# MODULE 1: Introduction

## BU SUMMER CHALLENGE
## Electrical Engineering: Smart Lighting Project

Beste Oztop
PhD Student
Boston University
boztop@bu.edu

# Overview

- Welcome!
- Introductions
- Our Objectives
- Course Overview
- Electrical Engineering Definition
- Devices; Network and Communication Channels

# Introductions

- Instructor: Beste Oztop *boztop@bu.edu*
- Teaching Assistant: Hudson Reynolds *hudsonre@bu.edu*
- Students
  - Introduce yourself
  - Share your expectations for this summer challenge program
  - One fact about yourself!
  - Pay attention to what others say – will come back later!

# Introductions

## Multimedia Communications Lab (MCL)

- Focuses on topics in ubiquitous computing and networking
- Their work is part of both the Photonics Center and the Center for Information and Systems Engineering

LESA Lighting Enabled Systems & Applications
A National Science Foundation Engineering Research Center

## The Engineering Research Center for Lighting Enabled Systems and Applications (LESA)

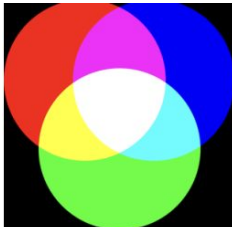
- 10 years $18M+ from National Science Foundation
- Core Academic Members

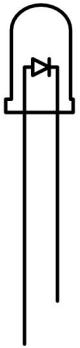
Rensselaer BOSTON UNIVERSITY UNM

- Engineering Light for a “brighter” future!

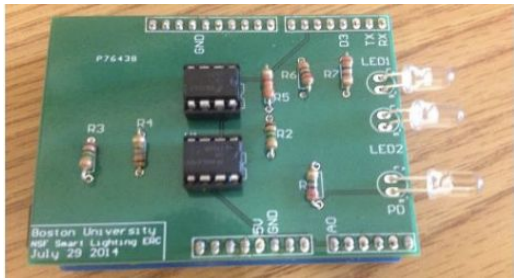
*For more information: https://sites.bu.edu/mcl/ https://lesa.rpi.edu/ https://www.bu.edu/smartlighting/*

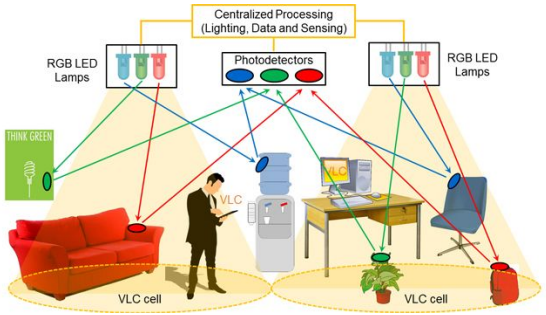
# Our Objectives

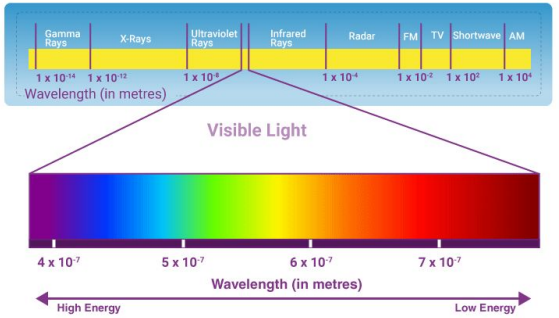




- Become familiar with:
  - The basic electrical components, circuits, signals and tools
  - Networking and communications concepts
  - Lighting and Light Emitting Diode (LED) technology
  - Visible Light Communication (VLC) technology



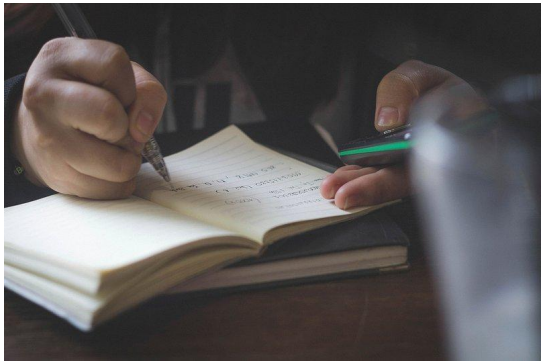
# Course Overview

- Login to PC: *<login id> <Kerberos password>*
- Course website: *https://www.bu.edu/peaclab/busc19/*

