Internet Routing

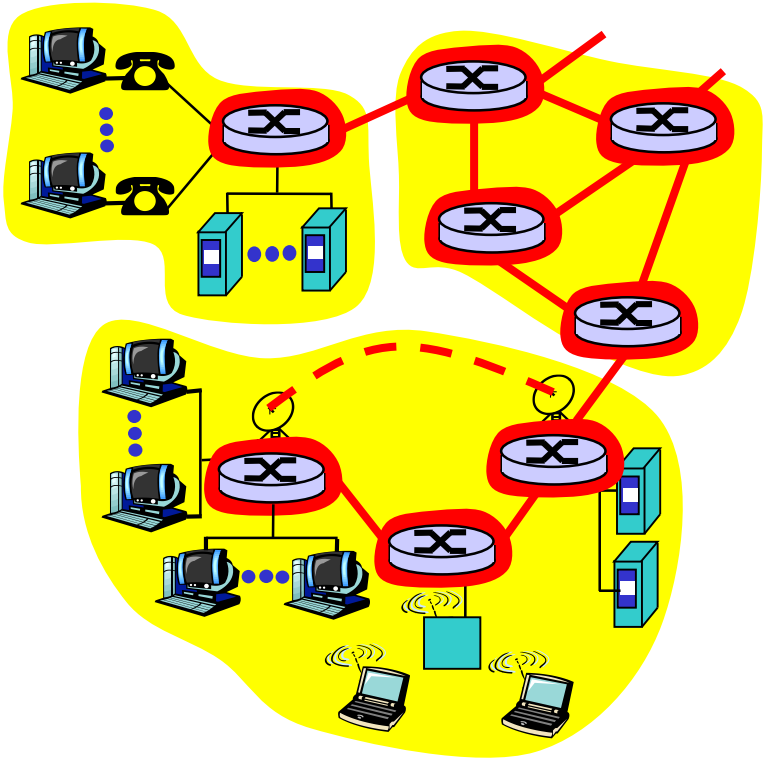
Review of Networking Principles

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"



