Lecture 5

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

→ Link layer.

- 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
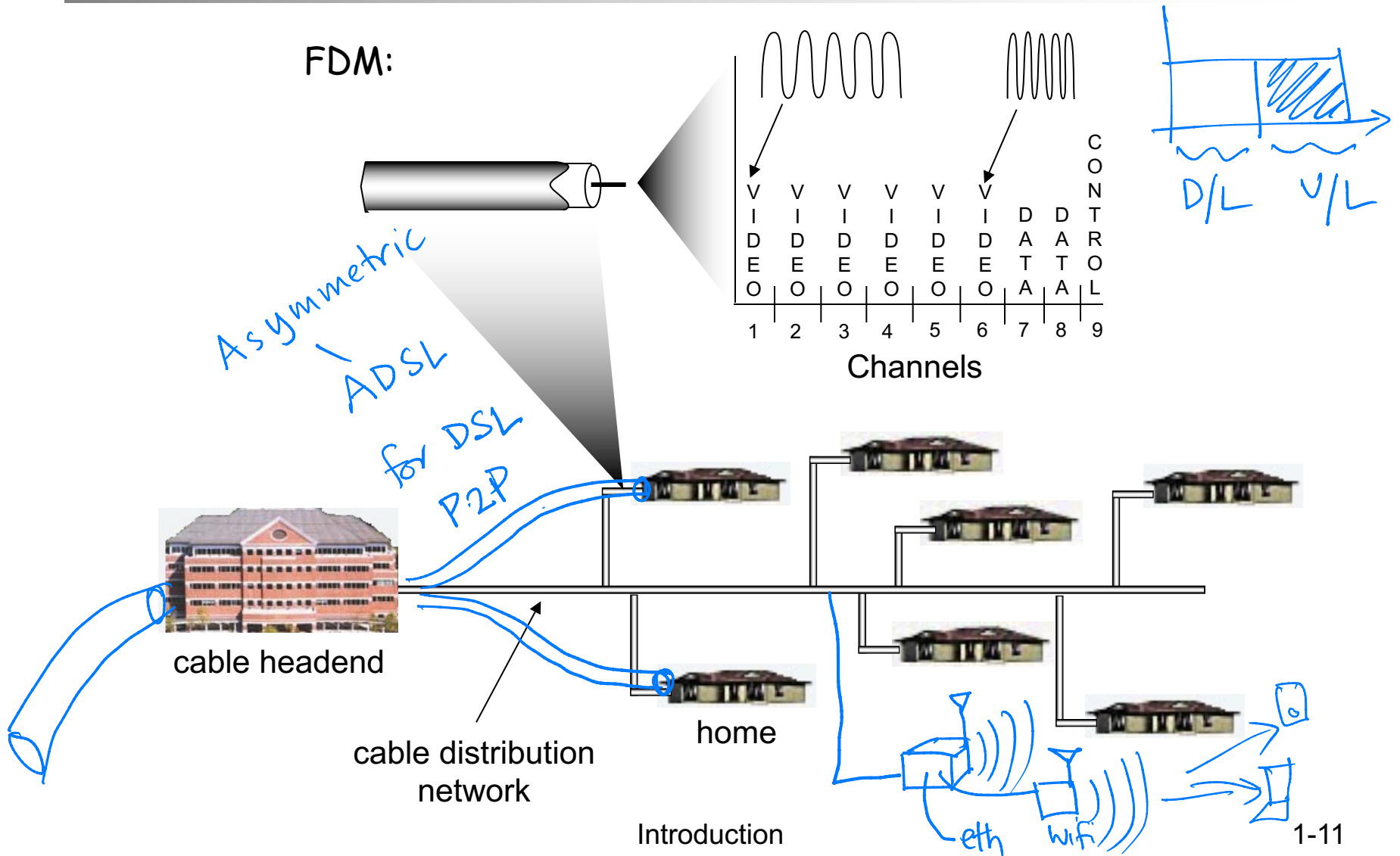 - Latency (Transmit time, Propagation delay, Queueing time, Processing time)
  - Wireless: SNR, SINR, Shannon's capacity,
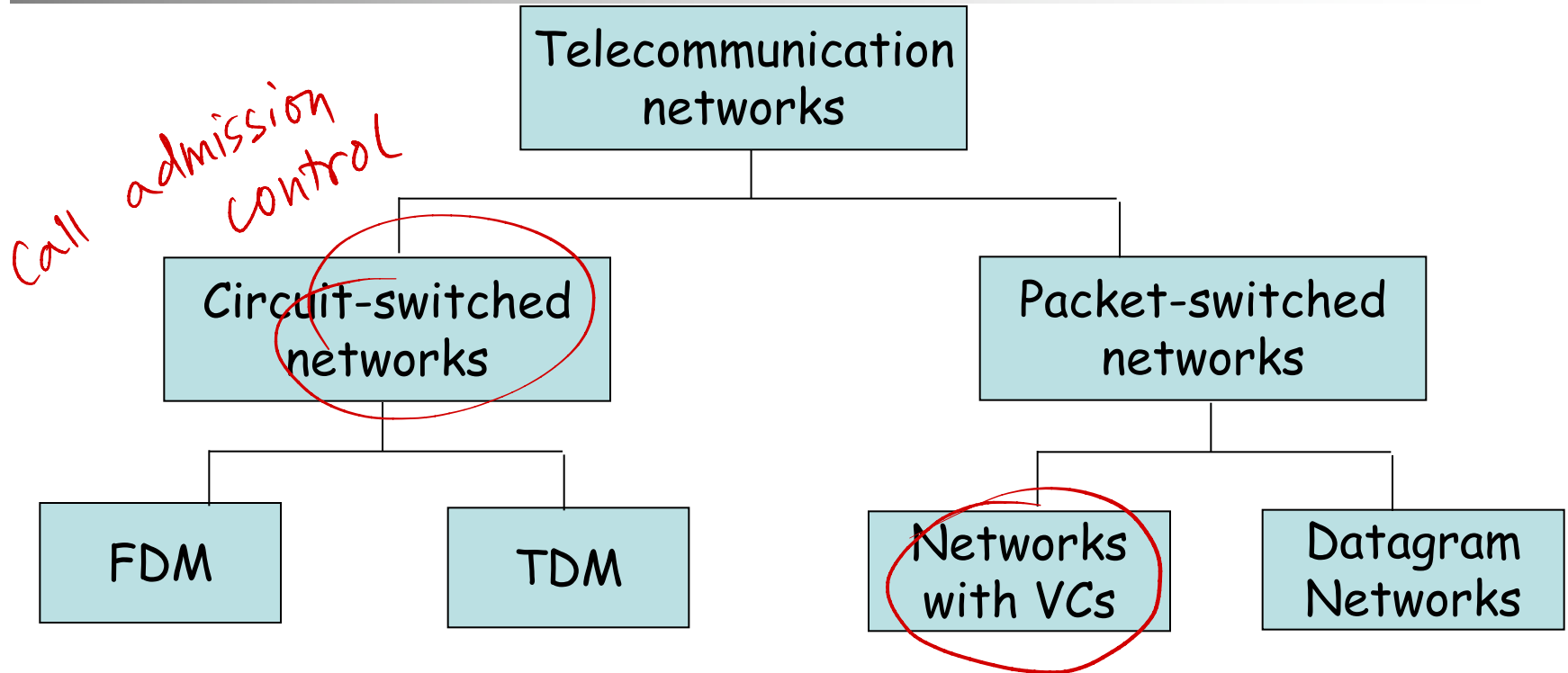
- Real Internet measurements (Traceroute)

