LAB2: Building Your Layer 2/3/4 Protocol Stack

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Goal

- You are going to implement a C/C++ program to replace layer 2/3/4 of the kernel protocol stack

- Build your own protocol stack is difficult, but worthwhile.

- Finishing this lab, you are expected to grow into a *system expert* (see next page) hopefully.

Application
Transport
Network
Link
Physical

We are working on these!

Two Types of Experts

Domain Experts Use the Infrastructure and Innovate Their Field
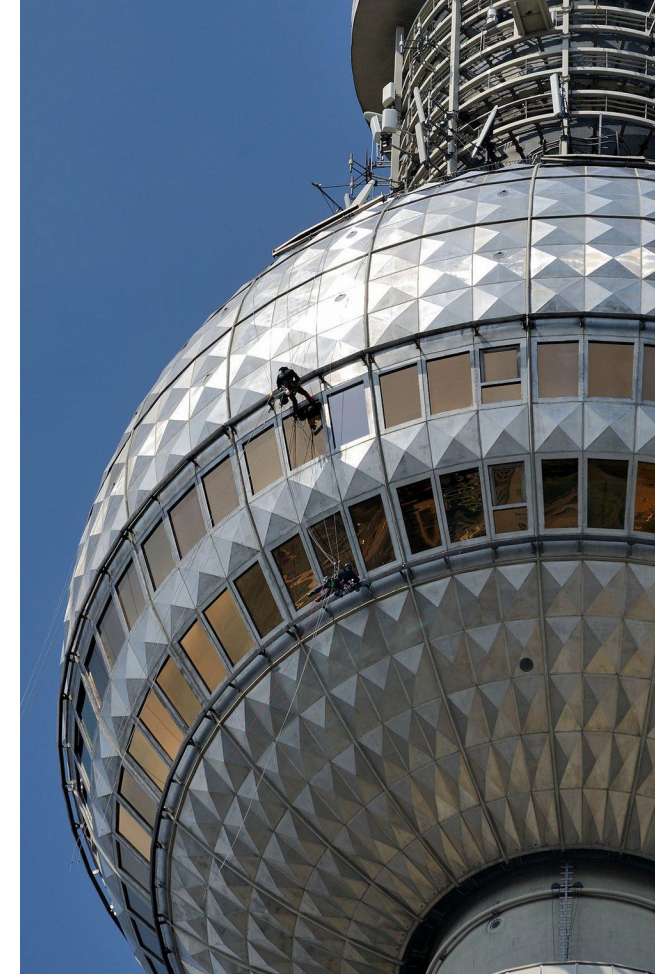
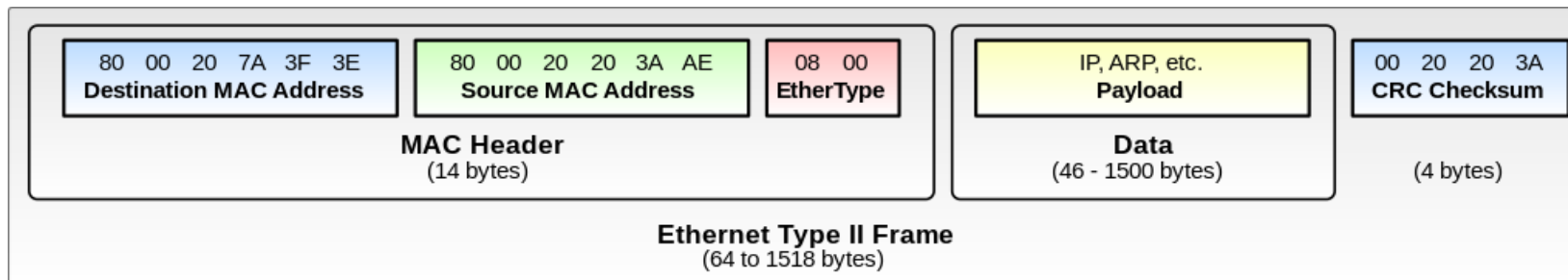System Experts Build and Renovate the Infrastructure

From Guojie

Overview

- Implement the 3 protocol layers from bottom to top, with 3 dues.

- You need to implement the interfaces we provide between layers.

- Feel free to contact us for more clarification and help.