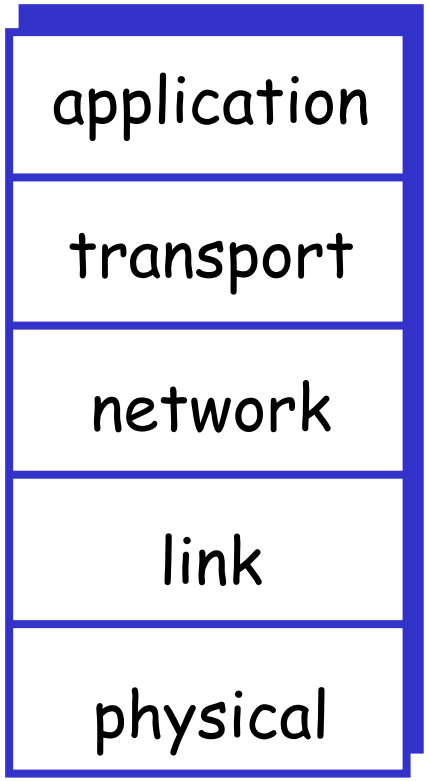
Routing

- *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

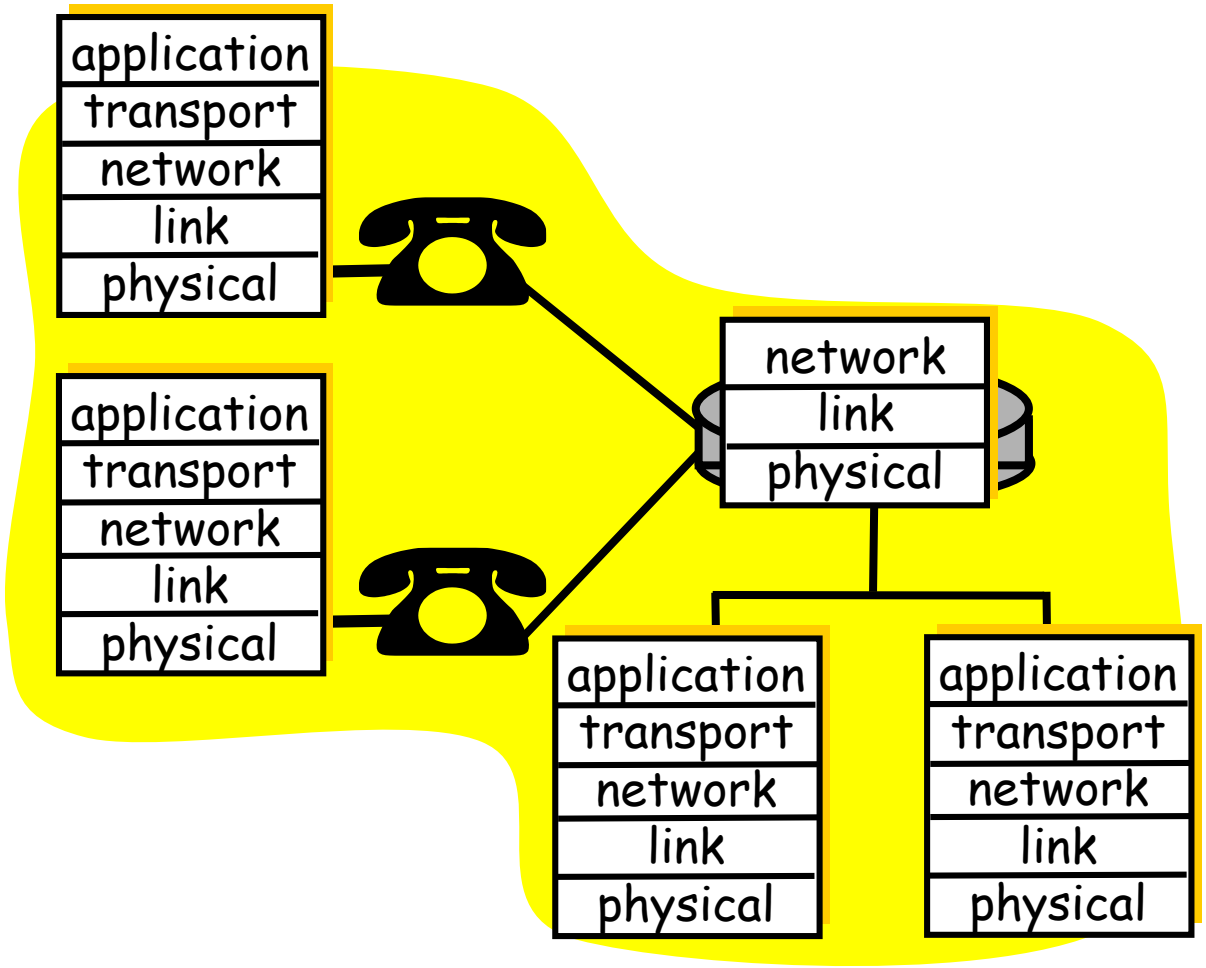
- Application: supporting network applications
- Transport: host-host data transfer
- Network: uniform format of packets, routing of datagrams from source to destination
- Link: data transfer between neighboring network elements
- Physical: bits "on the wire"