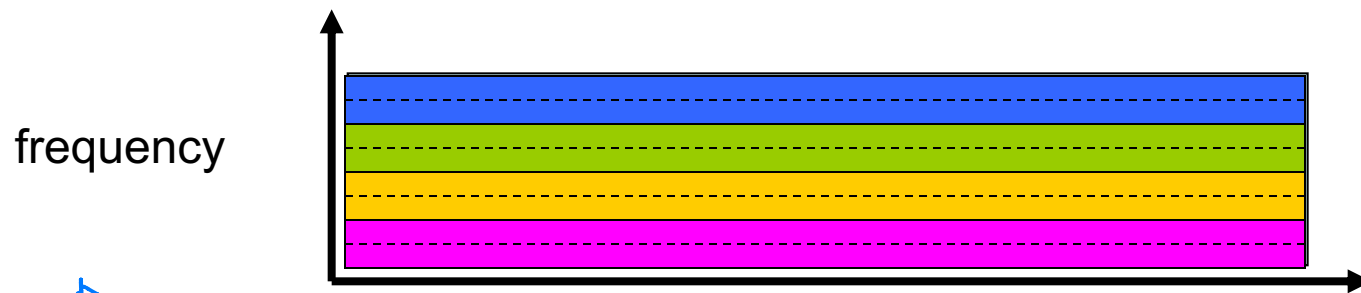- Timeline and history …

Cable Network Architecture: Overview

FDM:

Channels

V I D E O — 1
V I D E O — 2
V I D E O — 3
V I D E O — 4
V I D E O — 5
V I D E O — 6
D A T A — 7
D A T A — 8
C O N T R O L — 9

cable headend

home

cable distribution network

Network Taxonomy

Call admission control

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                    Telecommunication
                        networks

        Circuit-switched                Packet-switched
            networks                        networks

    FDM            TDM            Networks        Datagram
                                  with VCs        Networks
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• Datagram network is _not_ either connection-oriented or connectionless.

