The Picture So Far

- We have seen how to transmit frames/packets between stations over a single channel
  - Point-to-point or shared medium (LAN)
  - Framing, error control, MAC functions
- Problem: single channels don't scale
  - Can't build an 802 network to cover all of Kentucky, much less the whole country
  - Why not? Speed of light limitations
    - Even as channel capacity grows without limit, \((\text{frame xmit time} \to 0)\)
    - As network covers longer distance, fraction of capacity wasted waiting for protocol information to propagate approaches 1
      - Polls or equivalent (token-passing)
      - Collisions
    - Note: power requirements, increase in offered load due to more stations are not the primary reasons!
The Solution

• Add **Store-and-forward nodes** to connect networks
  - Some stations are **connected to multiple channels**
  - They **receive** packets and **relay** them to other channels
  - Relay nodes are called **Intermediate systems (ISs)**
Store-and-Forward Networks

- The **forwarding challenge**:
  - Each IS needs to make a decision for each packet:
    - Which channel to relay it to?
  - In general, there may be several choices of outgoing channel
    - Requirements: (i) packet arrives at its destination; (ii) packet doesn't go too far "out of the way"

- The **Fundamental principle of forwarding**:
  - Each packet **must contain information** the IS can use to make this decision
    - (Exception: random-walk routing: just forward the packet on any link.
      In a finite network, it arrives with probability 1.)
  - IS may also store **state information** to use in making the decision
Terminology: Switching vs. Forwarding

- These terms are sometimes used as synonyms
- **Switching** refers to the operation of connecting channels together to make a single channel
  - Circuit switching: relaying *signals*
    - Requires that all channels in network look (more or less) the same at the symbol level
      - Telephone network was originally circuit-switched
    - End-to-end delay is more-or-less fixed and predictable
  - Packet switching: relaying frames or packets
    - Allows different lower layers to be concatenated together
    - Introduces queueing delay
- **Forwarding** refers to relaying packets from one channel to another
  (Note: no such thing as "circuit forwarding")
Parts of the Problem

• Three separable aspects:
  1. Determining what paths lead to each destination ("Path discovery")
  2. Choosing a path to each destination ("Path selection")
  3. Ensuring that each packet follows the chosen path ("Forwarding")

• How to identify destinations?
  Different channels may use different addressing schemes

• Different approaches assign responsibility for these aspects to different parties
More Terminology

• So what is **Routing**?

• Refers to the **path discovery** and **path selection** parts of the problem (as opposed to forwarding)

• Typically, "routing" refers to the way the Internet Protocol solves the problem:
  - Global address space, **tied to topology**
  - IS's **exchange information** that enables them to determine the best path to each destination

  (More on this later)