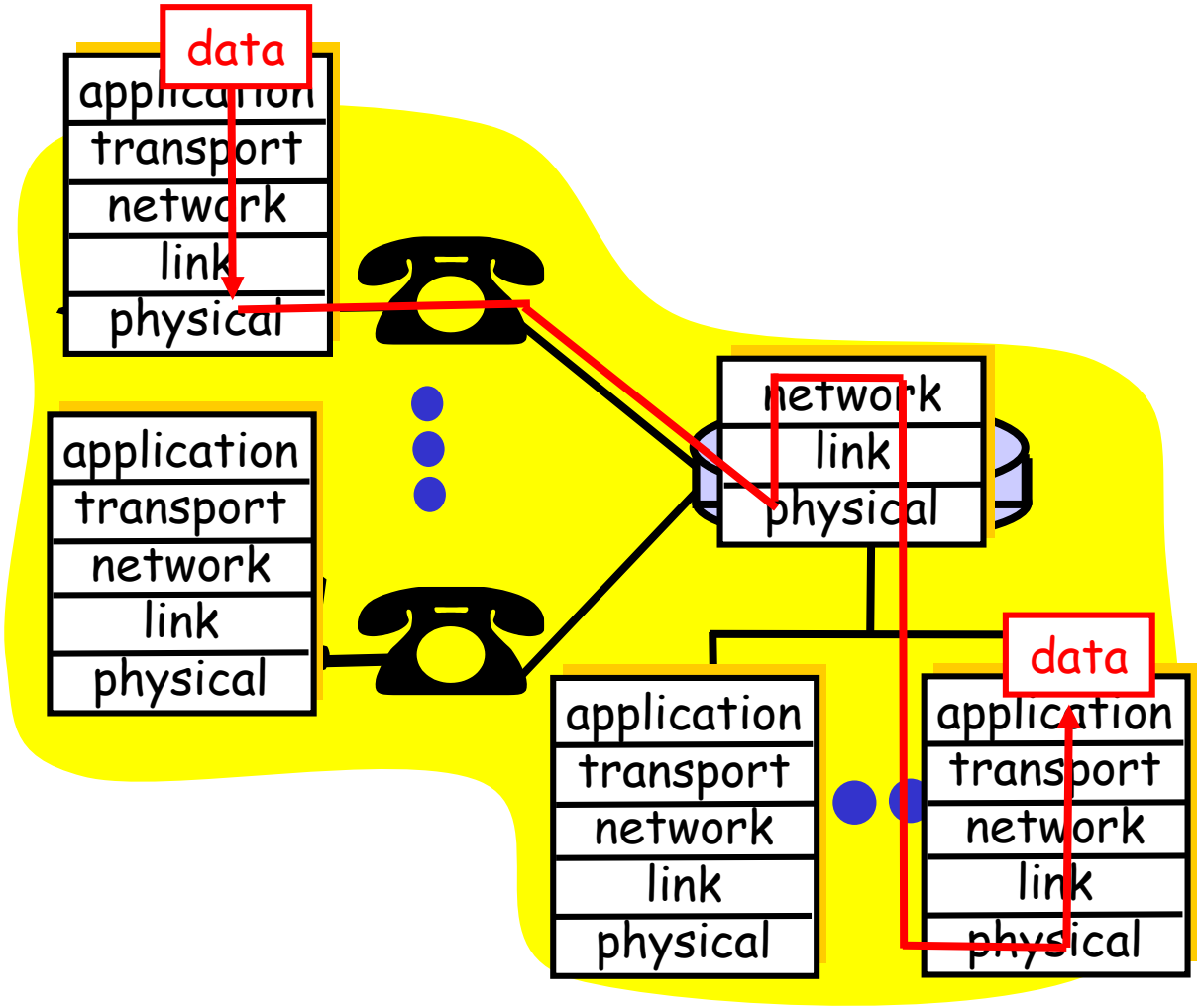
Layering: Logical communication

Each layer:

