MODULE 1: INTRODUCTION

SUMMER CHALLENGE

Electrical Engineering: Smart Lighting

Emre Ates

PhD Student

Boston University

ates@bu.edu

Overview

- Welcome!

- Introductions

- Course Structure and Objectives

- What is Electrical Engineering?

- Devices, Communication, Networks

Introductions

- Instructor: Emre Ates (ates@bu.edu)

- Teaching Assistants
  - Victor Ly

- Students…
  - Introduce yourself
  - Share 2 facts about yourself
  - Remember what is said! (We will come back to this later)

Introductions

- ## The Multimedia Communications Lab (MCL)
  - Primary Focus: "Ubiquitous distributed computing."
  - Various data communication techniques for a variety of content.

- ## The Engineering Research Center for Lighting Enabled Systems and Applications (LESA)
  - 10 years $18M+ from National Science Foundation
  - Core Academic Members
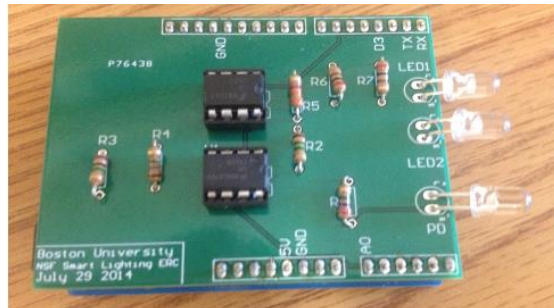

  - Engineering Light for a "brighter" future!

http://lesa.rpi.edu/
http://www.bu.edu/smartlighting/

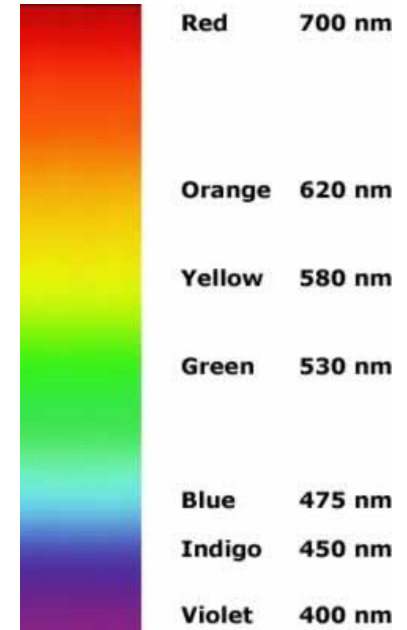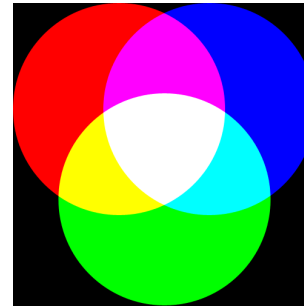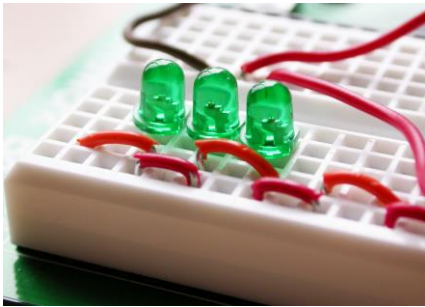Department of Electrical & Computer Engineering

Course Objectives

- Become familiar with:
    - The basic electrical components, circuits, signals and tools
    - Networking and communications concepts
    - Lighting and Light Emitting Diode (LED) technology
   - Visible Light Communication (VLC) technology

Red	700 nm
Orange	620 nm
Yellow	580 nm
Green	530 nm
Blue	475 nm
Indigo	450 nm
Violet	400 nm

BU Department of Electrical & Computer Engineering

Course Overview

- PC Login: **.\Challenge**   password: **Summer2018**
- Course website: http://www.bu.edu/peaclab/BUSC18/
- Course Schedule:

