Lecture 3

Internet

concepts, foundations

Facts and Concepts

- Layering : Analogy with airline industry —> protocols --> ISO / OSI architecture —> Success of layering evident today

- Network Edge : Client/server vs. P2P architecture vs. Hybrid

- Network Edge : Connection-less (UDP) vs. Connection-oriented service (TCP)

- Network Edge : Residential access networks : Wired access (DSL vs. Cable)

- Network Edge : Residential access networks : Wireless vs. Cellular vs. Satellite

- Network Core : Circuit switching vs. Packet switching

- Network Core : Circuit switching : FDM vs. TDM

- Network Core : Packet switching : Statistical multiplexing

- Network Core : Packet switching : Datagrams vs. Virtual circuits

- Network Computing : Cloud vs. Edge

- Foundations:
  - Signals: time and frequency domain representation (FFT)
  - Bandwidth, Spectrum
  - Carrier frequency, Modulation, encoding, decoding,
  - Bit rate, bit error rate (BER), Packet error rate (PER)
  - Throughput, Congestion
  - Latency (Transmit time, Propagation delay, Queueing time, Processing time)
  - Wireless: SNR, SINR, Shannon's capacity,

- Real Internet measurements (Traceroute)

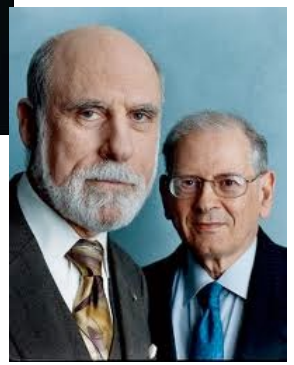
- Timeline and history …

On the Shoulders of Giants

- 1961: Leonard Kleinrock published a work on packet switching
- 1962: J. Licklider described a worldwide network of computers called Galactic Network
- 1965: Larry Roberts designed the ARPANET that communicated over long distance links
- 1971: Ray Tomilson invents email at BBN
- 1972: Bob Kahn and Vint Cerf invented TCP for reliable packet transport



