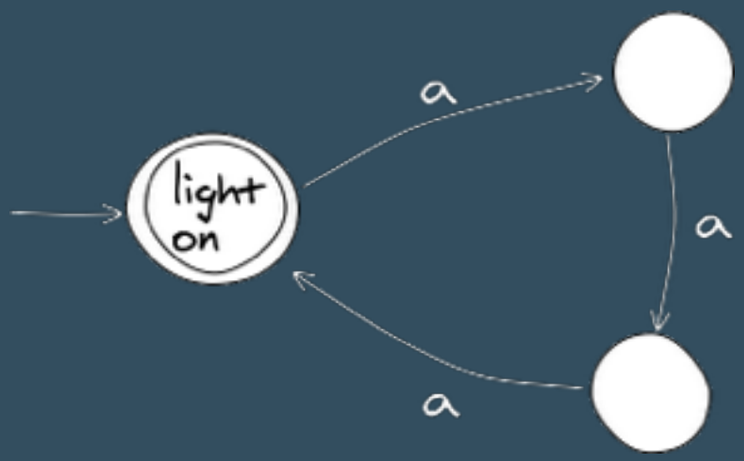
Spring 2015 - Berkeley, CA



CS24

FRESHMAN SEMINAR FOR CS SCHOLARS

WEEK 10 - NETWORKING

UNIVERSITY OF CALIFORNIA - BERKELEY

31 MARCH 2015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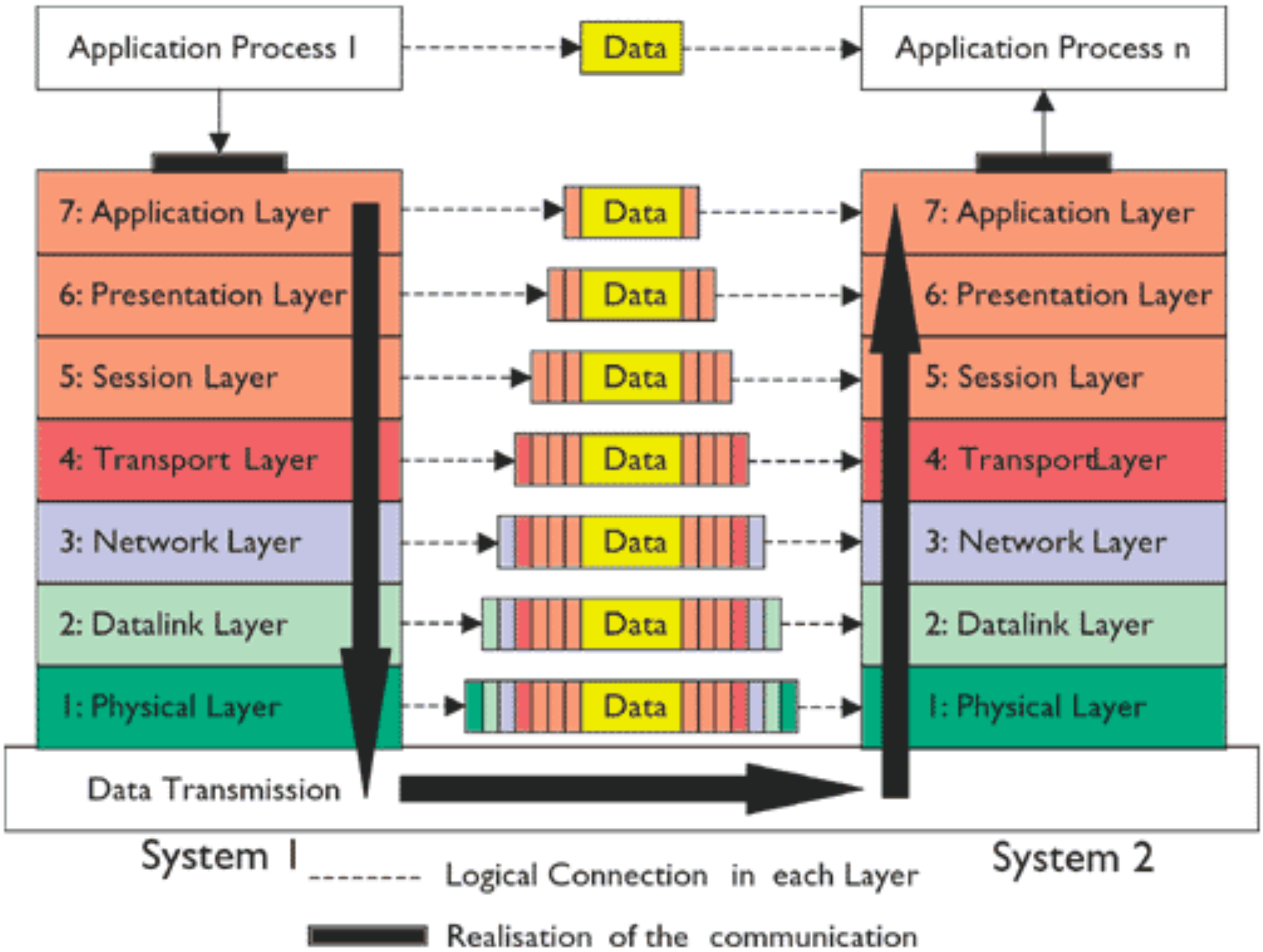
TELEGRAPH AND BANCROFT (1960)