- **See README.md for more tasks, hints and submit instructions.**

Part A: Link Layer

- Make use of **libpcap** to support sending/receiving **Ethernet II** frames.
- Bottom: libpcap functions, e.g. sending and receiving "framed" bitstreams.
- Top: device management, sending/receiving Ethernet II frames.
- Due: Oct. 7th.

80 00 20 7A 3F 3E **Destination MAC Address**	80 00 20 20 3A AE **Source MAC Address**	08 00 **EtherType**	IP, ARP, etc. **Payload**	00 20 20 3A **CRC Checksum**
MAC Header (14 bytes)			**Data** (46 - 1500 bytes)	(4 bytes)

Ethernet Type II Frame
(64 to 1518 bytes)

Part B: Network Layer

- Implement a simplified version of **Internet Protocol version 4**.
- Bottom: your Ethernet library.
- Inside: your routing algorithm.
- Top: sending/receiving packets over the whole Internet.
- Due: Oct. 21st.
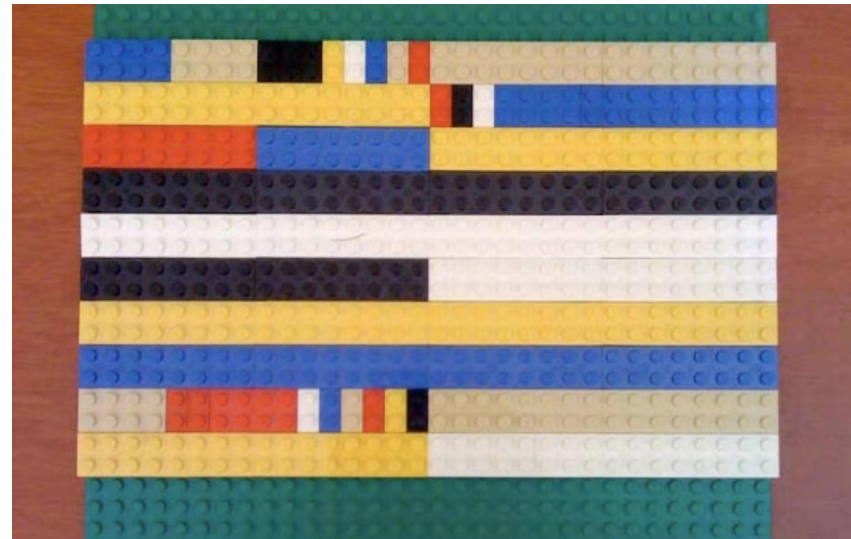
Part C: Transport Layer

