CS 344: Operating Systems I

02.20: Part III: Networking I

M/W 12:00 – 1:50 PM (LINC #200)

Sanghyun Hong

sanghyun.hong@oregonstate.edu

SAIL

Secure AI Systems Lab

Notice

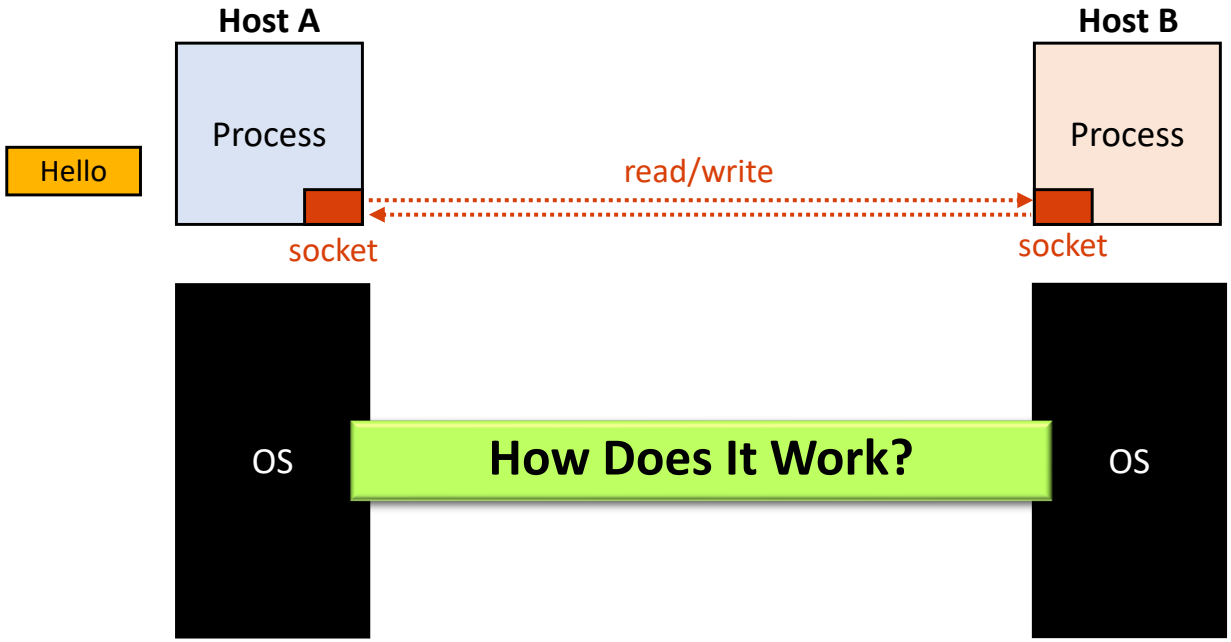
- Announcements
  - 1 more extra credit opportunities on Canvas
    - Build an ML classifier (+2%)
    - Multi-process data loader (+2%)

Topics for today

- Part III: Networking
  - Manage resources
    - OSI model
    - OSI (TCP/IP)

