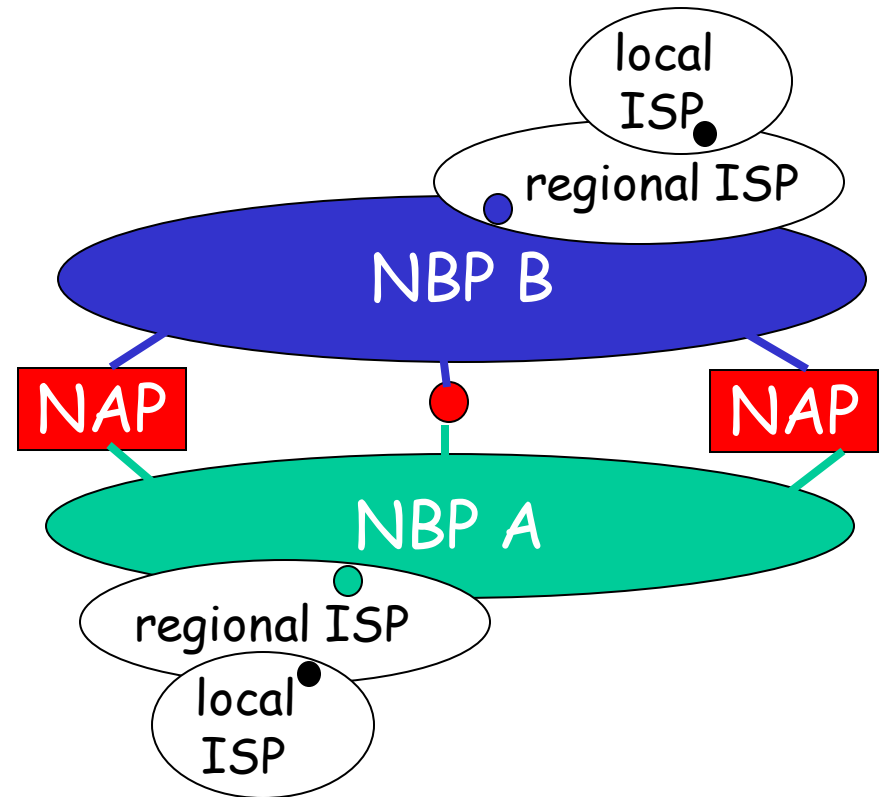


# Layering: Physical communication



# Internet structure: Network of networks

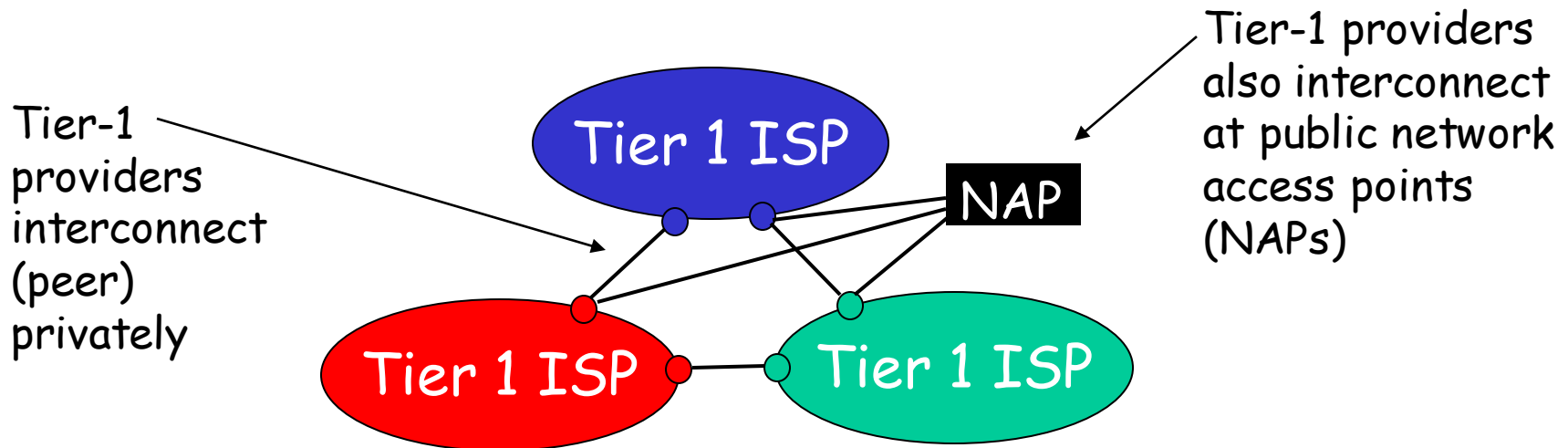
- ❑ Roughly hierarchical
- ❑ **National/international backbone providers (NBPs)**
  - E.g., BBN/GTE, Sprint, AT&T, IBM, UUNet
  - Interconnect (peer) with each other privately, or at public Network Access Point (NAPs)
- ❑ **Regional ISPs**
  - Connect into NBPs
- ❑ **Local ISP, company**
  - Connect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