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

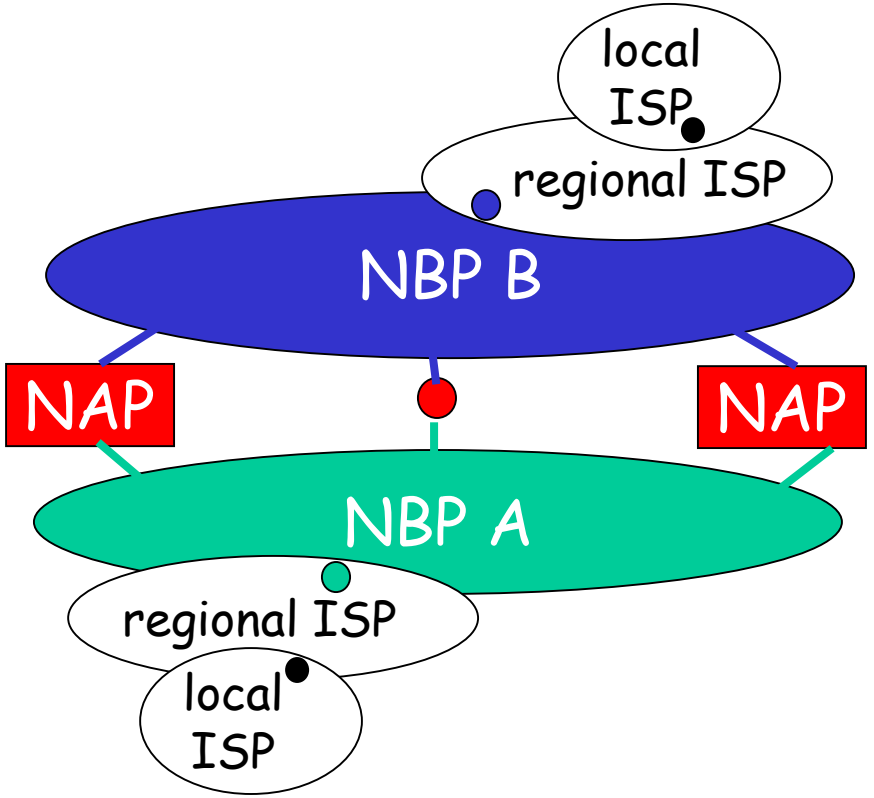


Layering: Physical communication



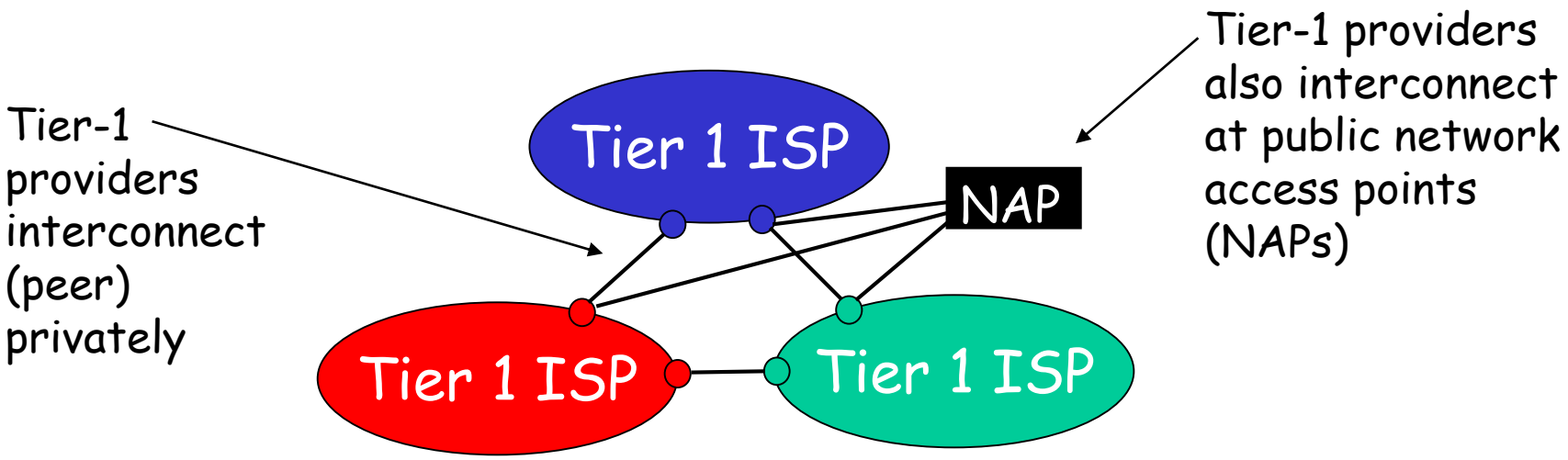
Internet structure: Network of networks

