

CS2105 Lecture 9

Link Layer

24 March, 2014

After this class, you are expected to be able to understand:

- how the role of link layer and the services it could provide.
- how parity and CRC schemes work
- different methods for accessing shared medium
- how ALOHA, Slotted ALOHA, CSMA, and CSMA/CD works
- how the DOCSIS standard incorporate different medium access techniques
- the framing of an Ethernet frame

“These Protocols Transmit At Random Interval. It May Sound Ridiculous, But The Reason They Do It Is Simply Beautiful.”

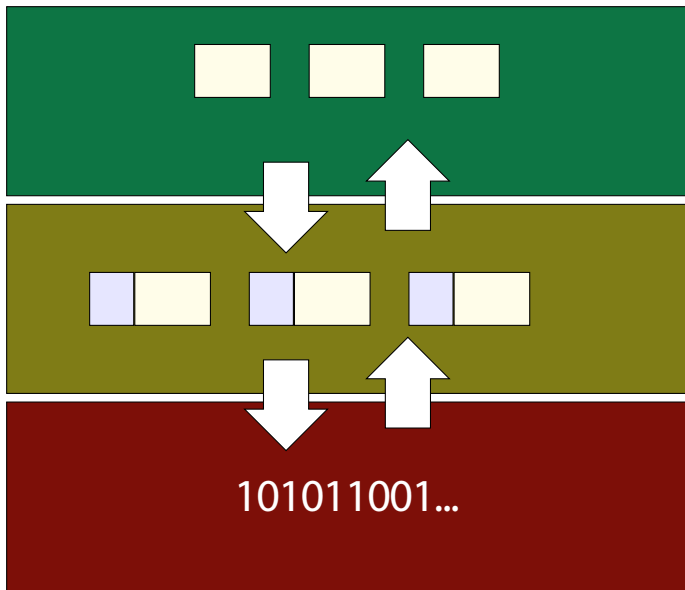
Application

Transport

Network

Link

Physical



Link layer provides
node-to-node communication
services of **frames**.

Possible services: **Framing**

Possible services:
Link Access

Possible services:
Reliable Delivery

Possible services:
**Error Detection and
Correction**

Parity Bit

2D Parity

Cyclic Redundancy Check

$$D2^r + R = nG$$

R is remainder of $D2^r / G$

CRC calculation is done in
base-2 arithmetic without carry
or borrow.

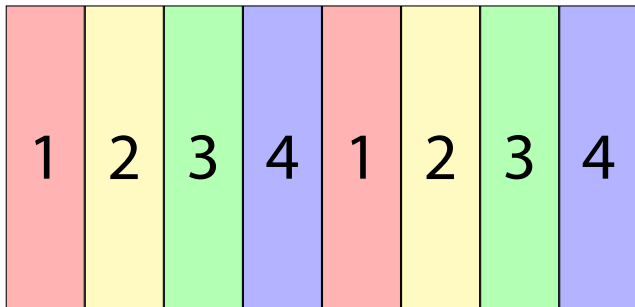
Example: $G = 1001$, $D = 101110$

Multiple Access Protocol

(for a shared medium)

1. Partition the Channel
2. Take Turns
3. Randomly Access

Time-Division Multiplexing



Frequency-Division Multiplexing



1. Partition the Channel
2. Take Turns
3. Randomly Access

Polling

Token Passing

Admin Matters

1. Partition the Channel
2. Take Turns
3. Randomly Access

Slotted ALOHA

Slotted ALOHA

The discussions about efficiency of ALOHA, Slotted ALOHA, CSMA, and CSMA/CD in the textbook is outside the scope of CS2105.