# Internet structure: Network of networks

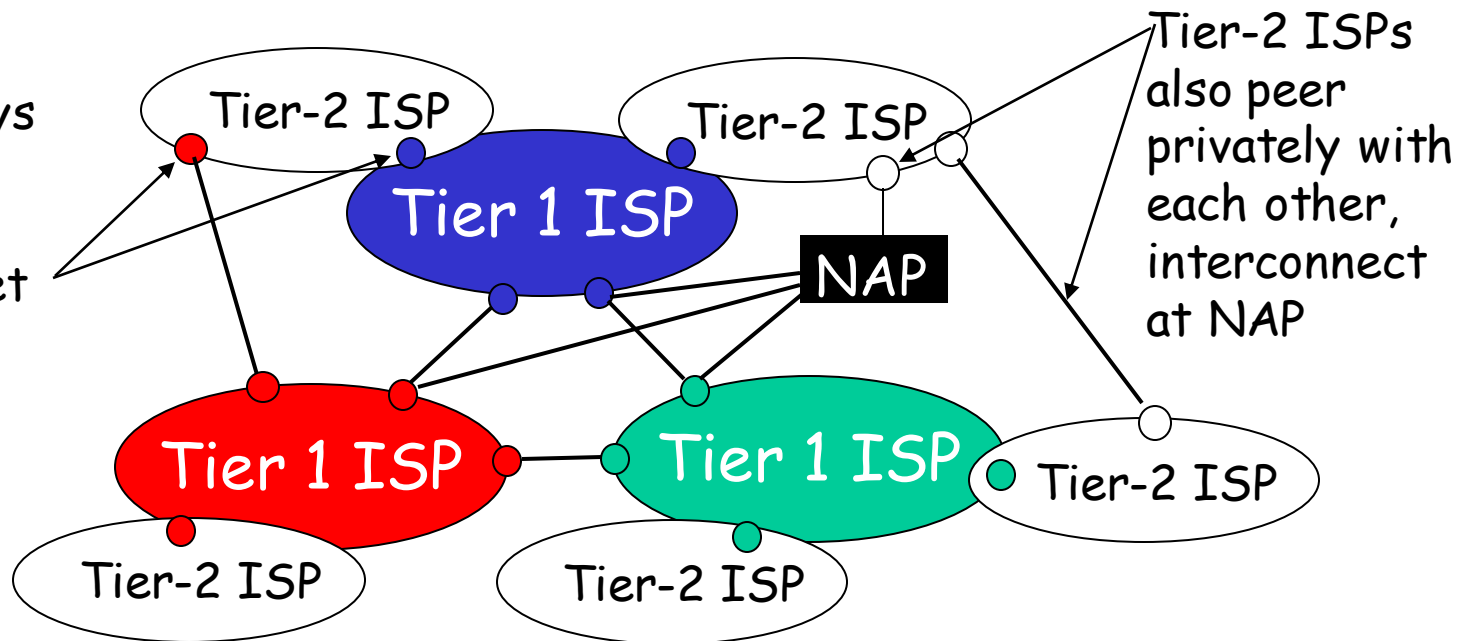
- ❑ Roughly hierarchical
- ❑ **At center: “tier-1” ISPs** (e.g., UUNet, BBN/Genuity, Sprint, AT&T), national/international coverage
  - Treat each other as equals