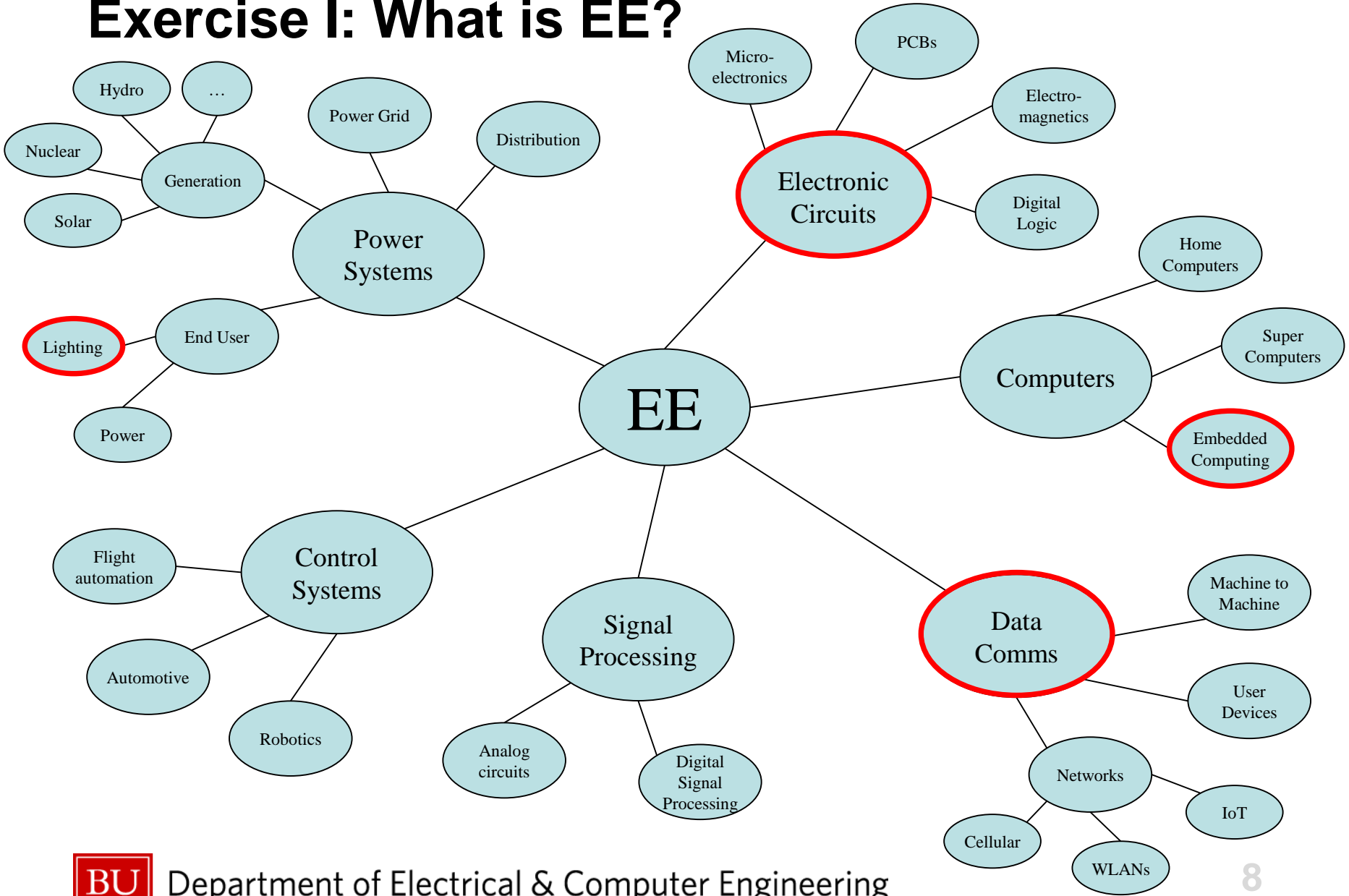| Module	Topic	Activities
1	Introduction	Electrical Engineering, Networks, Data Communication, and Smart Lighting
2	Analog Discovery Board	Operating the Analog Discovery Board, Electricity, and Signals
3	Basic Circuits	Investigate the operation of resistive and capacitive circuits
4	LEDs	LED operation and Electrical Characterization
5	PDs and VLC links	PD Operation and Optical Channel Characterization
6	The Smart Lighting Board	VLC Transceiver PCB assembly **Assignment: Presentation Topic Decision**
7	Analog Transmission	Investigate VLC transmission using analog signals
8	Digital Transmission	Investigate VLC transmission using digital signals
9	VLC Applications	Arduinos, VLC text messages, and presentation rehearsal
10	Presentations	**Student presentations**

Lab Notebooks

- Entries:

