CS183

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(Slides were adopted from Brian Crites and Alireza Abdoli)

Intro to Networks

Project proposal is due on Sunday

- Make sure your topic is feasible
- Make sure your topic is complex enough
- Make sure your topic is Linux Network administration oriented
- Make sure you have a plan in place
- One page may properly cover all the above but you can write more given that you are concise

Networking for System Administration

- We will be discussing networks primarily through TCP/IP (with a bit of UDP)
- Focus will primarily be on how to create and administer local networks, which will include how these networks connect to the internet but not how the internet functions (which is different from local networks)
- The network services we discuss will be in the context of local networking
- We will be discussing core networking concepts (routing, packet addressing, etc.) at a relatively high level
- Typically this discussion will provide just enough information to perform a system administration task such as network design or traffic debugging

The Open System Interconnect (OSI) Model

- Ratified in ~1983 by the International Organization for Standardization (ISO)
- Made up of 7 different levels of independent network abstraction
- Acrostic for remembering the levels: “All People Sip Tea Not Dr. Pepper”

1. Physical
2. Data Link
3. Network
4. Transport
5. Session
6. Presentation
7. Application

A unit of network stream is = metadata + “data”

- Plain data (a stream of bits) that traverses Internet will be transformed to small units.
- Each unit needs metadata

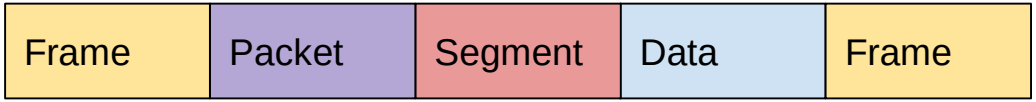
10010110110011110001	11010010000111110001	00110011011011110100	……

Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	
……	……	……	……	……	……	11010010000111110001
Headers (metadata)						**Data**

Level 1 (L1) - Physical

- Physical connection between network devices (computers & networking appliances)
  - Fiber, Ethernet, Wireless, etc.
- Data is carried and represented in its binary form (whatever that means for the physical connection carrying it)
- Handles flow control (when it should be sending vs. receiving) and limited error correction (usually through redundancy)
- Translates data layer requests into hardware-specific operations and passes incoming bitstreams to the data layer for processing