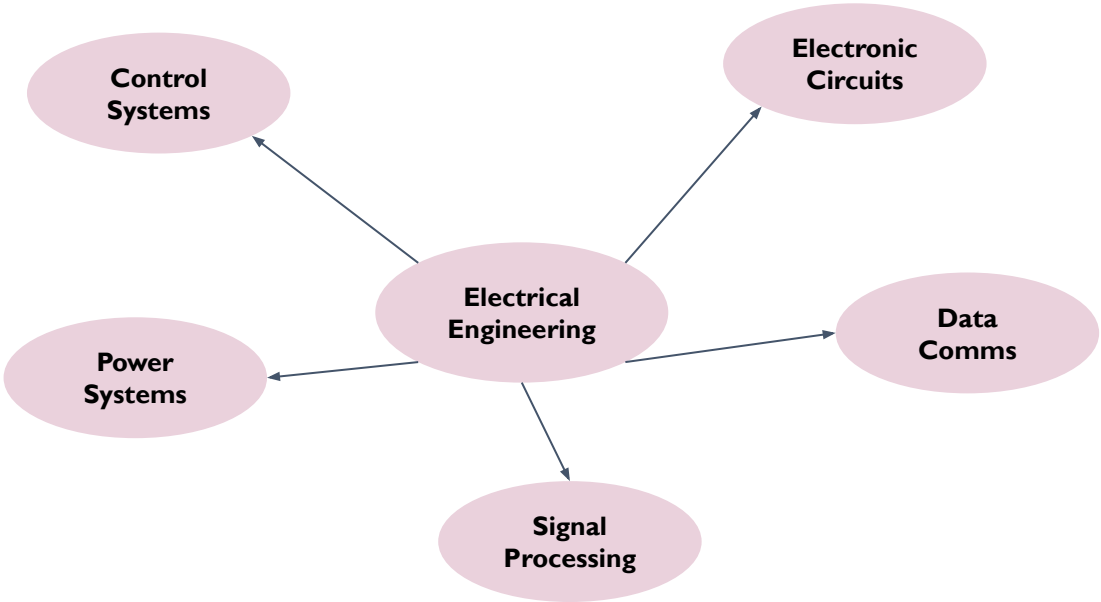
| Module | Topic | Activities |
|---|---|---|
| 1 | Introduction | Electrical Engineering, Networks, Data Communication, and Smart Lighting |
| 2 | Analog Discovery Board | Operating the Analog Discovery Board, Electricity, and Signals |
| 3 | Basic Circuits | Investigate the operation of resistive and capacitive circuits |
| 4 | LEDs | LED operation and Electrical Characterization |
| 5 | The Smart Lighting Board | VLC Transceiver PCB assembly & **Assignment: Presentation Topic Decision** |
| ***End of 1st Week*** | | |
| 6 | PDs and VLC Links | PD Operation and Optical Channel Characterization |
| 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** |
| ***End of the Challenge*** | | |

# Lab Notebooks


- Name / Group Members Names
- Date of Entry
- Experiment overview & hypothesis
- Sketches of experimental setup
- Measurements
- Calculations
- Results & observations
- Open questions

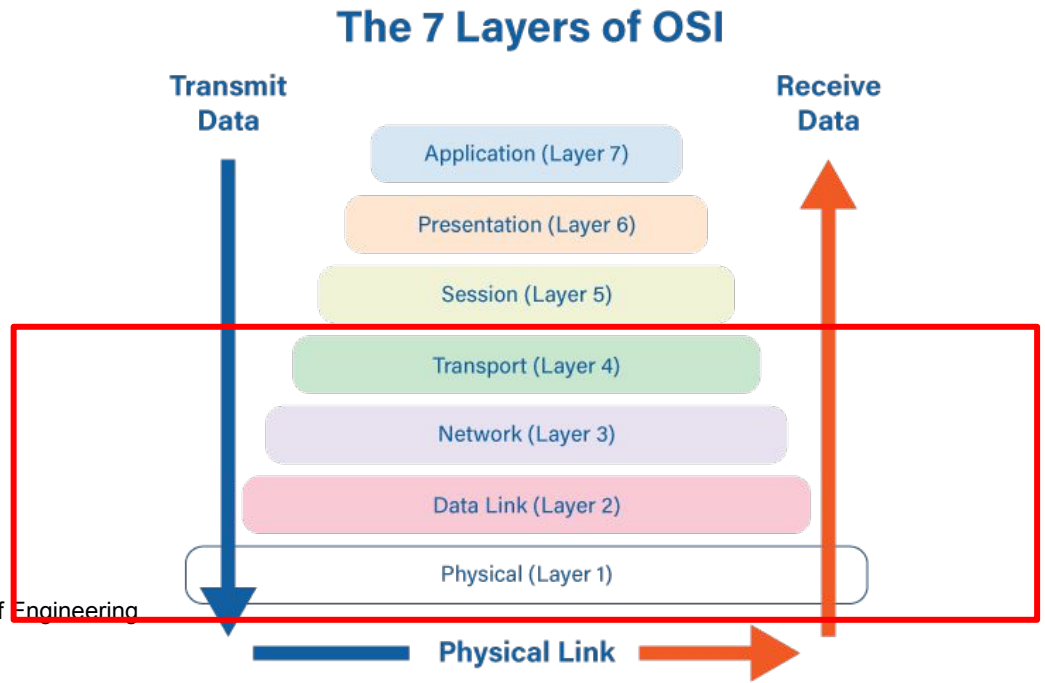


# Exercise: What is EE?



# Networks and Device Communication

- What are some devices that communicate?
- Open Systems Interconnection (OSI) Reference