    - Name / Group Members Names

    - Date of Entry

    - Experiment overview & hypothesis

    - Sketches of experimental setup

    - Measurements

    - Calculations

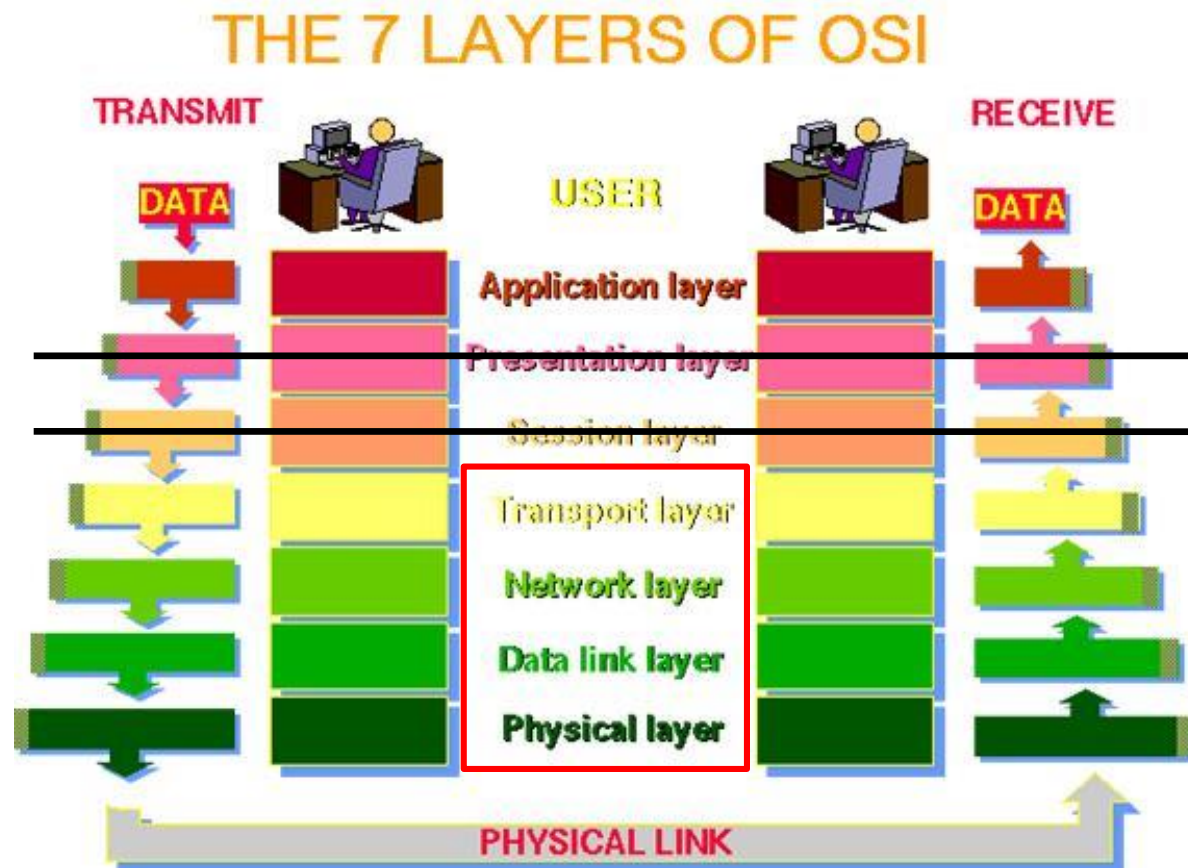   - Results & observations

    - Open questions
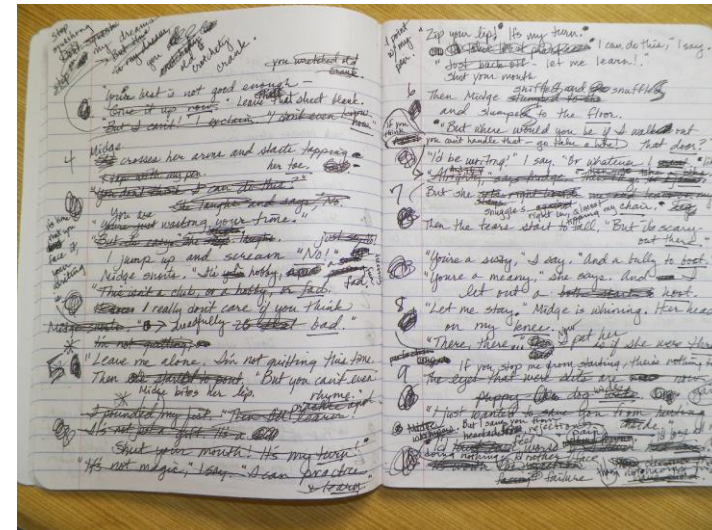
Exercise I: What is EE?