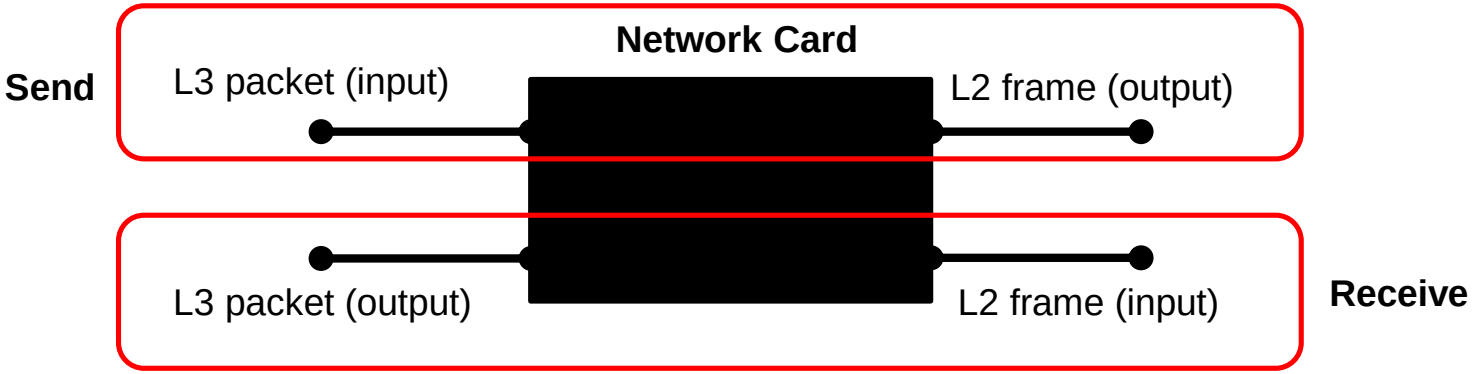
Level 2 (L2) - Data



- Uses a data **frame** to encode the source and destination **MAC addresses** as well as a error checksum around an IP packet
  - Frame adds two 6 byte MAC addresses (plus 2 for additional data)
  - Frame also adds a 4 byte checksum for error correction
  - MAC Addresses are how individual machines are “uniquely” addressed
  - MAC Addresses are set per-device by the manufacturer
- Handles sending information from one device on the local network to another
- *Individual* data frames cannot cross networks, although their internal data can
- The data layer is actually made up of two layers (more on this later)
- Examples of data link layer hardware are switches and network cards

What does L2 abstraction mean for network devices?

- Switches and network cards are L2 based devices
- Abstraction and encapsulation allows modular design and implementation