# Physical Layer

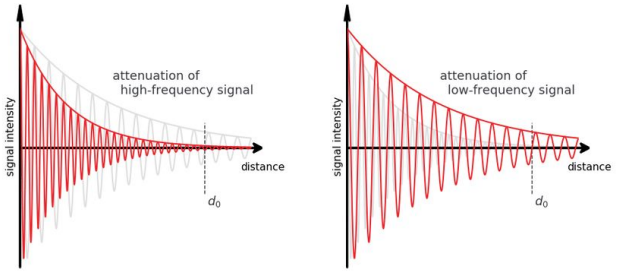
How can information pass from point to point?

- Audio Waves
- Radio Waves
- Light Signals
- Electrical Signals
- Vibrations

# Physical Layer

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

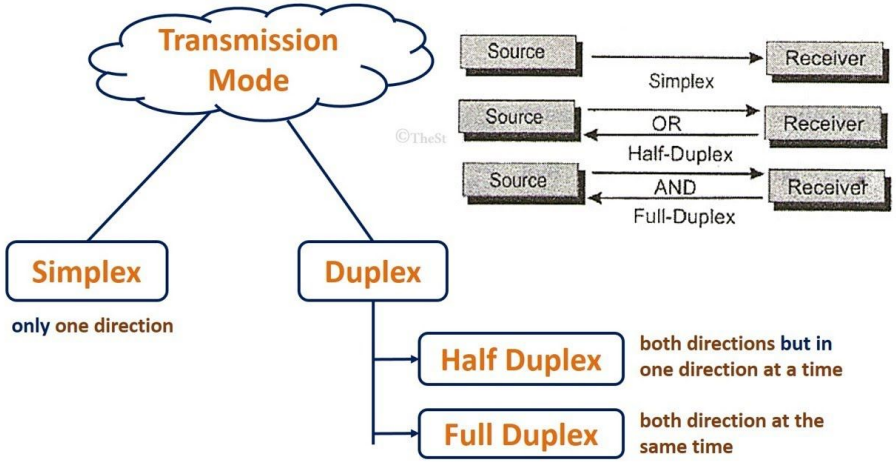
Attenuation



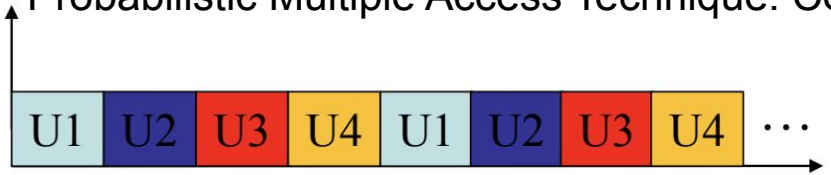

- Signal-to-Noise Ratio (SNR)
- Interference
  - What considerations occur with interference in wired links?
  - What about with wireless links?

# Data Link Layer

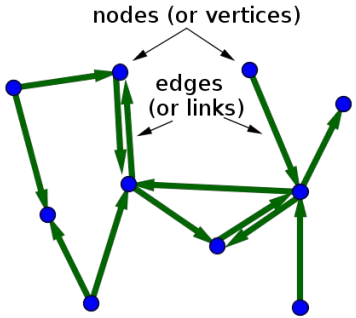
- Simplex/Duplex
  - Handshake – Message
  - Acknowledgement
  - Full duplex vs half duplex



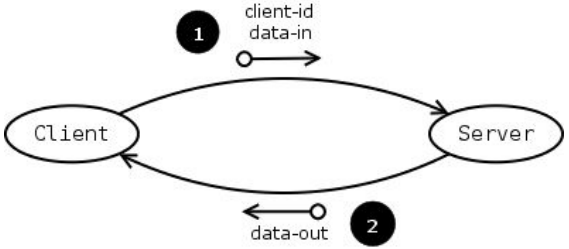

- Multiple Access
  - Resource Allocation Techniques: TDMA, FDMA, CDMA
  - Probabilistic Multiple Access Technique: CSMA