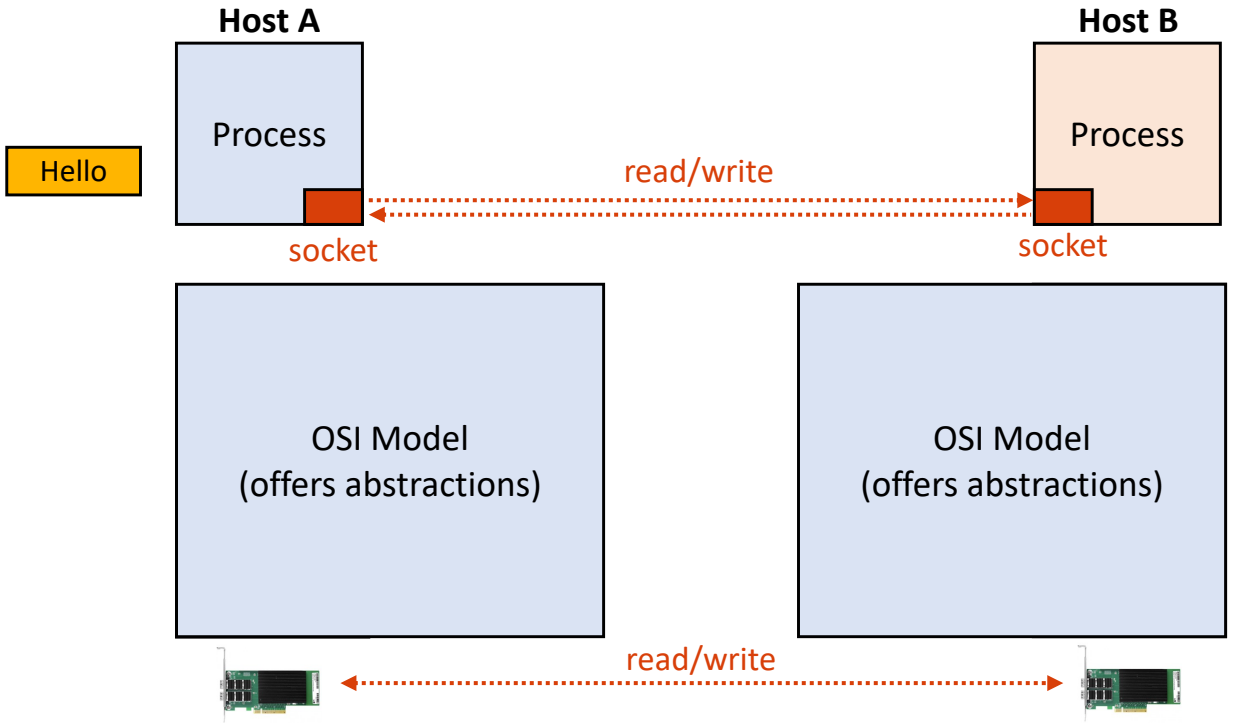
Manage resources

- Socket
  - Host A and B communicate over the Internet



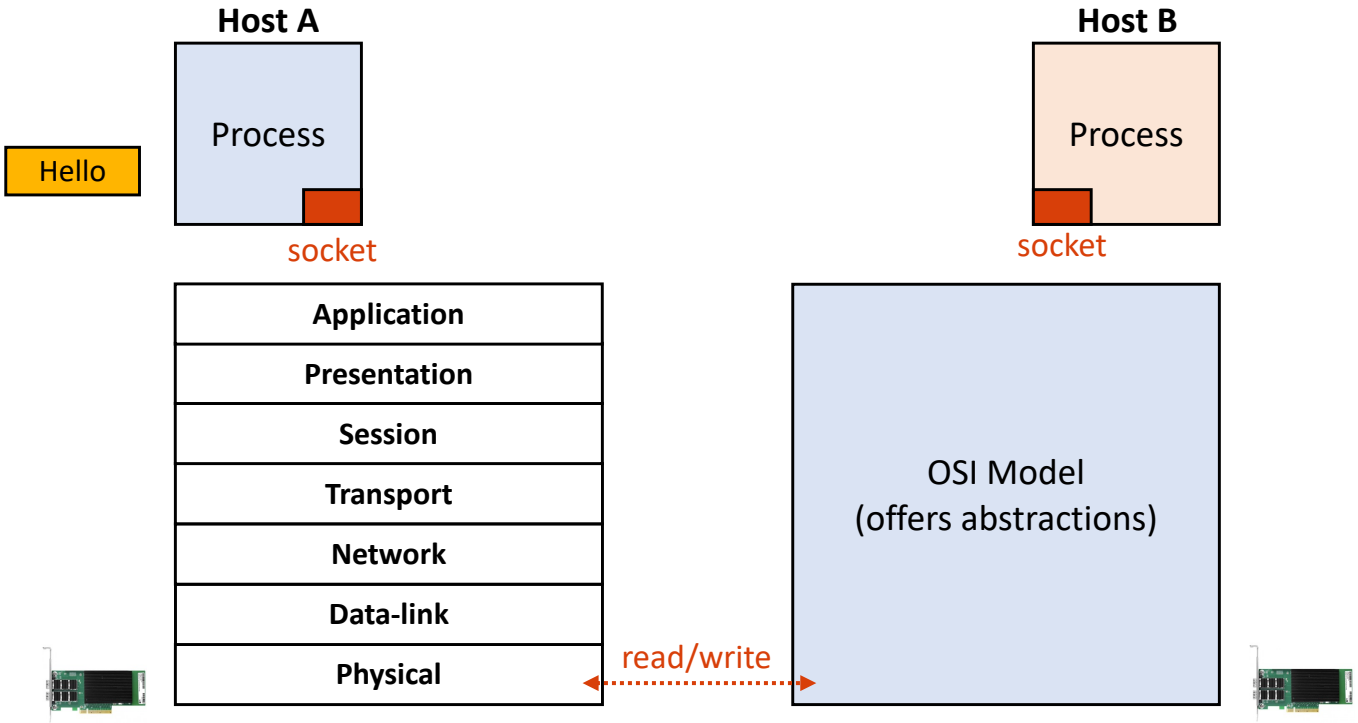
Manage resources

- **O**pen **I**nternet **I**nterface (**OSI**)