Networks and Device Communication

- What are some devices that communicate?
- OSI *Reference*

THE 7 LAYERS OF OSI

TRANSMIT — USER — RECEIVE

DATA — DATA

Application layer
Presentation layer
Session layer
Transport layer
Network layer
Data link layer
Physical layer

PHYSICAL LINK

Physical Layer

- How can information pass from point to point?
  - Audio waves
  - Light Signals
  - Radio Waves
  - Electrical Signals
  - Vibrations

- Attenuation
  - What happens when the signal is passed over a longer distance?

- Signal to Noise Ratio

- Interference
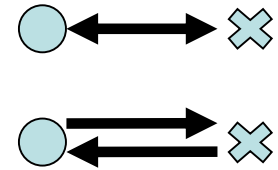
$$\frac{S}{N} \qquad \frac{S}{N} \qquad \frac{S}{N} \qquad \frac{S}{N}$$

  - What considerations occur with interference in wired links?
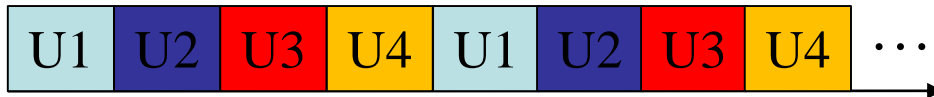 - What about with wireless links?
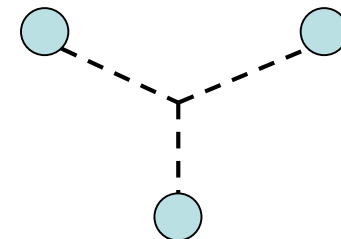
Data Link Layer

- ## Simplex / Duplex
  - Handshake – Message / Acknowledgement
  - Full duplex vs half duplex
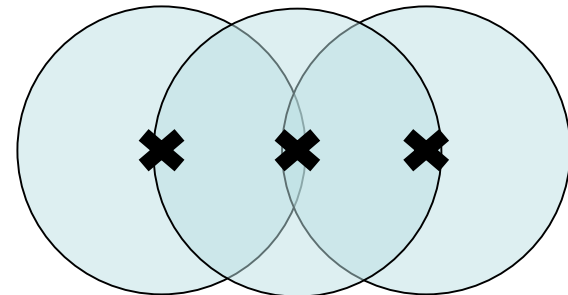 - Broadcasting

- ## Multiple Access
  - Resource Allocation Techniques: TDMA, FDMA, CDMA
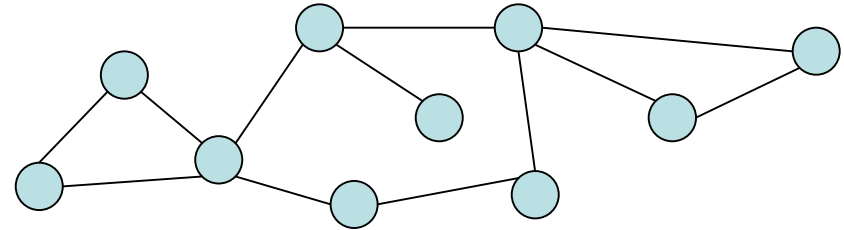 - Probabilistic Multiple Access Technique: CSMA

| U1 | U2 | U3 | U4 | U1 | U2 | U3 | U4 | $\cdots$ |

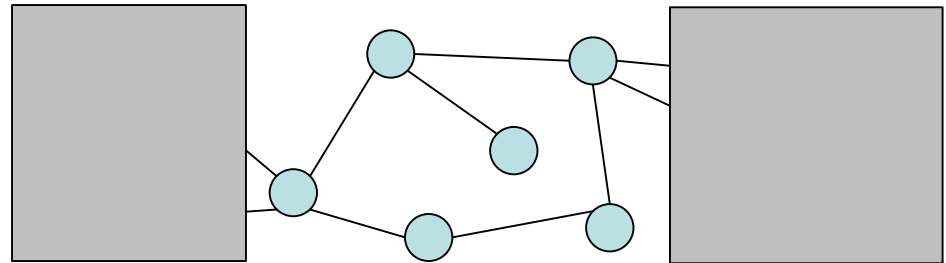- ## Wireless Considerations
  - Hidden Node Problem
  -