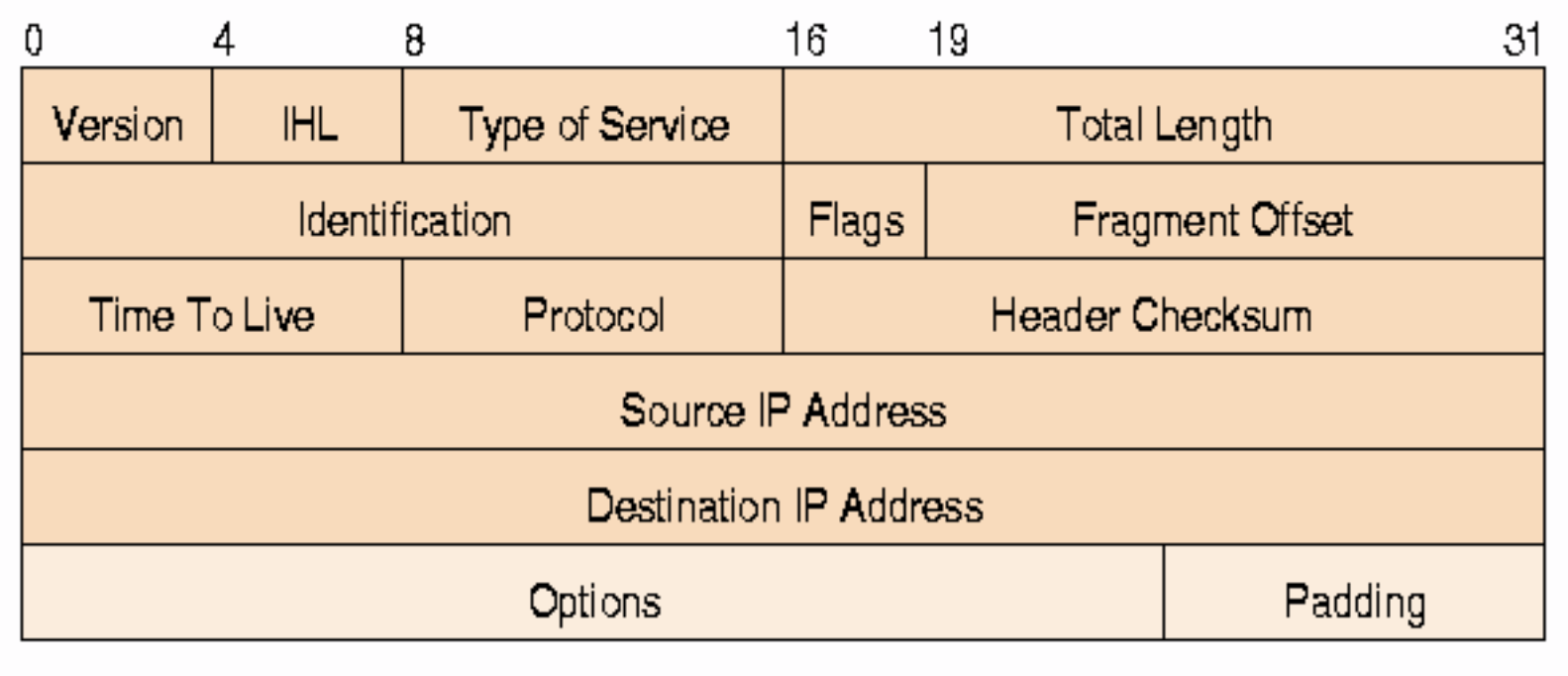


Packet	MAC destination	MAC source	Type	Frame Length	Frame Number

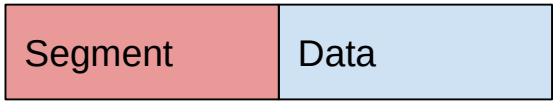
Level 3 (L3) - Network

- The layer containing the internet protocol (IP) which works with **packets**
  - Packet adds two 4 byte IP addresses (plus 16 bytes of additional information including time to live and total length)
- Handles moving data between networks, a process known as routing
- When data gets to a network boundary, the frame is removed and the IP addresses are inspected to know what new frame to create
- Performs no error control or correction itself
- Examples of L3 devices are network routers

Packet Structure



Level 4 (L4) - Transport



- Service to Service or Host to Host communication using either the Transmission Control Protocol (**TCP**) or User Datagram Protocol (**UDP**) and addressed through port numbers