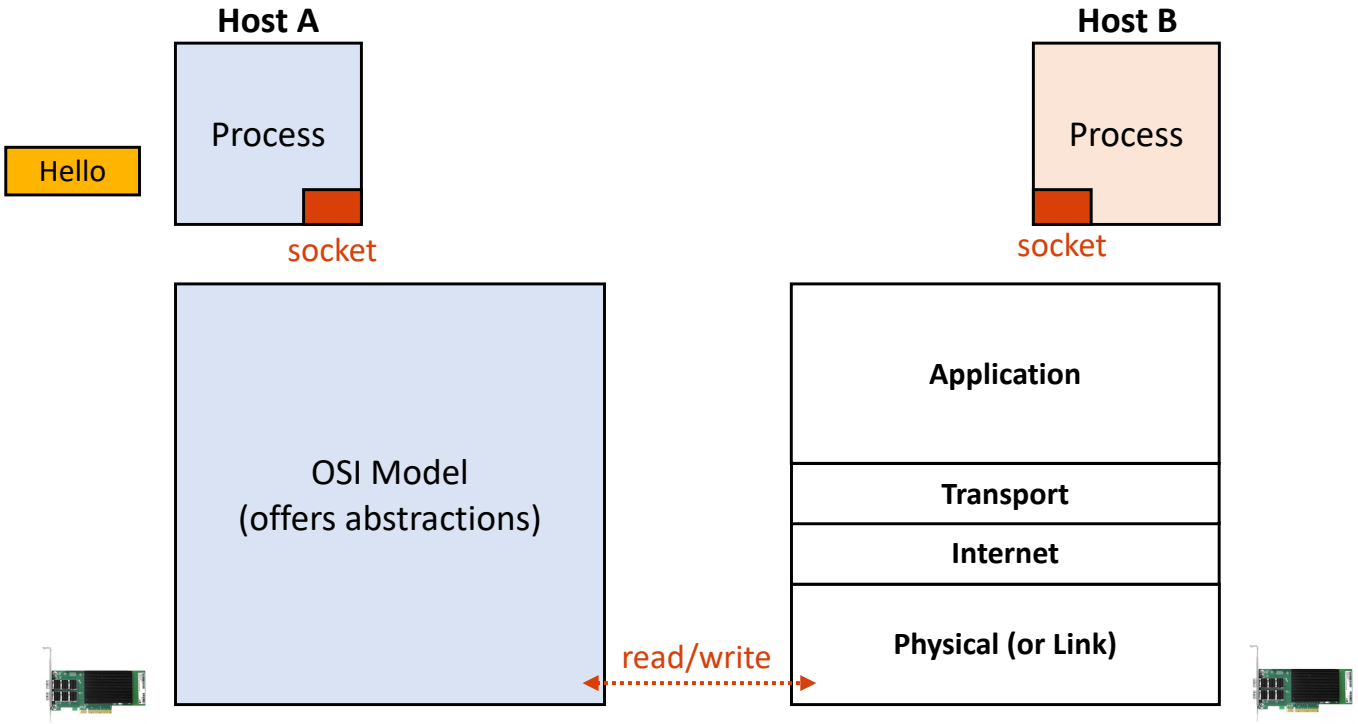
Manage resources: OSI 7-layer model

- **O**pen **I**nternet **I**nterface (**OSI**)