# 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

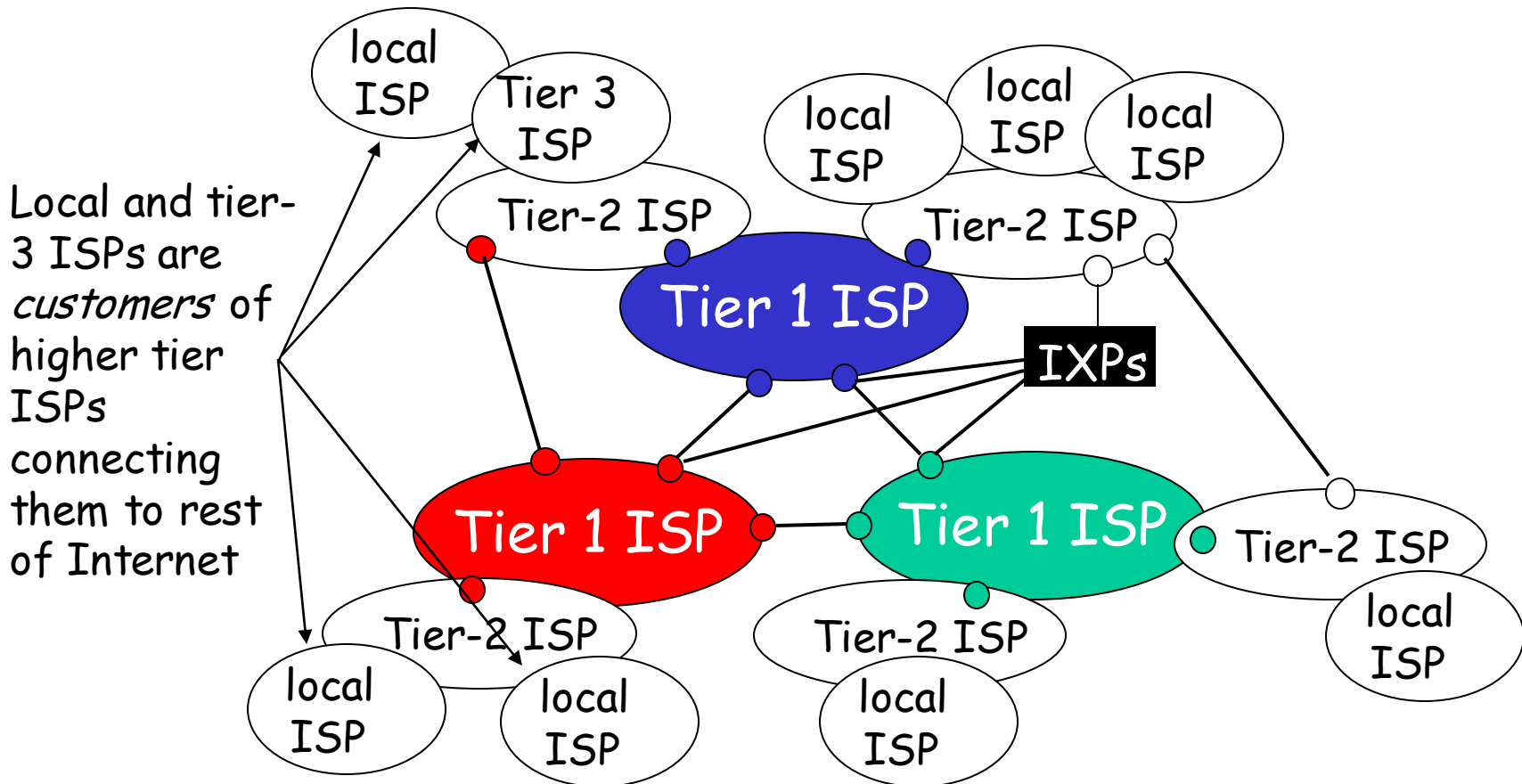
- Tier-2 ISP pays tier-1 ISP for connectivity to rest of Internet
- tier-2 ISP is *customer* of tier-1 provider