  - TCP: send it and expect a response with an unordered delivery
  - UDP: send it and forget it protocol with an ordered delivery (best effort)
  - The Internet Assigned Numbers Authority (IANA) keeps a list of well known ports (0 - 1023) which are the ones requiring elevated permissions in order to bind to in Linux/UNIX
- Handles flow control, congestions, errors, and multiplexing

Level 5 (L5) - Session

Data

- Handles opening, closing, and managing a connection session between end-user applications over a network
- Sockets implement this layer when using UNIX*

Level 6 (L6) - Presentation

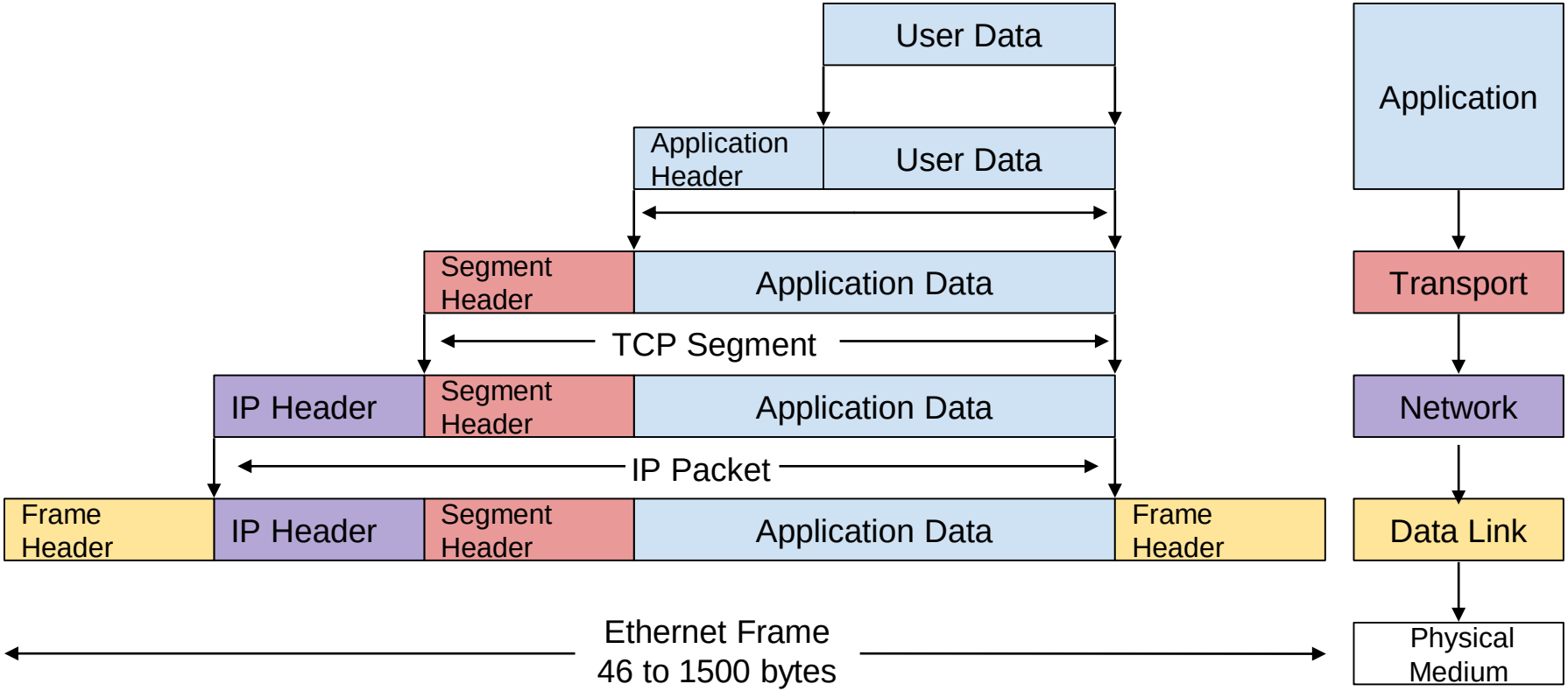
- Covers data conversion, character code translation, compression, encryption and decryption between the network format and what is expected by your application