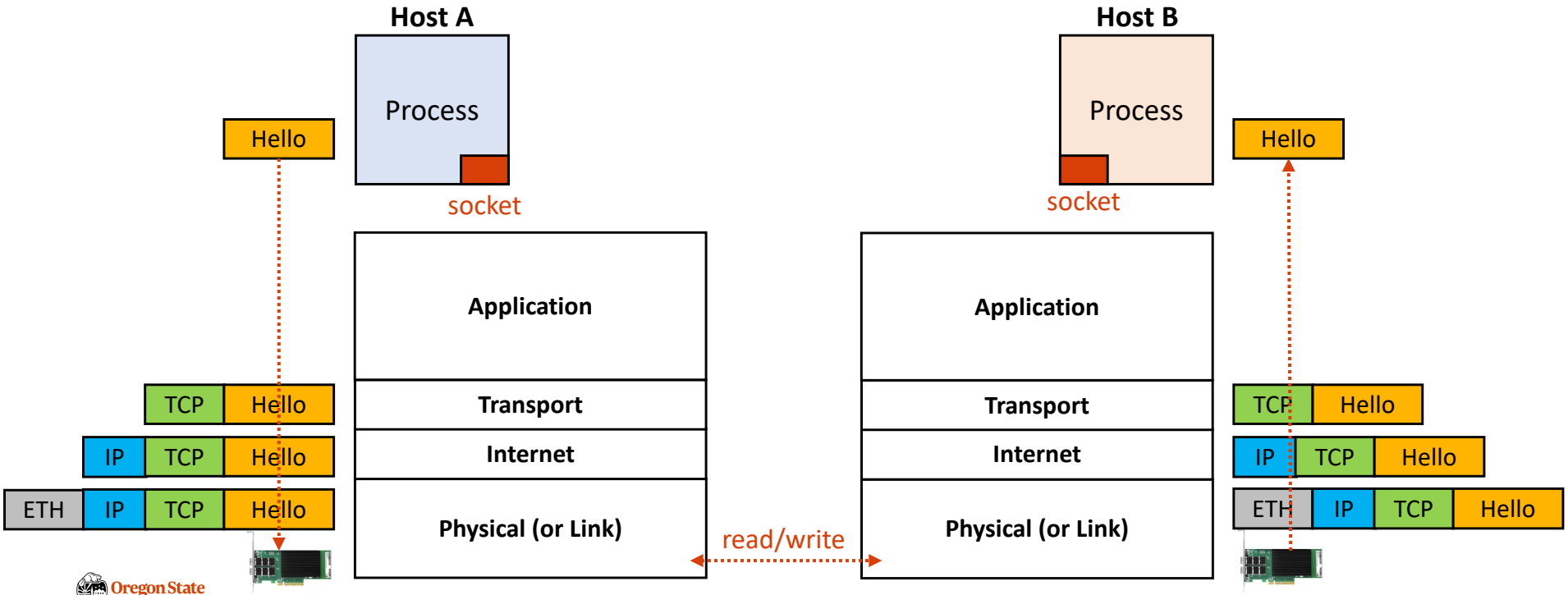
Manage resources: TCP/IP model

- **O**pen **I**nternet **I**nterface (**OSI**)