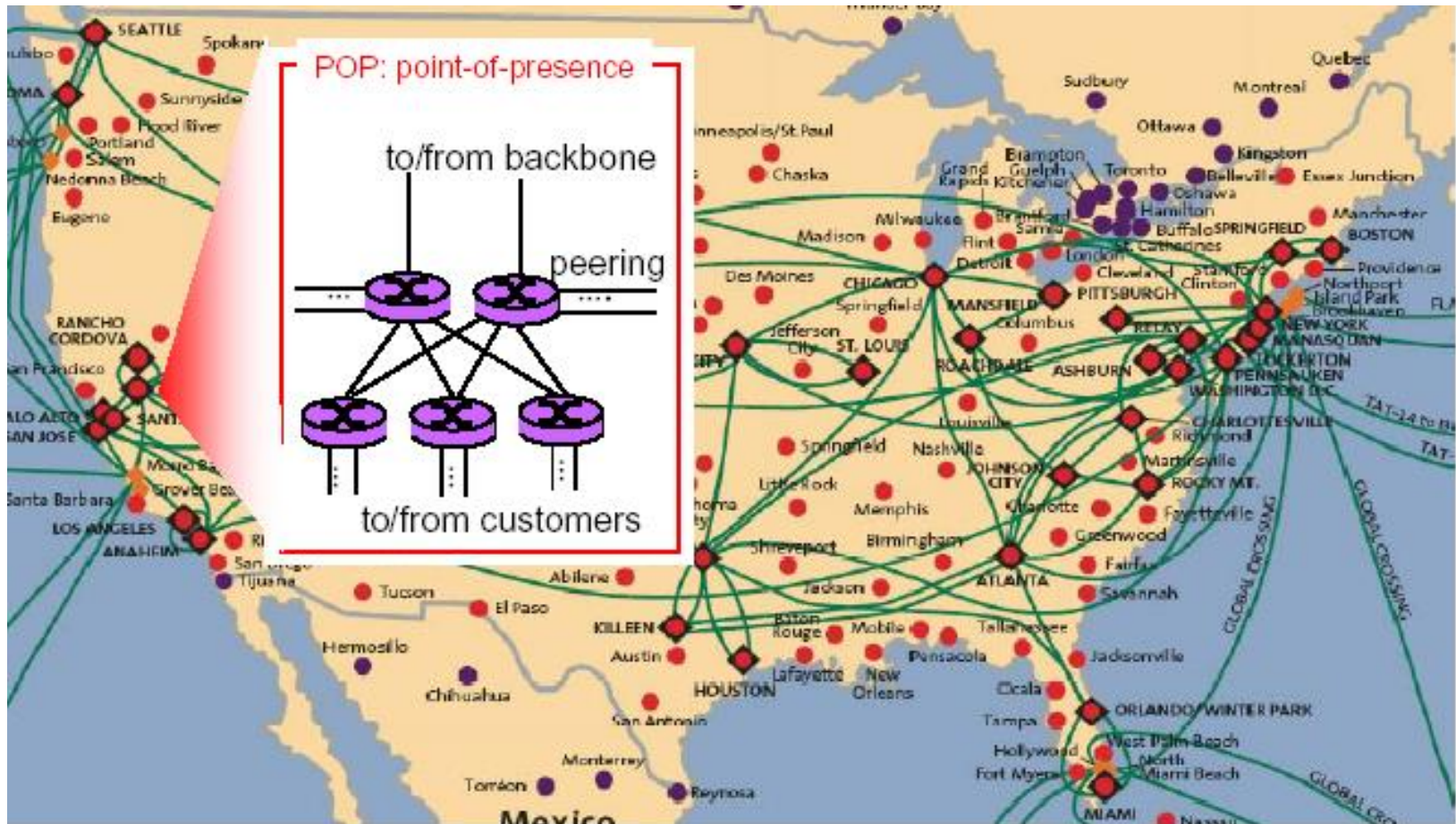
# Internet structure: Network of networks