• Internet provides both connection-oriented (TCP) and connectionless services (UDP) to apps.
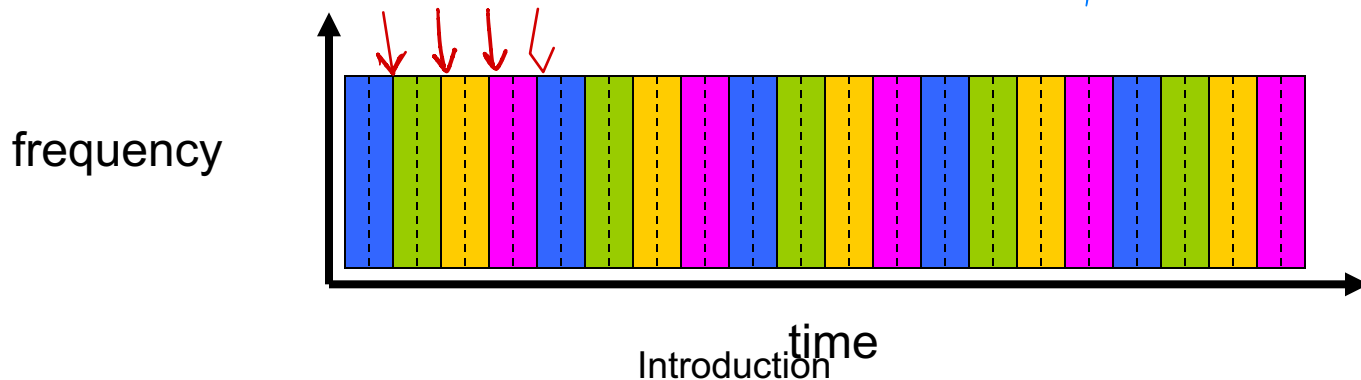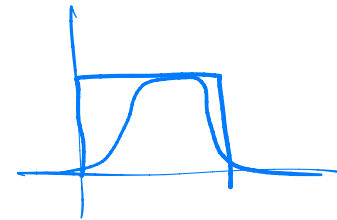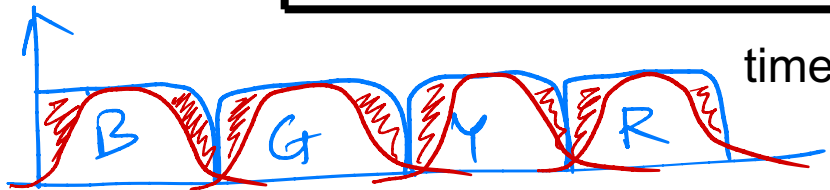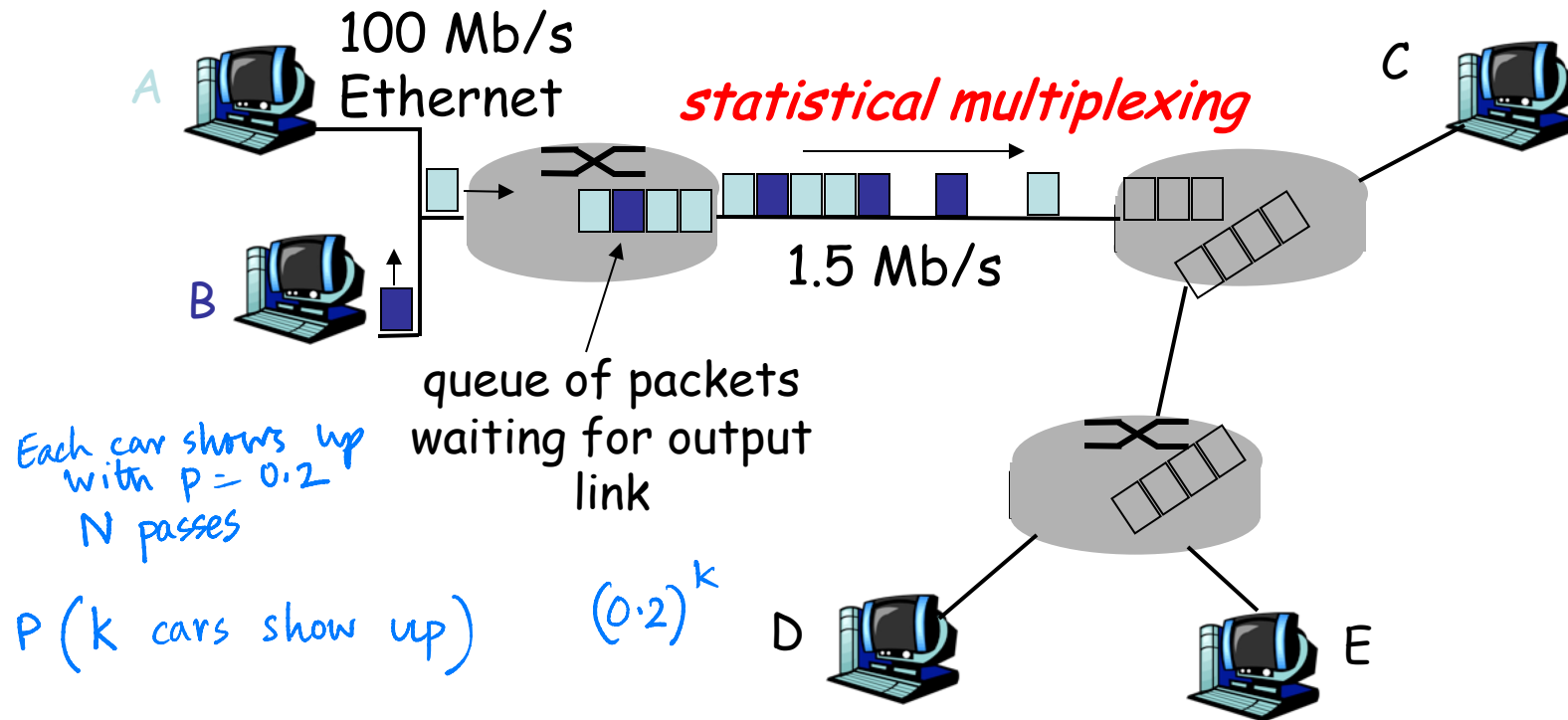
Circuit Switching: FDM and TDM

FDM

Example:

4 users

frequency

time

TDM

frequency

time

Packet Switching: Statistical Multiplexing

100 Mb/s Ethernet

A

statistical multiplexing

C

1.5 Mb/s

queue of packets waiting for output link

B

Each car shows up with $p = 0.2$
N passes

$P(k$ cars show up$)$ $(0.2)^k$

D   E

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.

$\binom{N}{k}(0.8)^{N-k} \cdot (0.2)^k$

Introduction   1-16

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Assignment # -1

Watch "City in the Sky" documentary on ~~Netflix~~ *BBC*

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