# Network Layer

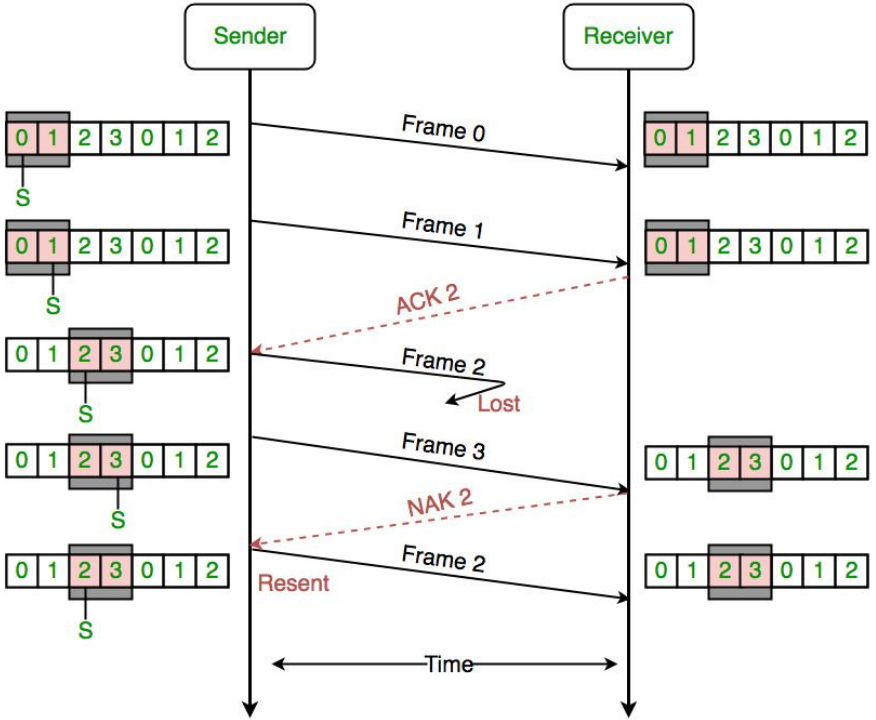


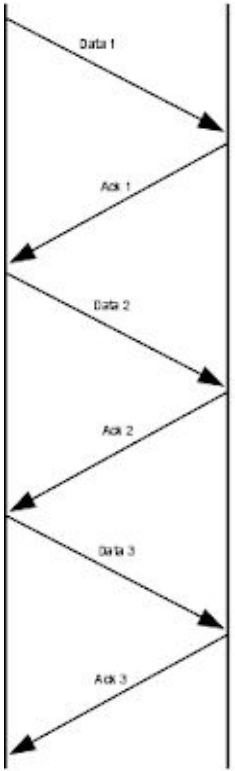

- Nodes, Links, and Graphs
- Addressing
  - If you pass the message, how does the next device know the destination of the message?
- Message passing
  - Full vs Partial knowledge
  - Internet Protocol (IP)



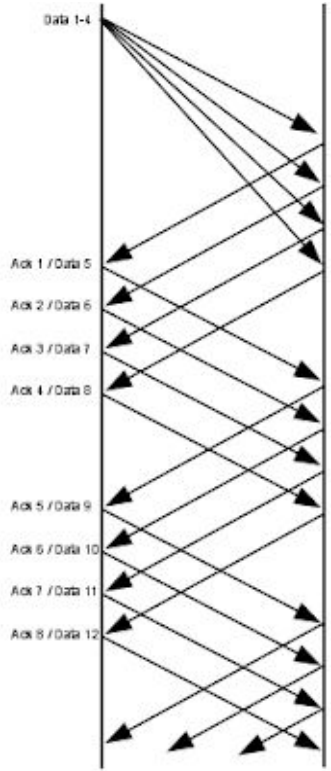

- Wireless Mesh Network
  - Fully wireless networks also use routing concepts.
  - Small conversations can occur simultaneously with minimal interference!

# Transport Layer

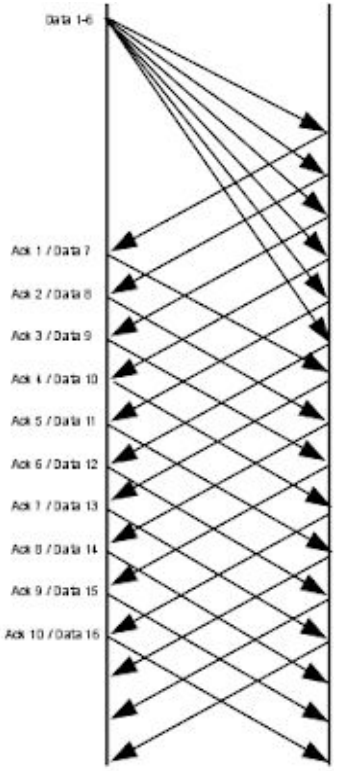



WinSize = 1




WinSize = 4




WinSize = 6

Sliding Windows, bandwidth 6 packets/RTT

# Think – Pair – Share