http://edugeeks.in/wp-content/uploads/2013/10/osi-model-.gif



PHYSICAL TRANSMISSION MEDIA [OPTICS/COPPER]

PHYSICAL LAYER (PHY)

ENCODING AND SIGNALING, TOPOLOGY

UNIVERSITY OF CALIFORNIA - BERKELEY

3 MARCH 2015

Abstraction Provided: We can send a single bit unreliably from point A to point B, where A and B are close to each other.

How this is Achieved: We leave that to EE people.

Example Implementations:

Copper wires, wireless, optic fibres, etc.

FIBER OPTICS

ETHERNET/ WFI/ RADIO/ ULTRASONIC

DATA LINK LAYER (DLL)

LOGICAL LINK CONTROL(LLC) AND MEDIA ACCESS CONTROL (MAC)

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3 MARCH 2015

Requirements: Those provided by layer 1.

Abstraction Provided: Sending n bits of data reliably from point A to point B, where A and B are close to each other.

How this is Achieved: Use error correcting codes in order to send n bits reliably. (This involves sending n + k bits where the k bits encode some redundant information. See CS 70 for more examples of error correcting codes.) Also, quite often the recipient will respond to the sender saying "I got the message". The sender will keep sending the message until that happens. There are many implementations of layer 2, and each one does slightly different things.

Example Implementations: Ethernet, WiFi

ERROR CODES

TWO TYPES
ARQ - AUTOMATIC REPETITION REQUEST
FEC - FORWARD ERROR CORRECTION

REPITION CODE: 1011 1011 1011 —> 1011 0111 1011 (ERROR!)
PARITY BIT: # OF ONES E.G., 1011 —> 3... 1010 —> (ERROR!)
CHECKSUM E.G. SUM(BYTE(FOR EACH CHAR IN MSG))
CRYPTO HASH FUNCTIONS

INTERNET PROTOCOL (IP), GATEWAYS, ROUTERS

NETWORK LAYER (NET)

IPV4, IPV6 ADDRESSING

UNIVERSITY OF CALIFORNIA - BERKELEY

3 MARCH 2015

Requirements: Those provided by layer 2, the existence of people needing a large network