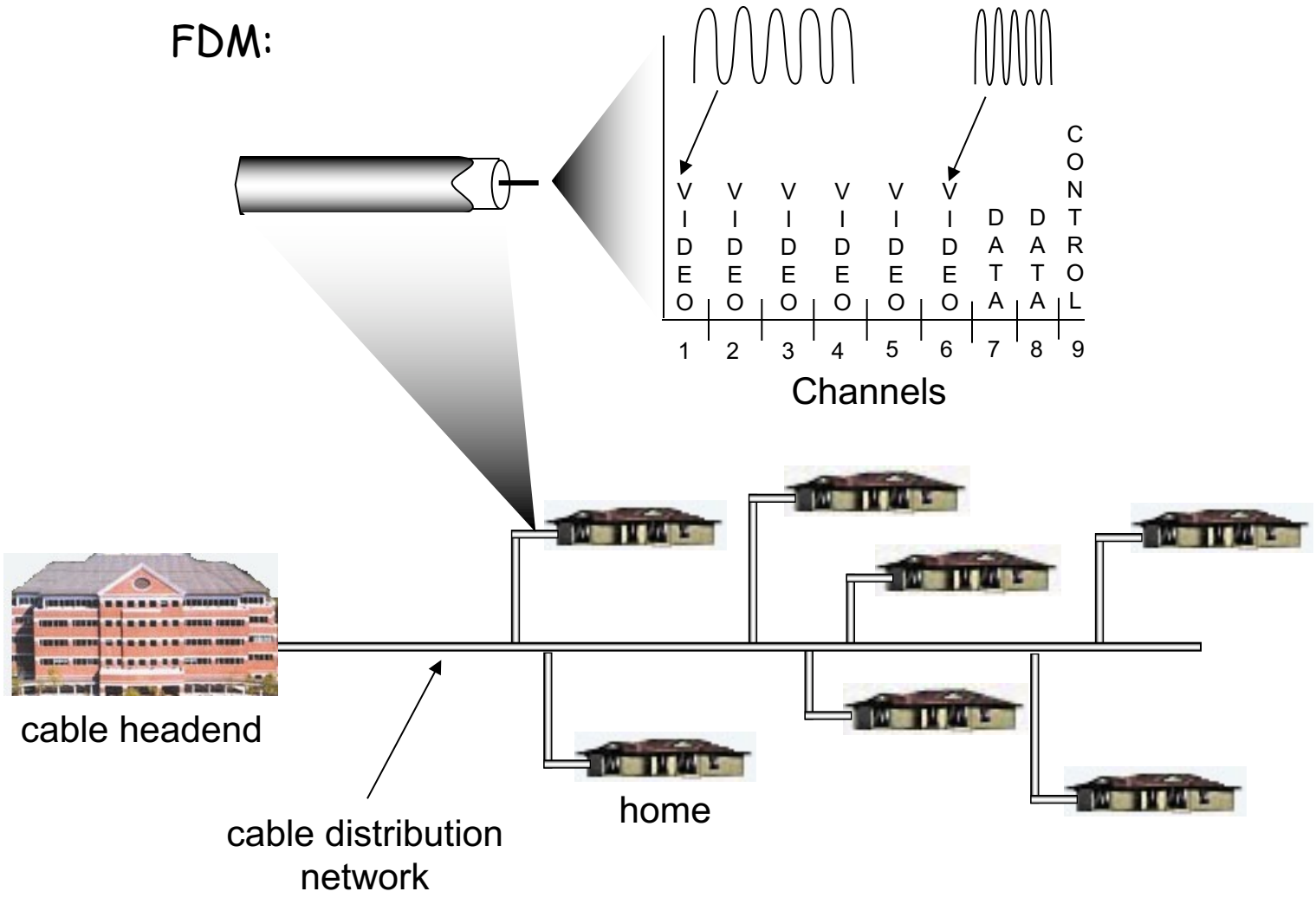




On the Shoulders of Giants …

- 1973: David Clark, Bob Metcalfe implemented TCP and designed ethernet at Xerox PARC
- 1975: Paul Mockapetris developed DNS system for host lookup
- 1980: Radia Perlman invented spanning tree algorithm for bridging separate networks
- Things snowballed from there on …