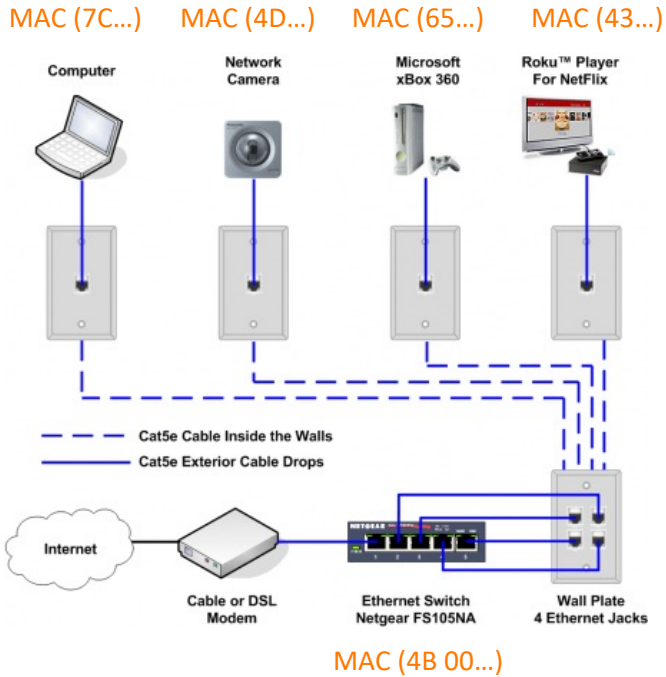
TCP/IP MODEL: PACKET ENCAPSULATION

- Packet encapsulation in the TCP/IP model



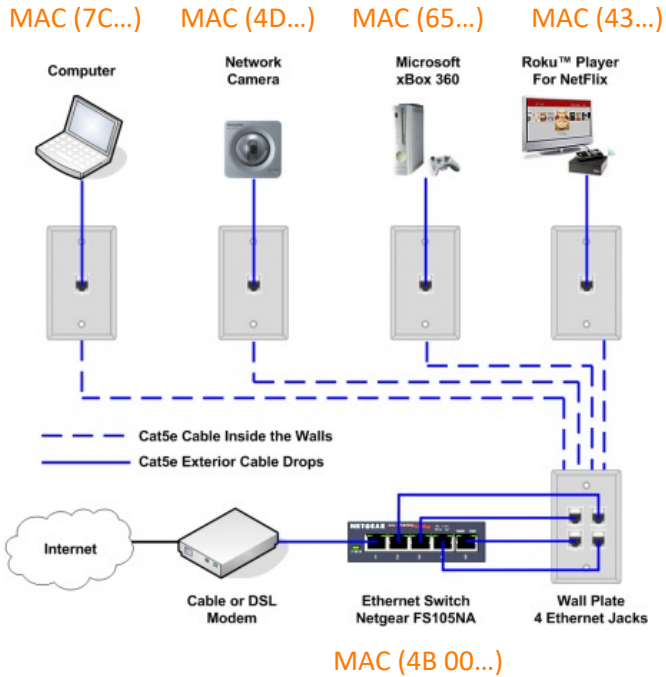
TCP/IP MODEL: ETHERNET (PHYSICAL LAYER)

- Ethernet Protocol (~80s)
  - Each network device (NIC) has 48-bit **MAC address**
  - Each NIC is connected via Ethernet **cable**



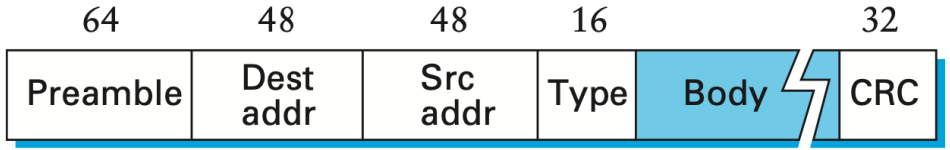
TCP/IP MODEL: ETHERNET (PHYSICAL LAYER)

- Ethernet Protocol (~80s)
  - Each network device (NIC) has 48-bit **MAC address**
  - Each NIC is connected via Ethernet **cable**
  - ETH **header** contains:
    - (64 bit) Preamble (0x111111111… or a unique data)
    - (48-bit) Destination MAC address
    - (48-bit) Source MAC address
    - (16-bit) Type
    - (up to 1500 bytes) Data
    - (32-bit) CRC for error correcting



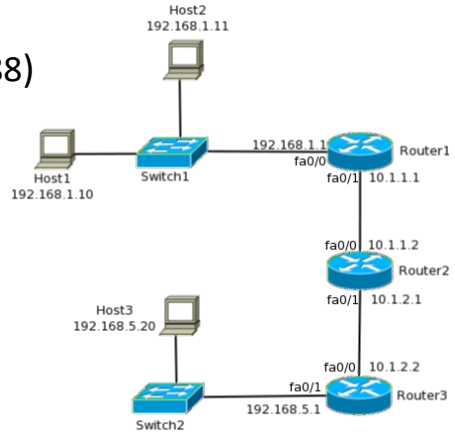
TCP/IP MODEL: ETHERNET (PHYSICAL LAYER)

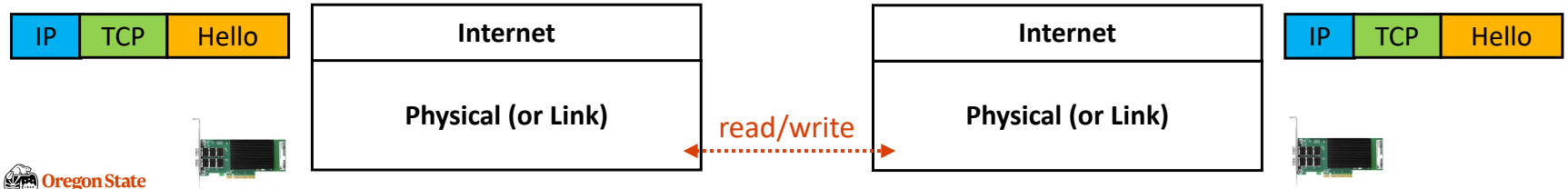
- Ethernet Protocol (~80s)
  - Each network device (NIC) has 48-bit **MAC address**
  - Each NIC is connected via Ethernet **cable**
  - ETH **header** contains:
    - (64 bit) Preamble (0x111111111… or a unique data)
    - (48-bit) Destination MAC address
    - (48-bit) Source MAC address
    - (16-bit) Type
    - (up to 1500 bytes) Data
    - (32-bit) CRC for error correcting