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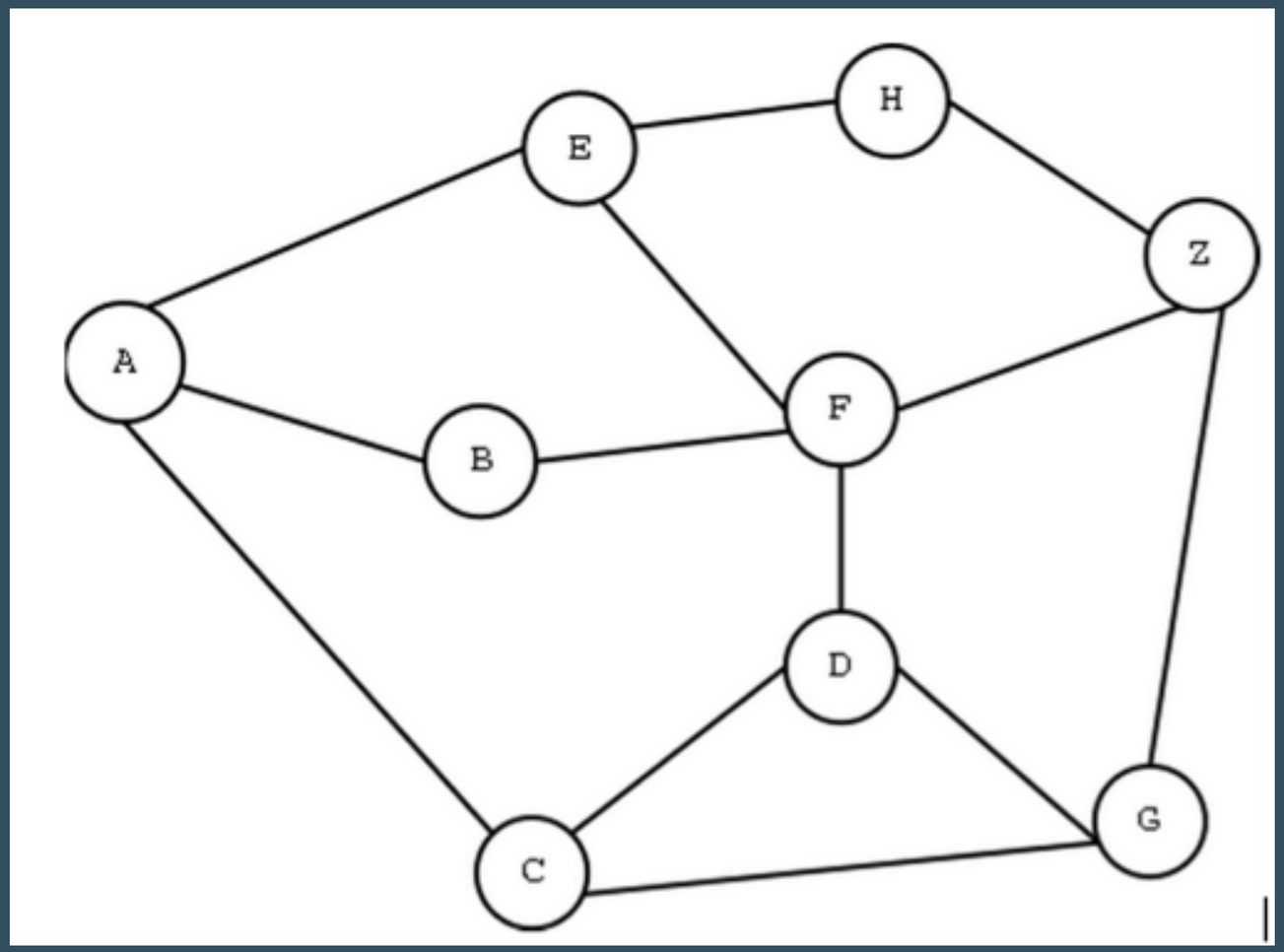
Abstraction Provided: Sending data unreliably (explained later) from point A to point B, where A and B are somewhere on Earth (not necessarily close to each other).

Implementations:

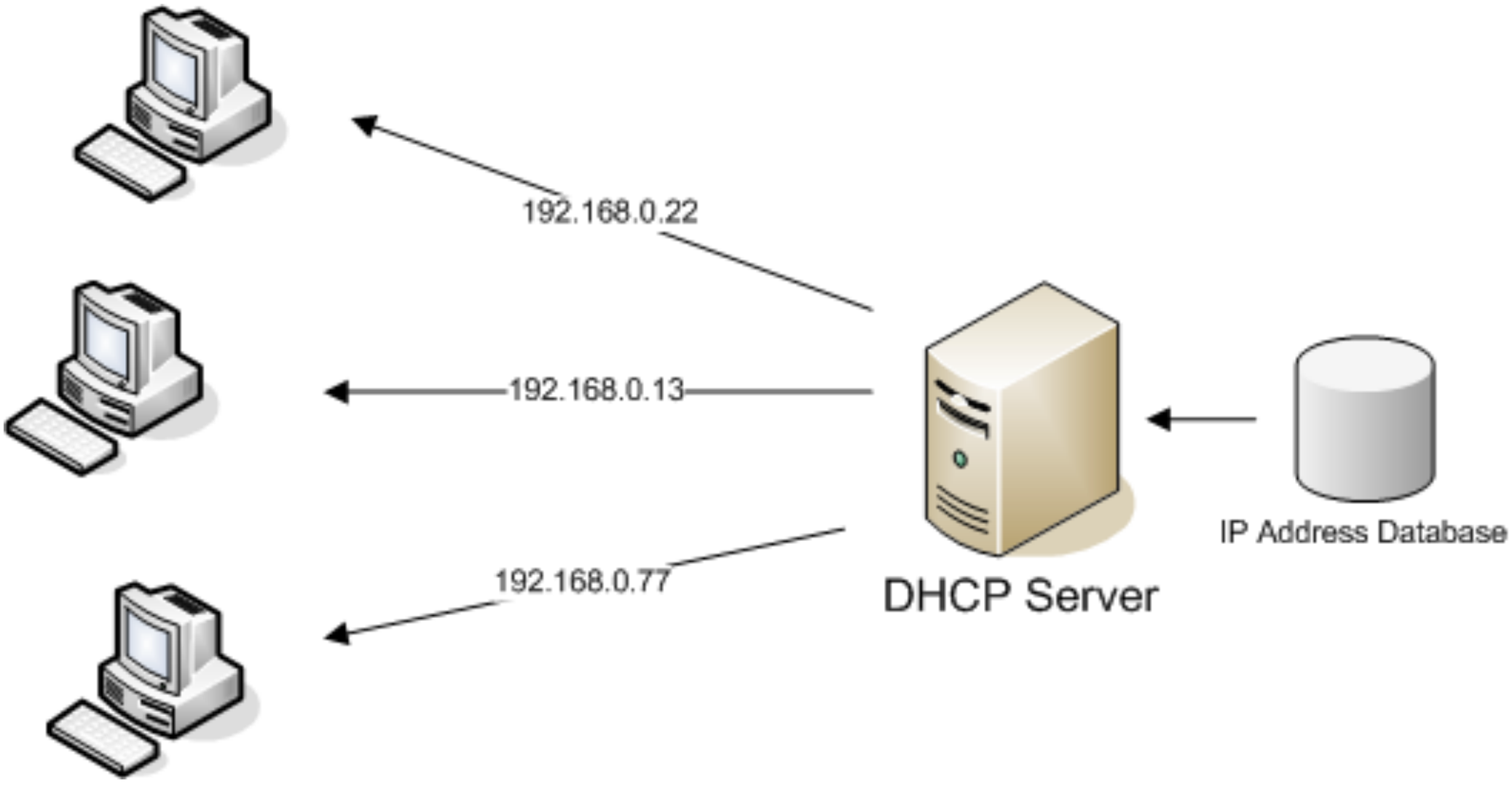
Build a graph of all devices connected to the Internet. The vertices of the graph are the devices, the edges are links between devices. (Devices linked by an edge can communicate using layer 2.) In order to send messages to anyone, you send it to a neighbor, who forwards it on, who forwards it on... until it reaches the destination.