## □ “Tier-3” ISPs and local ISPs

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



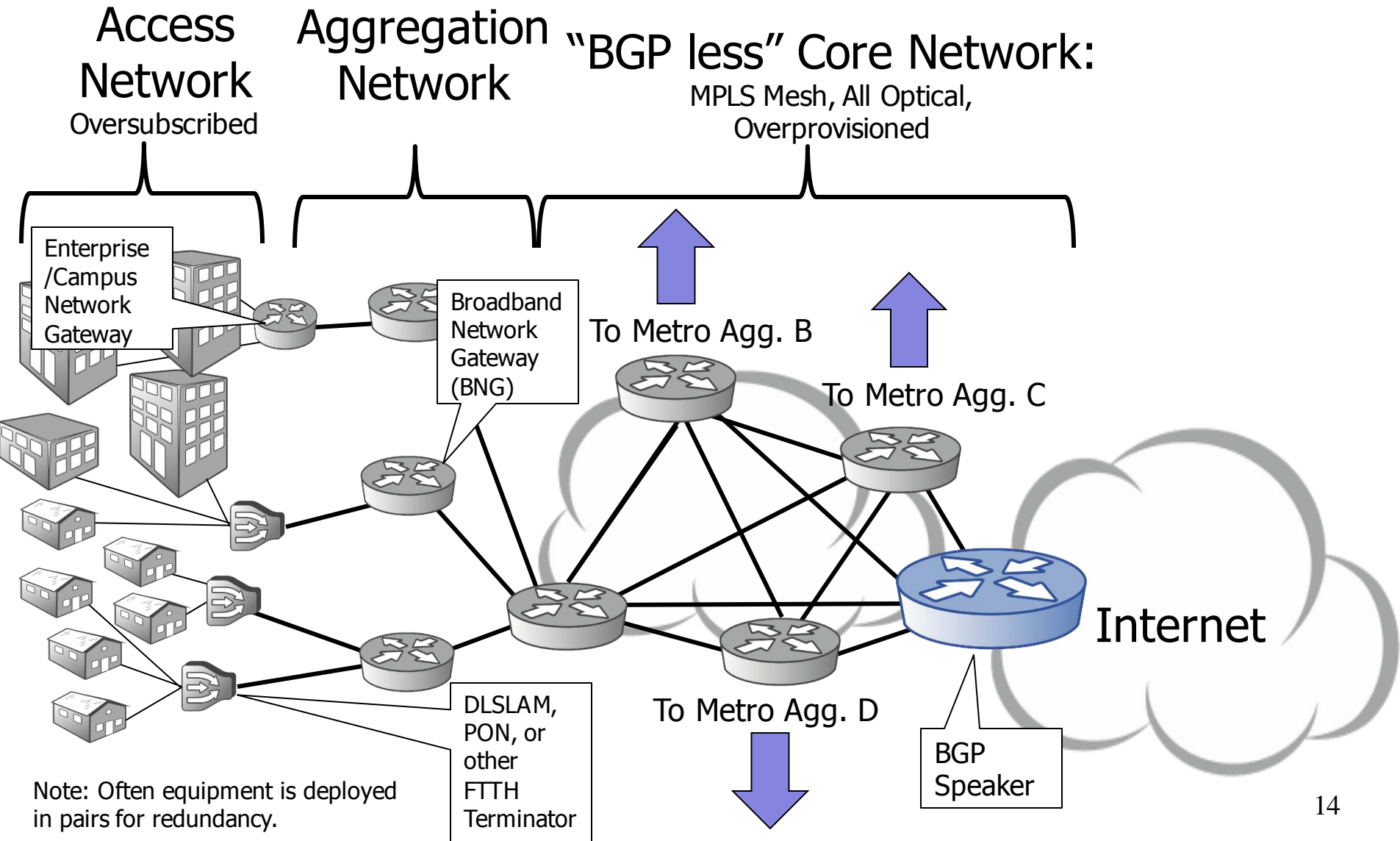