- Implement a simplified version of **TCP protocol**, providing a subset of **socket interfaces**.
- Bottom: your IP library.
- Inside: connection state machine.
- Top: reliable connection via network.
- Due: Nov. 18th.

```
                              +---------+ ---------\      active OPEN
                              |  CLOSED |            \    -----------
                              +---------+<---------\   \   create TCB
                                |     ^              \   \  snd SYN
                   passive OPEN |     |   CLOSE        \   \
                   ------------ |     | ----------       \   \
                    create TCB  |     | delete TCB         \   \
                                V     |                      \   \
                              +---------+            CLOSE    |    \
                              |  LISTEN |          ---------- |     |
                              +---------+          delete TCB |     |
                   rcv SYN      |     |     SEND              |     |
                  -----------   |     |    -------            |     V
 +---------+      snd SYN,ACK  /       \   snd SYN          +---------+
 |         |<-----------------           ------------------>|         |
 |   SYN   |                    rcv SYN                      |   SYN   |
 |   RCVD  |<-----------------------------------------------|   SENT  |
 |         |                    snd ACK                      |         |
 |         |------------------           -------------------|         |
 +---------+   rcv ACK of SYN  \       /  rcv SYN,ACK        +---------+
   |           --------------   |     |   -----------
   |                  x         |     |     snd ACK
   |                            V     V
   |  CLOSE                   +---------+
   | -------                  |  ESTAB  |
   | snd FIN                  +---------+
   |                   CLOSE    |     |    rcv FIN
   V                  -------   |     |    -------
 +---------+          snd FIN  /       \   snd ACK            +---------+
 |  FIN    |<-----------------           ------------------>|  CLOSE  |
 | WAIT-1  |------------------                               |   WAIT  |
 +---------+          rcv FIN  \                             +---------+
   | rcv ACK of FIN   -------   |                            CLOSE  |
   | --------------   snd ACK   |                           ------- |
   V        x                   V                           snd FIN V
 +---------+                  +---------+                    +---------+
 |FINWAIT-2|                  | CLOSING |                    | LAST-ACK|
 +---------+                  +---------+                    +---------+
   |                rcv ACK of FIN |                 rcv ACK of FIN |
   |  rcv FIN       -------------- |    Timeout=2MSL -------------- |
   |  -------            x         V    ---------        x          V
   \ snd ACK                  +---------+delete TCB        +---------+
    ------------------------>|TIME WAIT|------------------>| CLOSED  |
                              +---------+                  +---------+

                         TCP Connection State Diagram
                                 Figure 6.
```
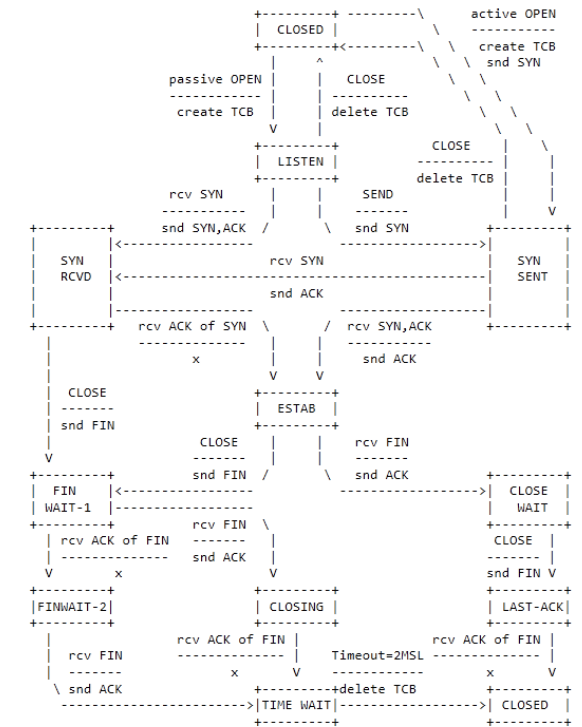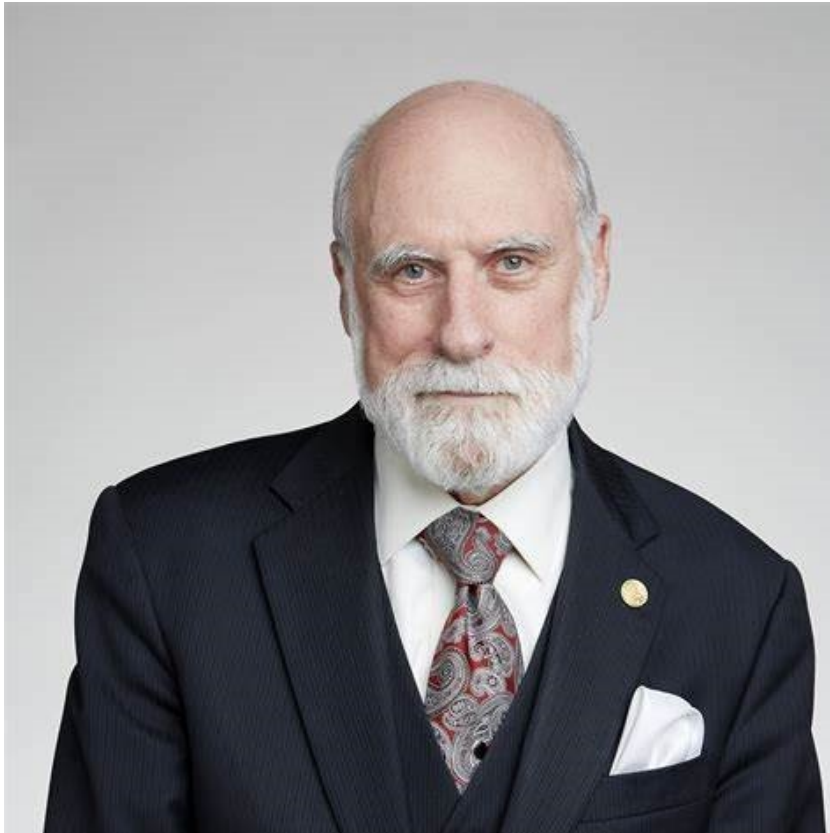
Thanks and Have Fun!

If I have seen further... it is by standing upon the shoulders of giants.
-- *Isaac Newton*