- 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



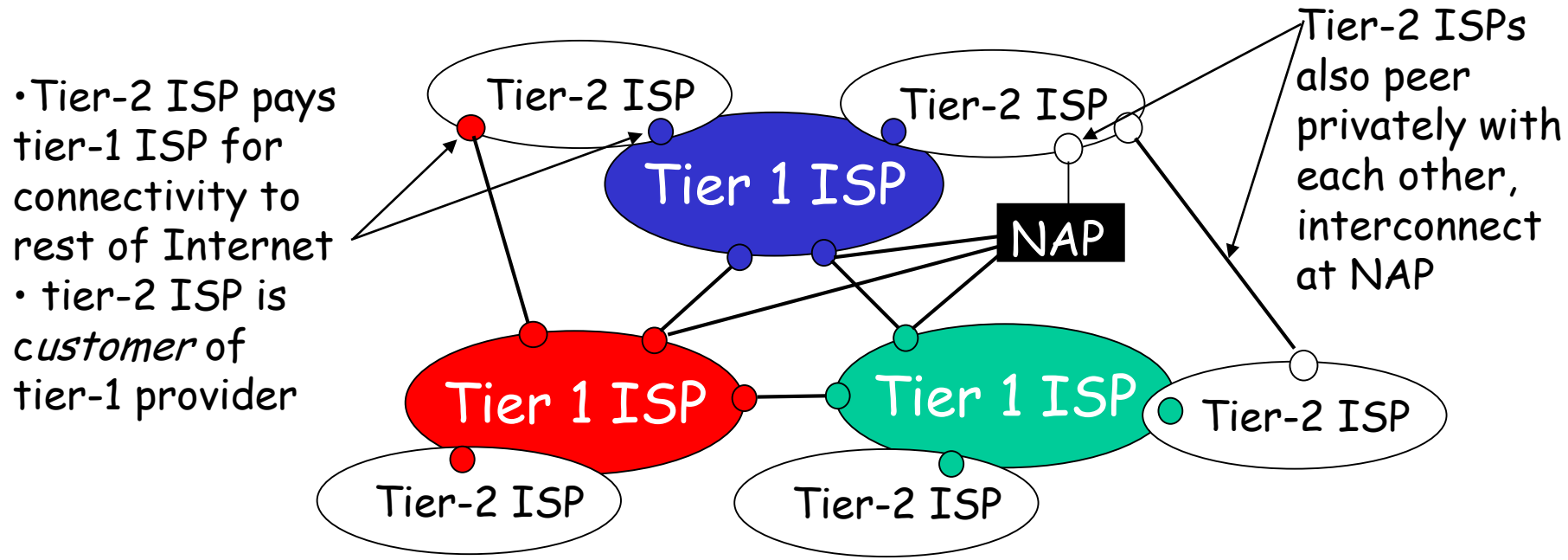
Internet structure: Network of networks

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



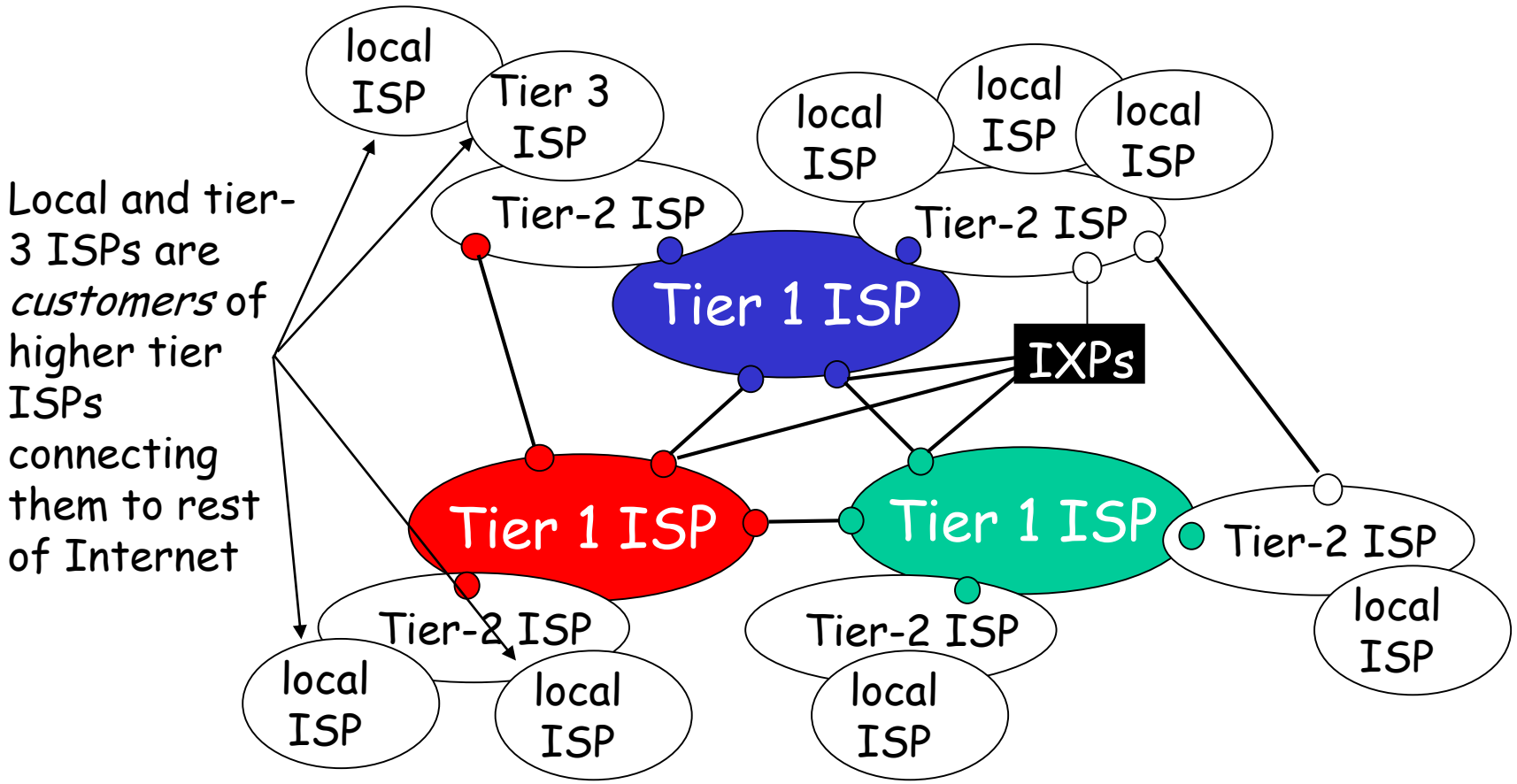
Internet structure: Network of networks