Network Layer

- Nodes, Links, and Graphs

- Addressing

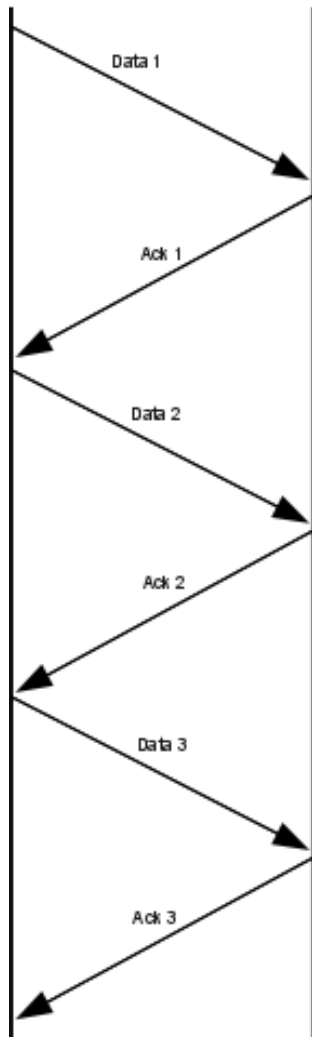 - If you pass the message, how does the next device know the destination of the message?

- Message passing

  - Full vs Partial knowledge
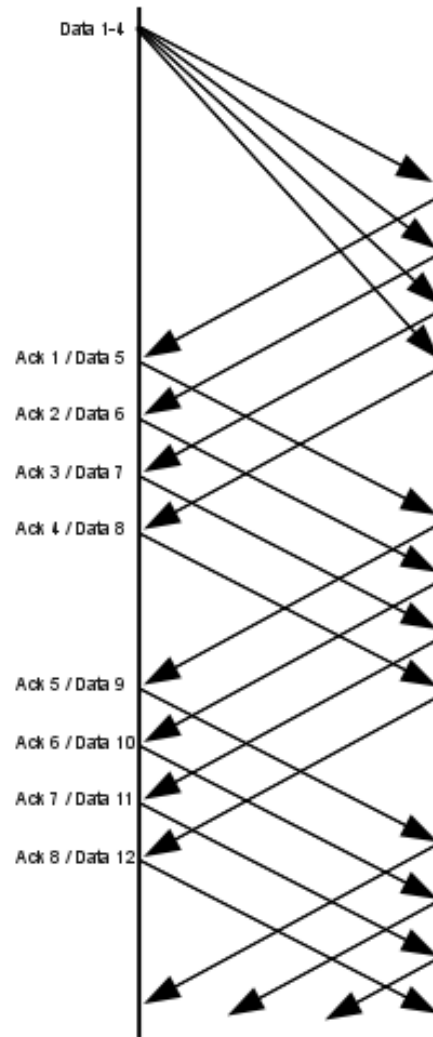 - Internet Protocol (IP)

- Wireless Mesh Network

  - Fully wireless networks also use routing concepts.
  - Small conversations can occur simultaneously with minimal interference!
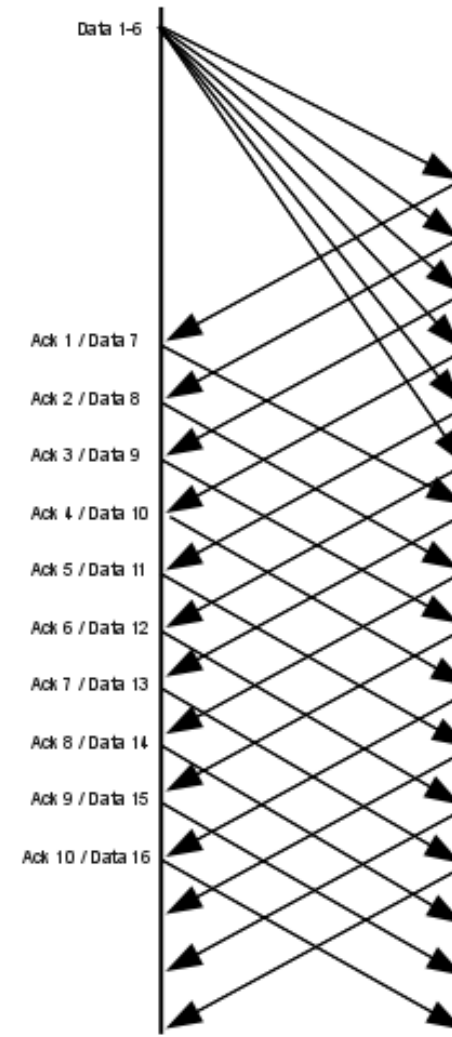
Transport Layer

Sliding Windows, bandwidth 6 packets/RTT

Think – Pair – Share

- What did you today?