Level 7 (L7) - Application

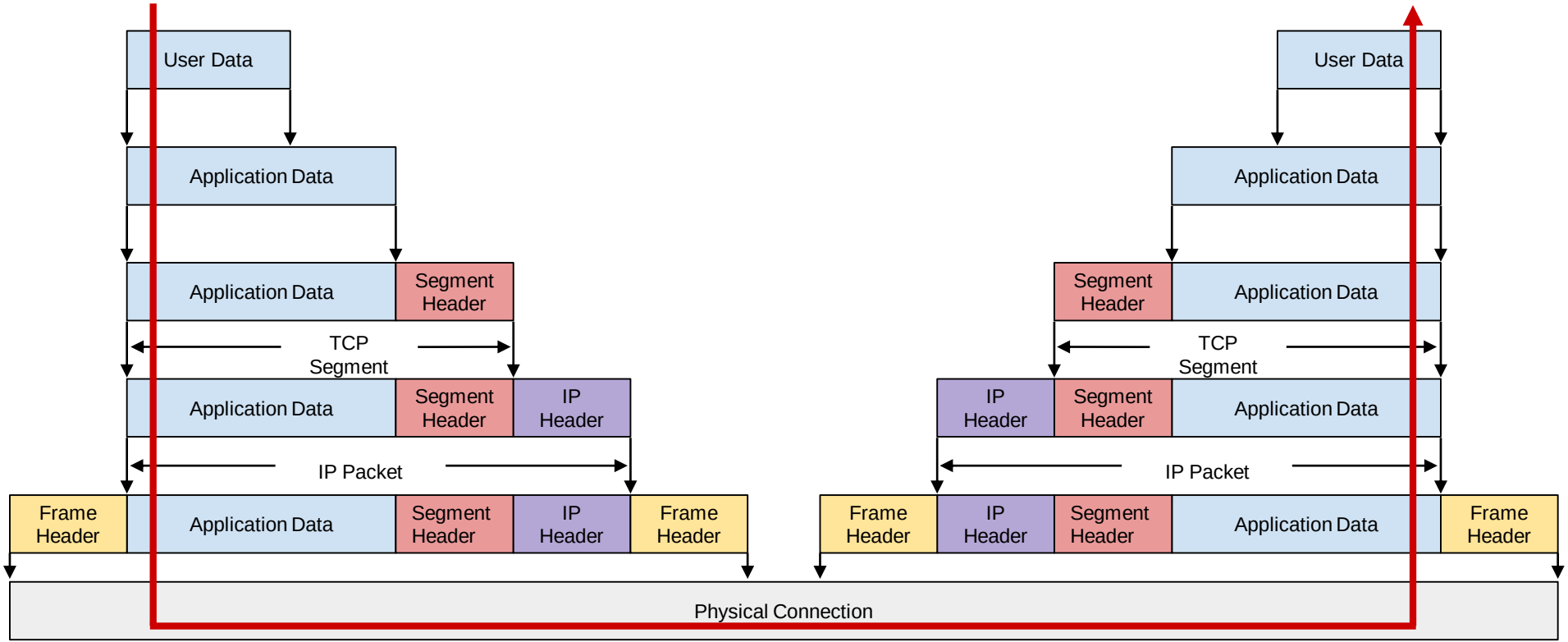
Data

- All applications that utilize the network fall under this layer
  - Remote Host Login: Telnet, Secure Shell (SSH)
  - File Transfer: File Transfer Protocol (FTP), Trivial File Transfer Protocol (TFTP)
  - Electronic Mail: Simple Mail Transfer Protocol (SMTP)
  - Networking Support: Domain Name System (DNS)
  - Remote host management: Simple Network Management Protocol (SNMP), Common Management Information Protocol over TCP (CMOT)

OSI Data Transfers

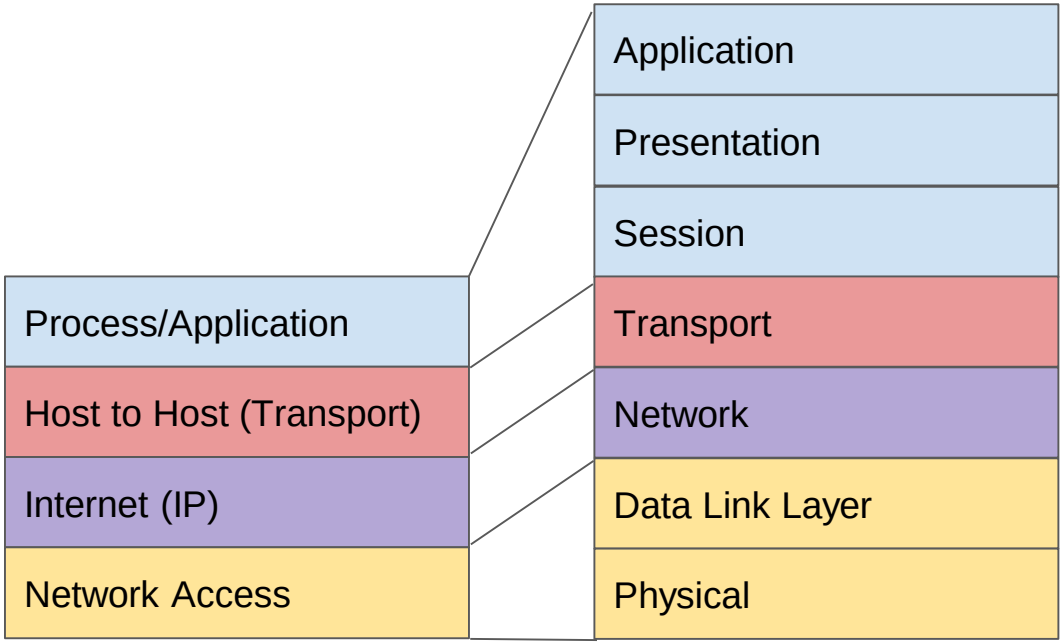


How Data Moves



Alternative View (DoD)

- More condensed view of the networking abstraction model with only 4 layers
- Better segmented to the layer we actually need to differentiate between
- We will typically refer to this model, but you should know the OSI model



Let’s demonstrate network communication in action

- I need 8 volunteers!

Group Send:
- Marod Application
- Jacob Transport
- Sebastion Network
- Fuga Physical

Group Receive:
- Kevin Application
- Erin Trasnport
- Sahas Network
- Pranathi Physical

Questions?

Additional Resources

IANA Service Name and Transport Protocol Port Number Registry