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

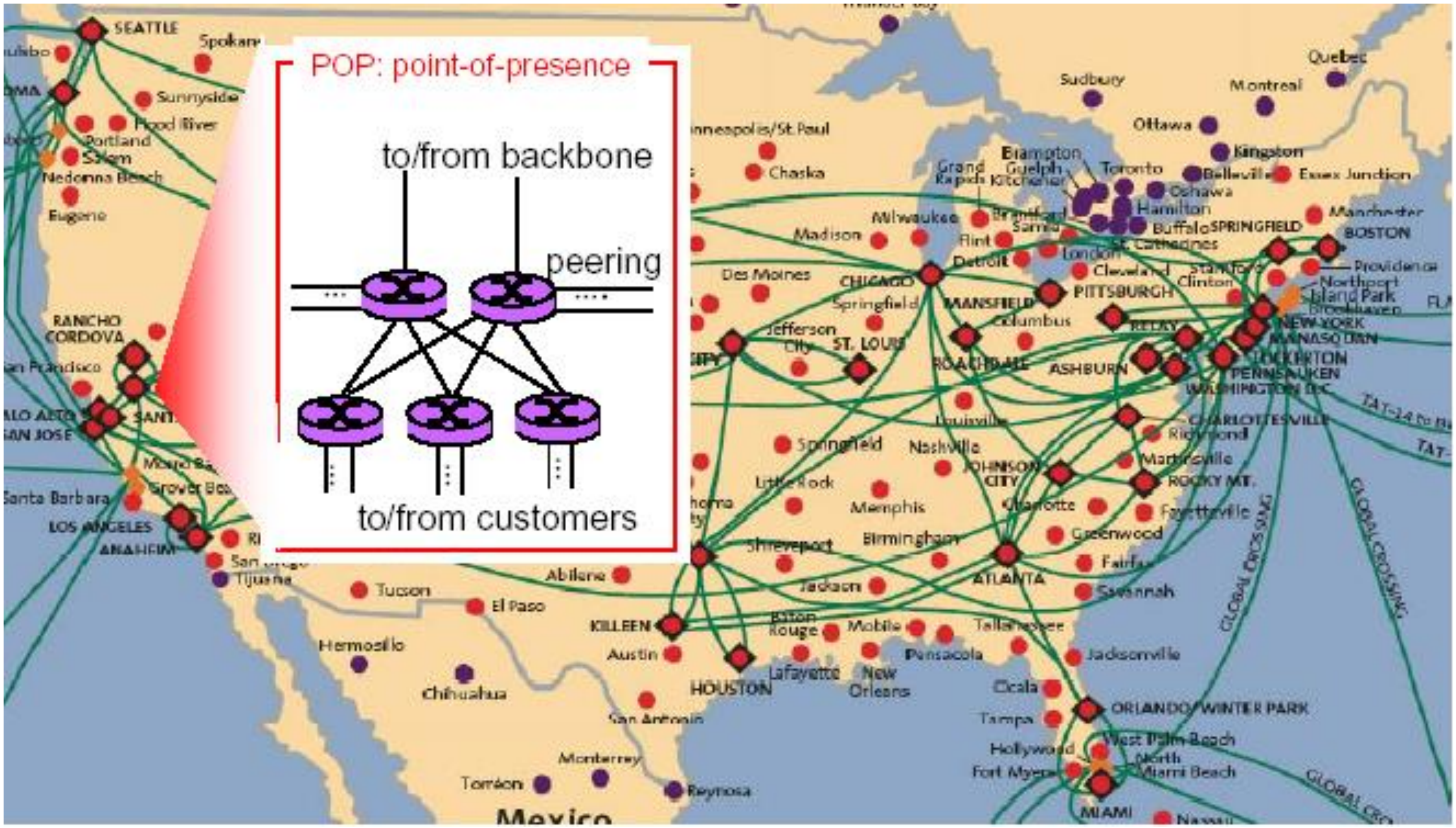


Internet structure: Network of networks

- "Tier-3" ISPs and local ISPs
  - Last hop ("access") network (closest to end systems)