Cable Network Architecture: Overview

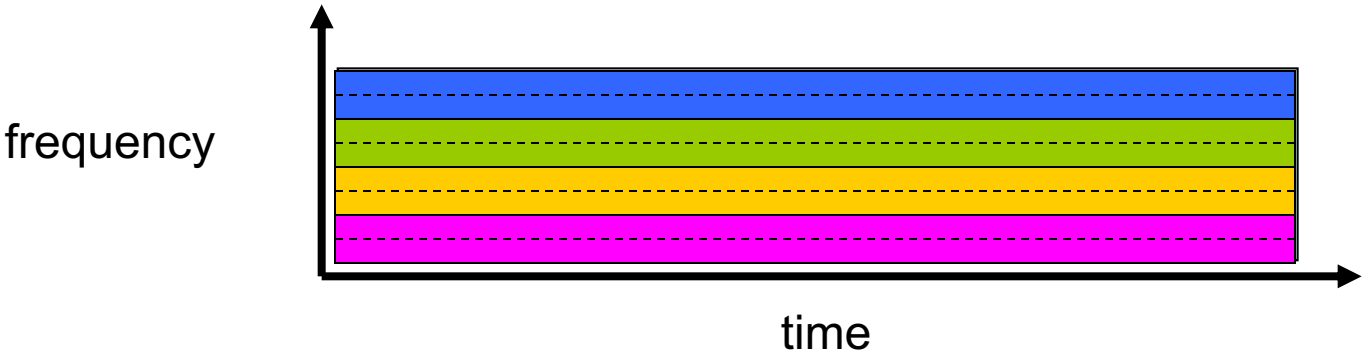


Circuit Switching: FDM and TDM

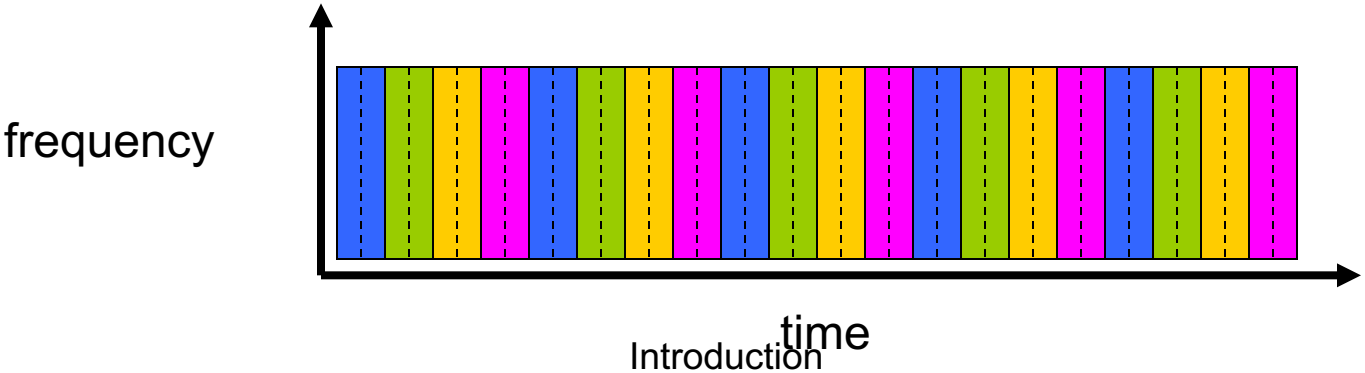
Example:

4 users

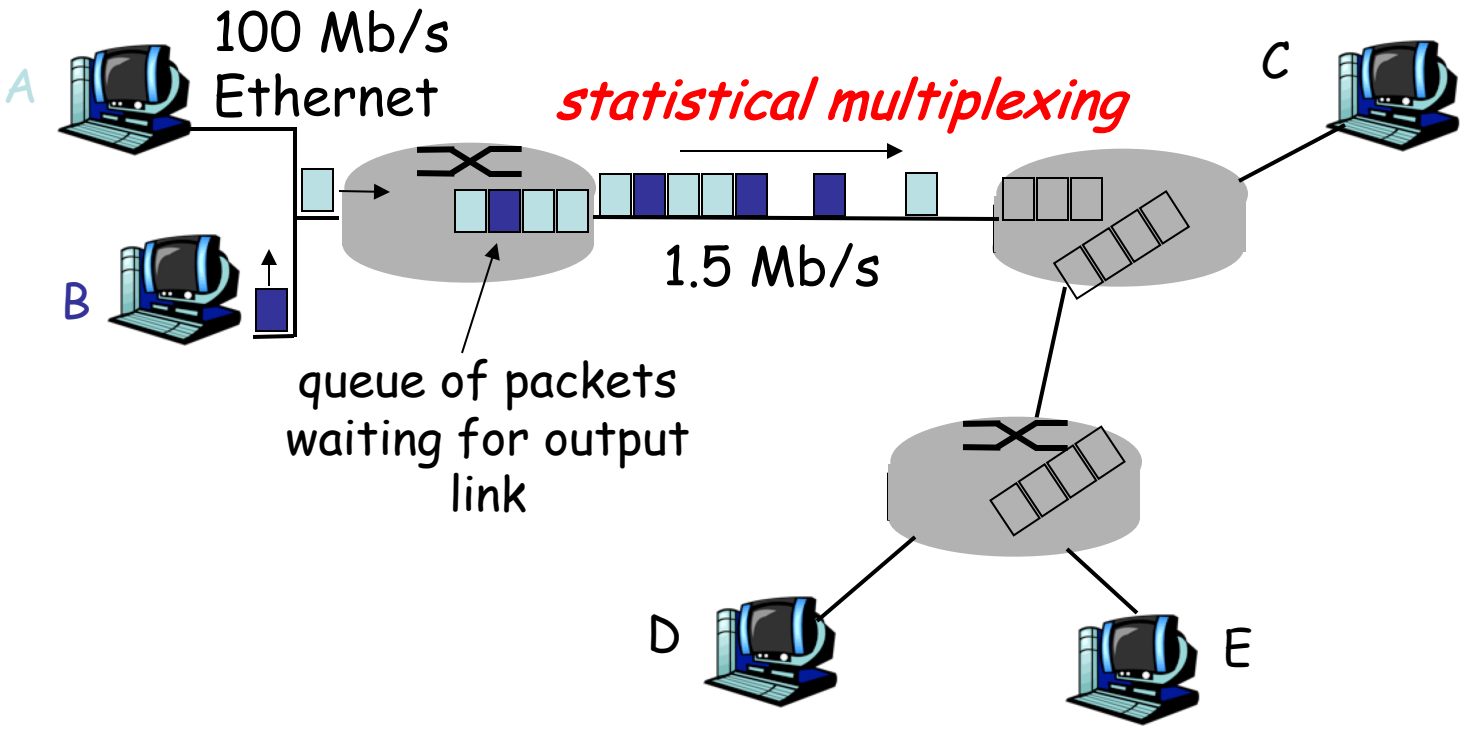
FDM



TDM



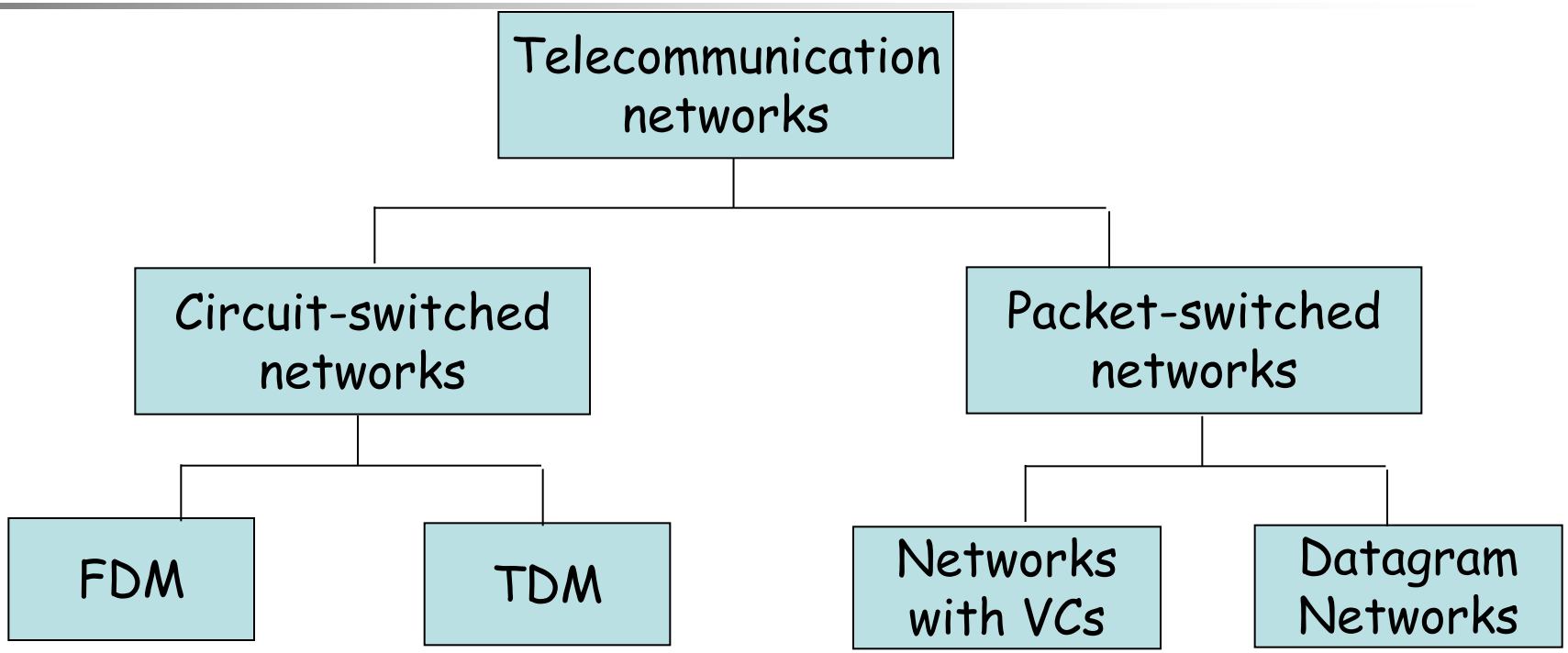
Packet Switching: Statistical Multiplexing



Sequence of A & B packets does not have fixed pattern, shared on demand ➡ ***statistical multiplexing***.

TDM: each host gets same slot in revolving TDM frame.

Network Taxonomy



- Datagram network is *not* either connection-oriented or connectionless.
- Internet provides both connection-oriented (TCP) and connectionless services (UDP) to apps.

Assignment # -1

Watch "City in the Sky" documentary on Netflix

You will appreciate both airline systems and
The Internet much more than you do now …