ALOHA



CSMA (Carrier Sense Multiple Access)



When there is a frame to send:

repeat

while channel is busy **do**

wait

end while

start sending

while has more bits **do**

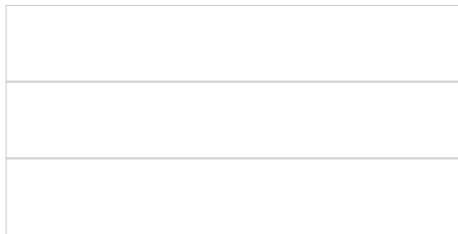
continue sending

end while

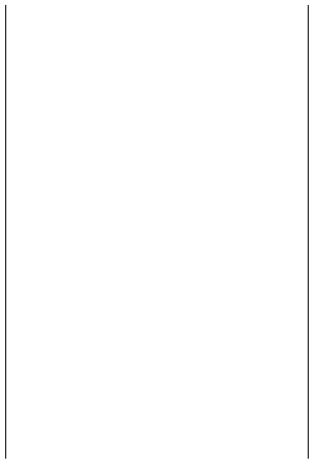
stop sending

until frame is sent without collision

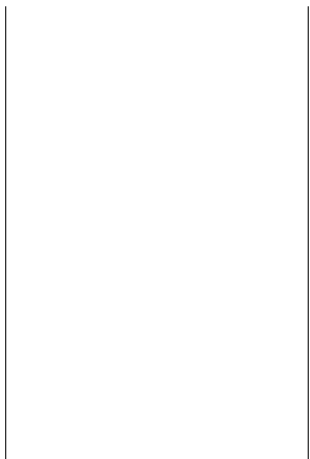
CSMA/CD (Carrier Sense Multiple Access/Collision Detection)



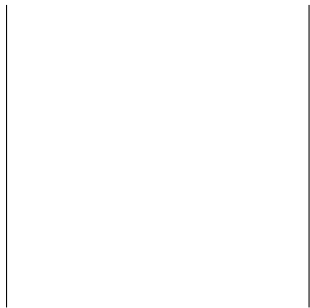
While channel is not idle, wait



if collide during transmission, stop



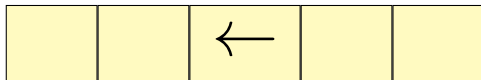
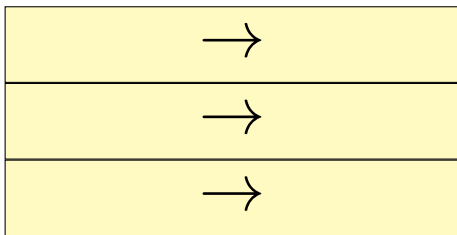
At n -th consecutive collision, let $m = \min(n, 10)$. Pick K randomly from $\{0, 1, \dots, 2^m - 1\}$. Wait for 512K bit time.



When there is a frame to send, set $n = 1$

```
repeat  
  while channel is busy do  
    wait  
  end while  
  start sending  
  while no collision or has more bits do  
    continue sending  
  end while  
  stop sending  
  if there is a collision then  
     $K = \text{random}(0, 2^n - 1)$   
    Wait 512K bit time  
     $n = \min(n + 1, 10)$   
  end if  
until frame is sent completely
```

Example: DOCSIS

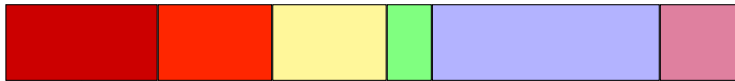


Example: DOCSIS

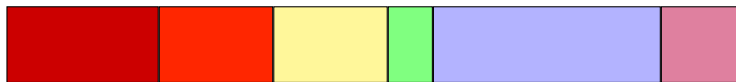
- ▶ Use FDM to divide upstream and downstream into multiple channels
- ▶ Use TDM for upstream (channels are shared)
- ▶ CMTS assign slots to cable modems
- ▶ Cable modems send slot requests in random access manner.

Ethernet Framing Example



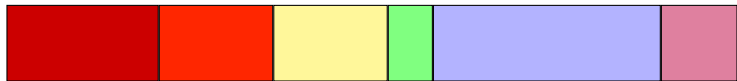


Preamble
(8 bytes)

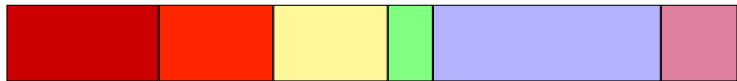


Src MAC
Address
(6 bytes)

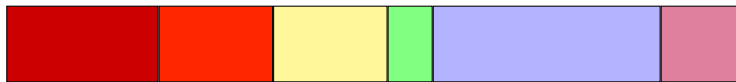
Dest MAC
Address
(6 bytes)



Type
(2 bytes)



Data
(46-1500 bytes)



CRC
(4 bytes)