INTERNET PROTOCOL (IP) ADDRESS



Every device gets an IP address, which is just like a mailing address. When we want to connect to another device, we send out a "packet" (sequence of bits) whose destination is that device's IP address.

THE SLOWNESS THAT IS AIRBEARS



TRANSMISSION CONTROL PROTOCOL

TRANSPORT LAYER

USER DATAGRAM PACKETS (UDP)

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3 MARCH 2015

Requirements: Layer 3.

Abstraction Provided: Depends on the protocol. Usually it allows you to transfer data between programs (in layer 3, we were only concerned with transferring data between devices - but if each device has multiple programs running, how do we know to which program we should deliver the data?) It can also provide reliability, in-order delivery, and other such guarantees.

How this is Achieved: See CS 168. The key idea for transferring data between programs is port numbers, which are "addresses" for each program (just like how IP addresses are "addresses" for each device).

Why is this a separate layer from layer 3? There is one key difference - layer 4 is implemented exclusively at the endpoints of the data transfer. That is, when I want to send some data from my computer in Berkeley to India, the relevant layer 4 protocols run on my computer and on the computer in India - nowhere else. On the other hand, in layer 3, the relevant protocols are running on all of the routers and devices along the path from my computer to the computer in India.

Example Implementations: TCP, UDP and ICMP are the most common ones. The World Wide Web (aka websites) uses TCP. Skype and other streaming applications use UDP. DNS uses UDP. The ping command on Unix systems uses ICMP.

THE OTHER LAYERS

SESSION LAYER

USER-COMPUTER SESSION CONTROL

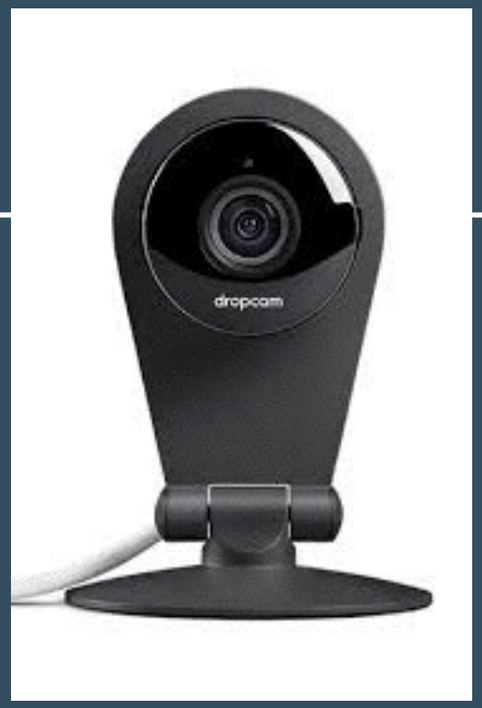
PRESENTATION

FORMATTING

APPLICATION

CHOOSING WHAT TO COMMUNICATE

THE INTERNET OF EVERYDAY THINGS



TODOS

RECIPES AND TOPICS DUE ON APRIL 12

SUMMARIES DUE AT THE END OF SEMESTER - MAY 8

QUESTIONS ?

Week 11

PHYSICAL COMPUTING / WORK SESSION?

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24 FEBRUARY 2015