TCP/IP MODEL: IP LAYER

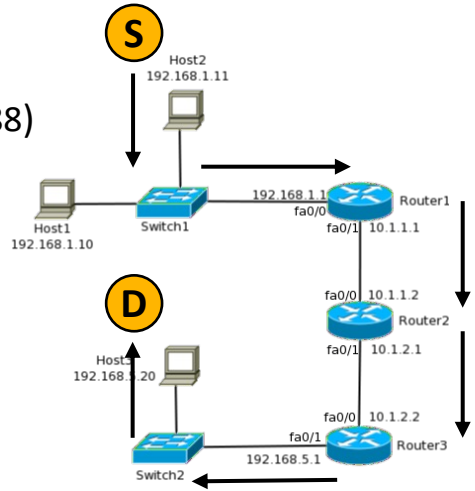
- Internet Protocol (IP)
  - IP allows us to connect multiple networks
  - Each host has a unique IP address
    - **IPv4**: 32-bit address (e.g., 147.56.28.101)
    - **IPv6**: 128-bit address (e.g., 2001:db8:3333:4444:5555:6666:7777:8888)

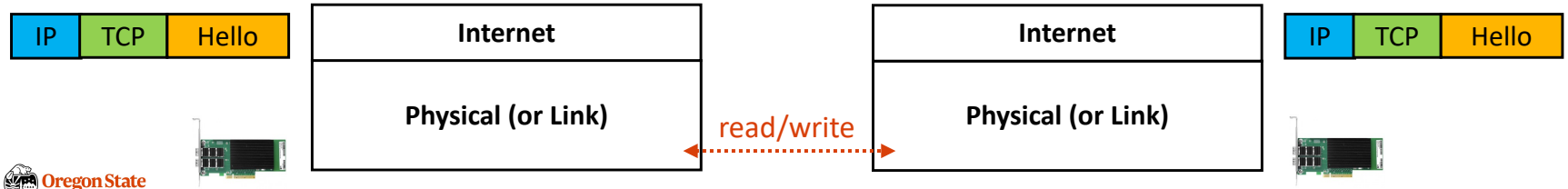




TCP/IP MODEL: IP LAYER

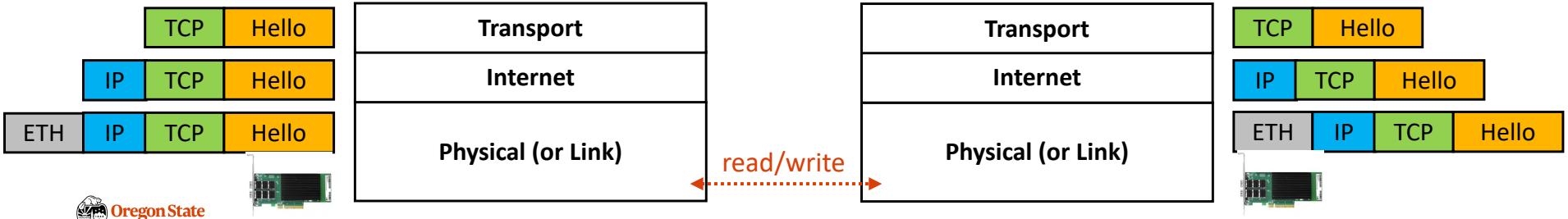
- Internet Protocol (IP)
  - IP allows us to connect multiple networks
  - Each host has a unique IP address
    - **IPv4**: 32-bit address (e.g., 147.56.28.101)
    - **IPv6**: 128-bit address (e.g., 2001:db8:3333:4444:5555:6666:7777:8888)
  - IP data (packets) is **routed** based on **destination IP**