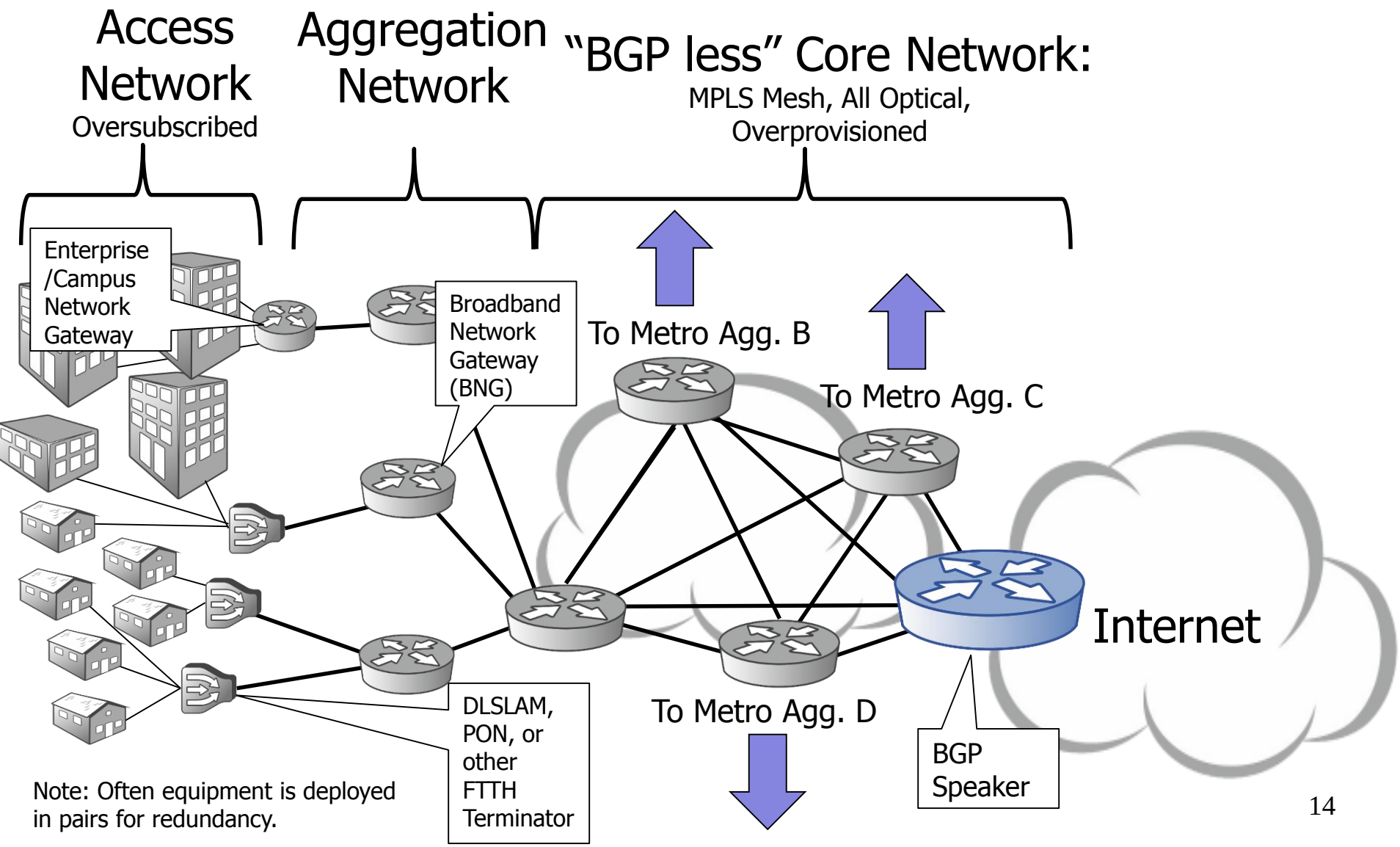
Example Tier-1 ISP: Sprint



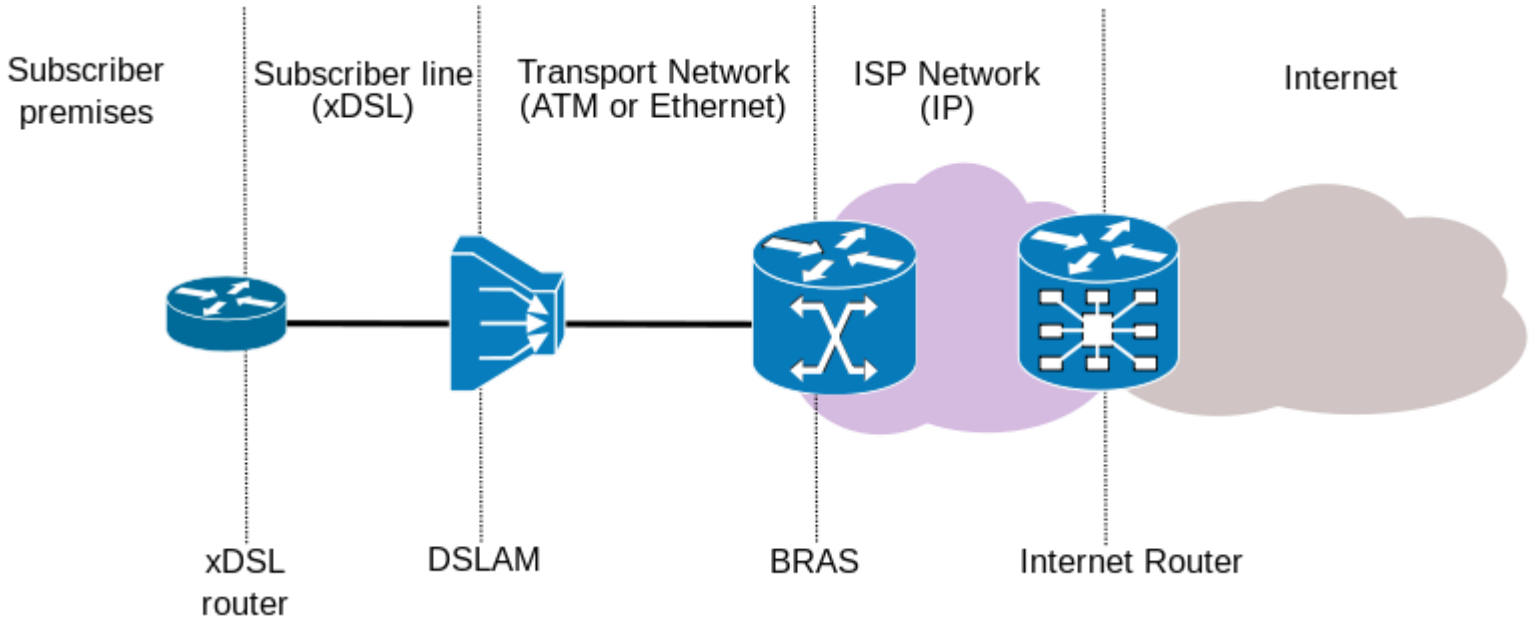
The Operator View

- 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