# Example Tier-1 ISP: Sprint



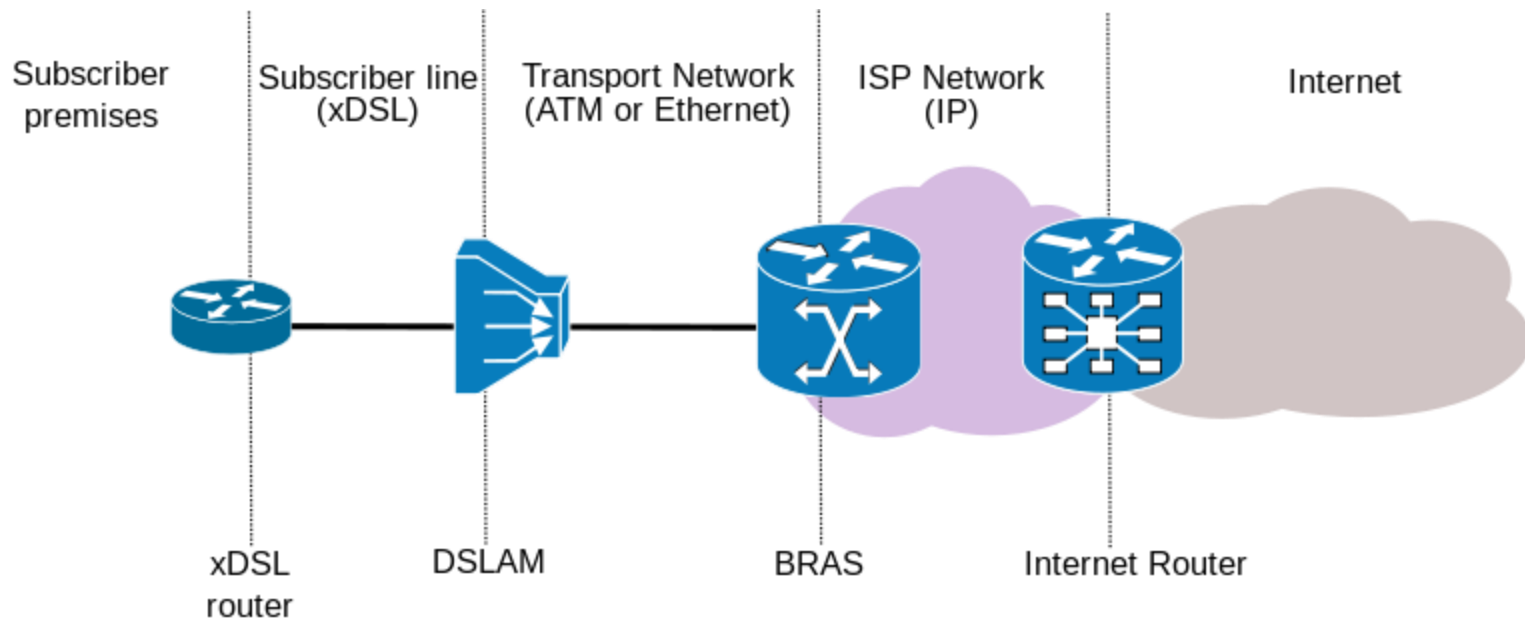
# The Operator View

- ❑ 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