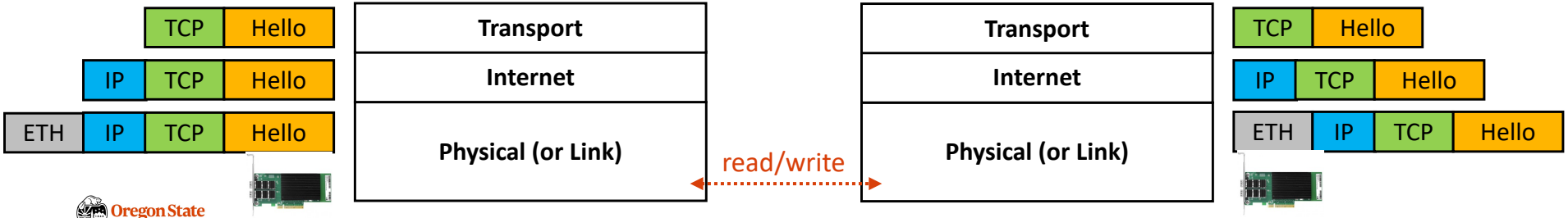
TCP/IP MODEL: TRANSPORT LAYER

- TCP vs UDP **Protocol**
  - **T**ransmission **C**ontrol **P**rotocol: **TCP** Packet
    - (16-bit, for each) Source and destination ports
    - (32-bit) Sequence number
    - (32-bit) Acknowledgement number
    - Others: flags, checksums, window-size, pointer, …
  - **U**ser **D**atagram **P**rotocol: **UDP** Packet
    - (16-bit, for each) Source and destination port
    - (16-bit, for each) Length and checksum



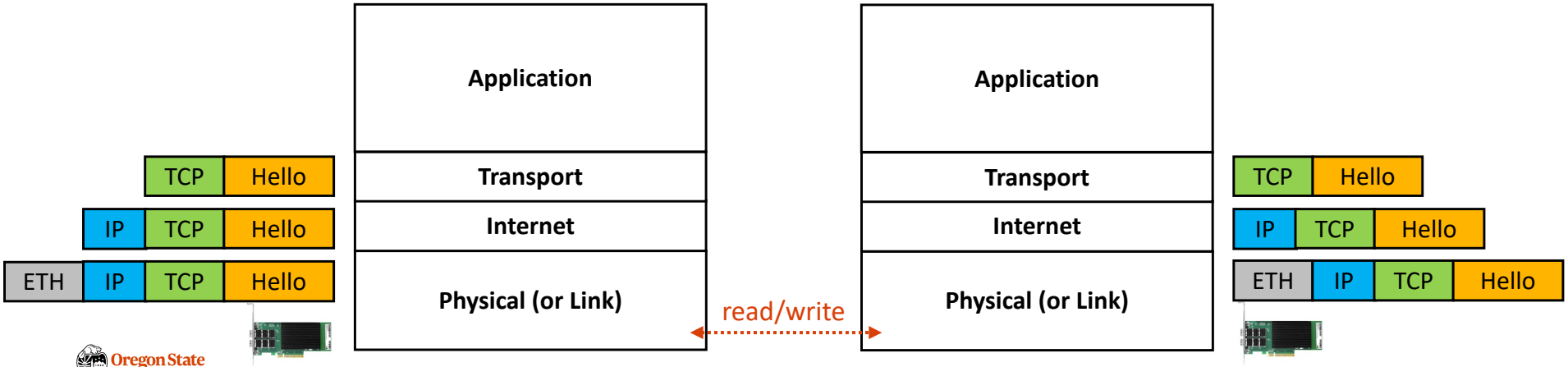
TCP/IP MODEL: TRANSPORT LAYER

- TCP vs UDP **Protocol**
  - TCP requires an established connection, but UDP is not (broadcast)
  - TCP can use sequences, but UDP is not
  - TCP is like a PIPE; data won't be lost, but UDP will (can lose data)
  - TCP guarantees delivery, but UDP does not
  - TCP is slower than UDP (suppose that we deliver all the packets)



TCP/IP MODEL: APPLICATION LAYER

- Application layer
  - Support various user-defined or OS-defined protocols (on top of TCP/UDP)
  - **TCP-based :** HTTPS, HTTP, SMTP, POP, FTP, …
  - **UDP-based:** Video streaming, conferencing, DNS, VoIP, …



Topics for today

- Part III: Networking
  - Manage resources
    - OSI model
    - OSI (TCP/IP)

Thank You!

M/W 12:00 – 1:50 PM (LINC #200)

Sanghyun Hong

sanghyun.hong@oregonstate.edu

Oregon State University

SAIL

Secure AI Systems Lab