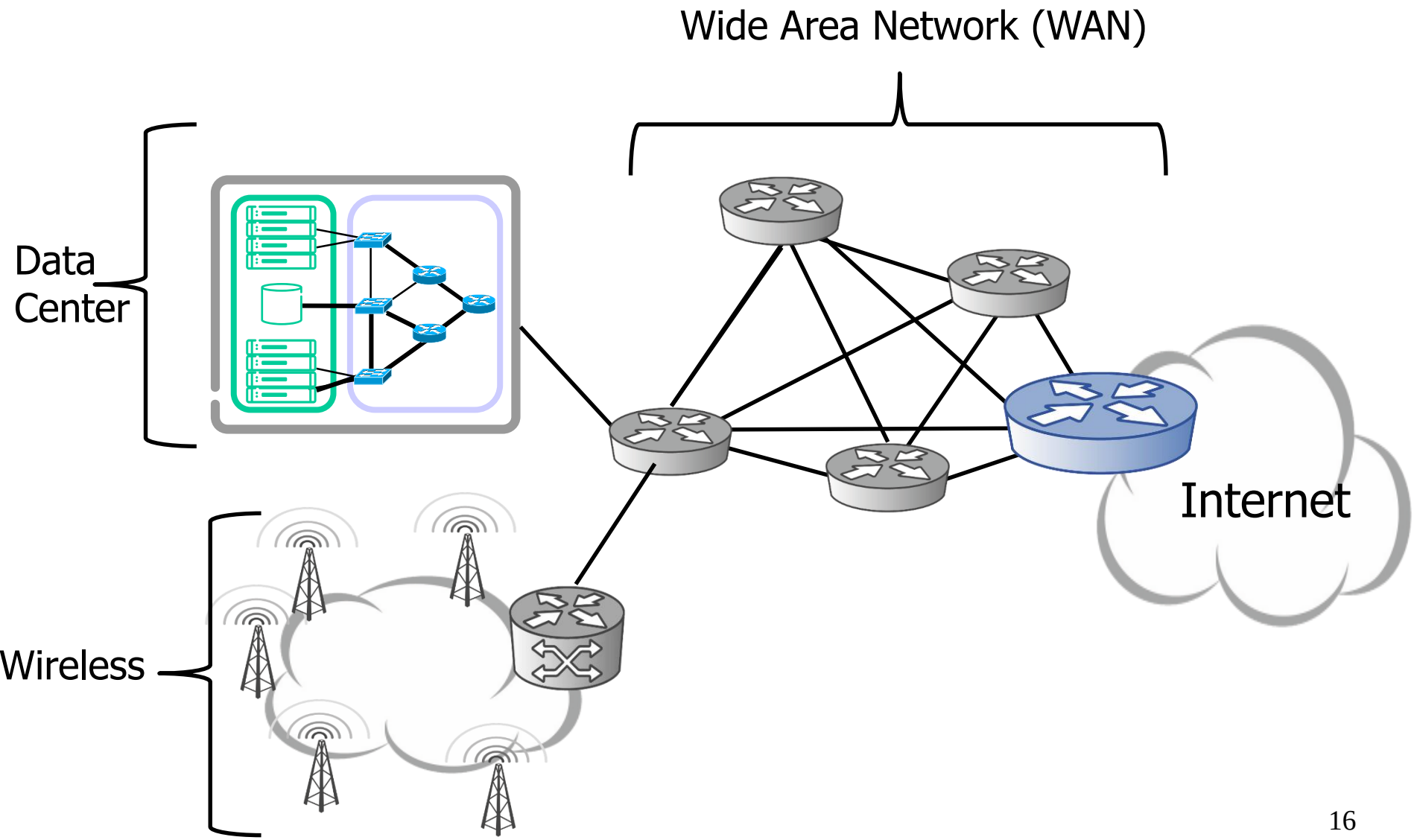


The Operator View:xDSL Detail



From http://en.wikipedia.org/wiki/File:XDSL_Connectivity_Diagram_en.svg

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