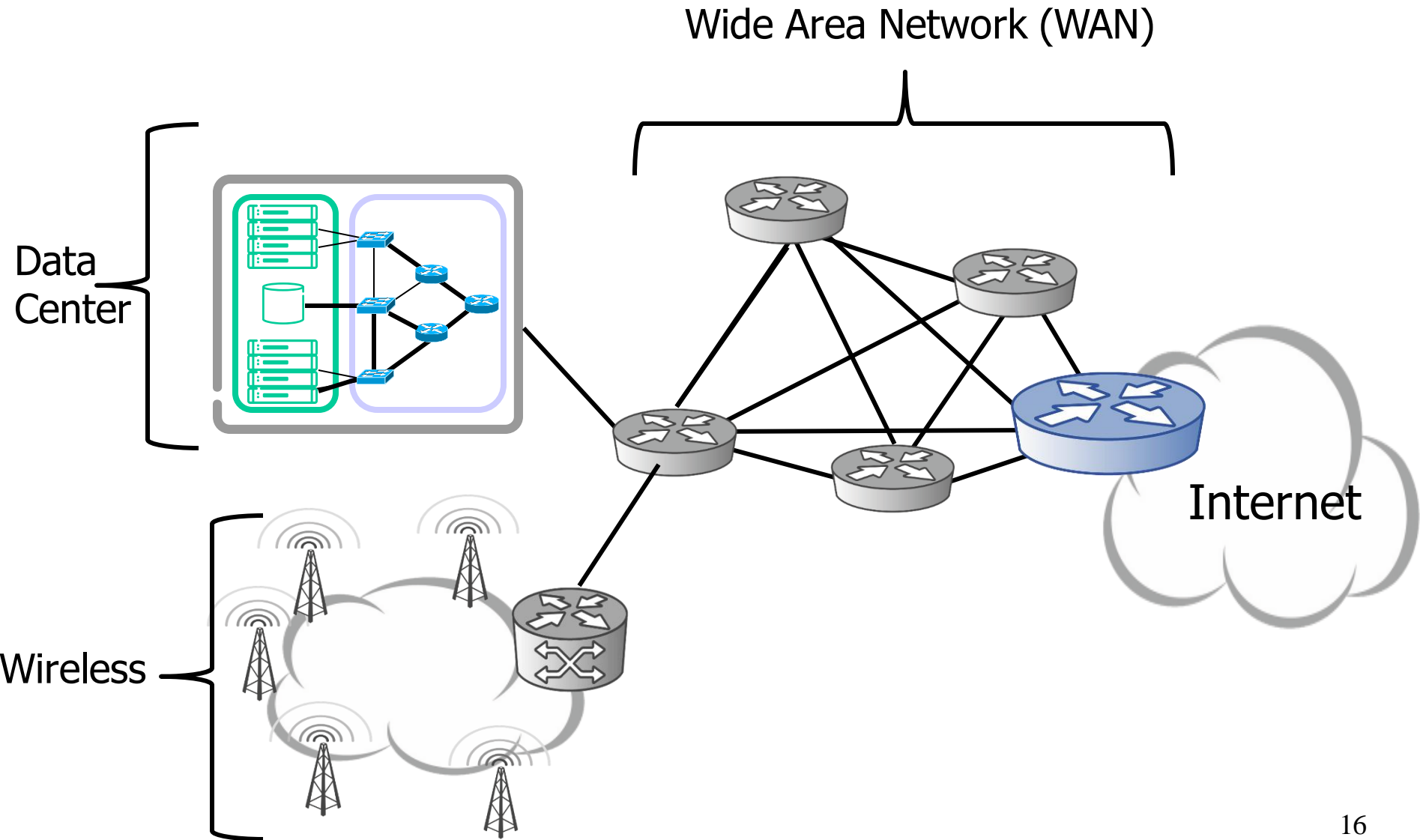
# The Operator View: Architectural



# 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