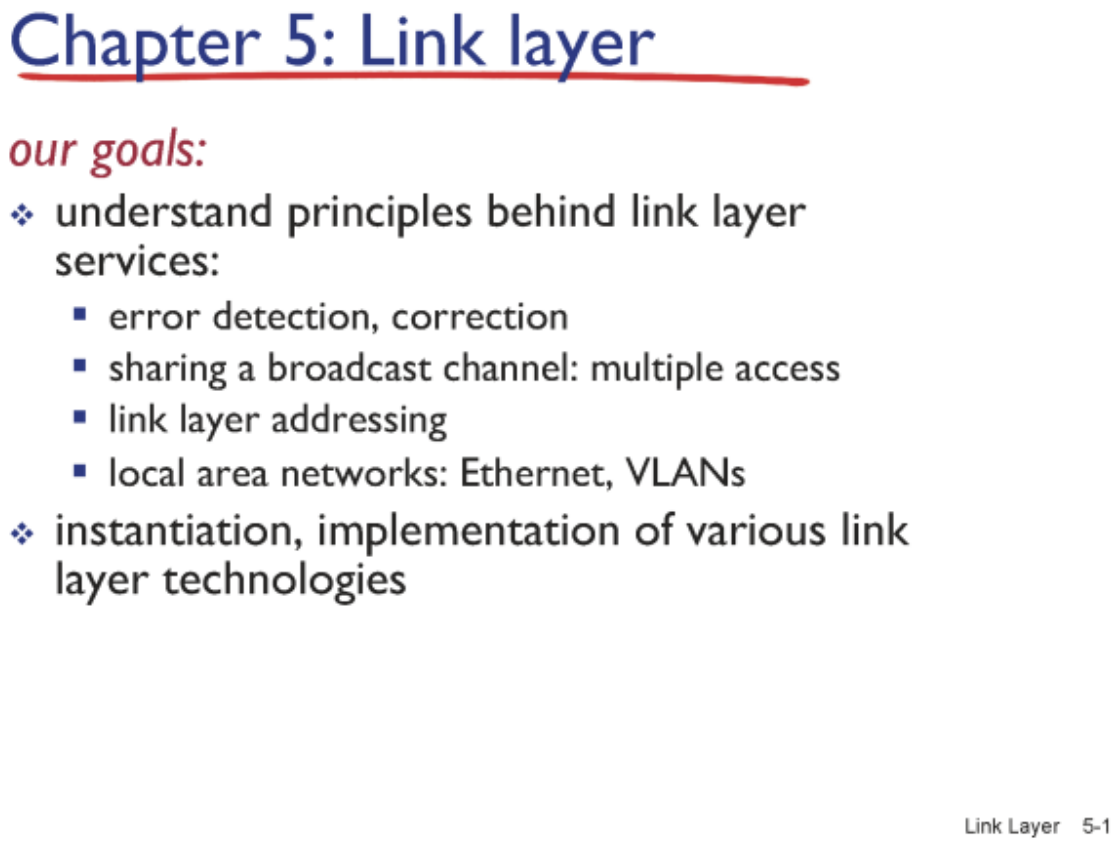
링크계층1

작성일시	@2022년 11월 6일 오후 5:28
강의날짜	@2022/11/06
편집일시	@2022년 11월 6일 오후 7:49
분야	네트워크
공부유형	스터디 그룹
복습	☐
태그	



공유하는 채널이 존재함 본인만을 위해 전용선이 존재하는 것이 아님

게이트웨이라우터한테 얘기하는 것은 다 들림

Collision(충돌) : 그래서 둘 이상이 얘기하면 섞임 → 신호가 섞임 → 해독 불가능 → 채널 낭비

충돌하지 않아야 메시지가 내가 원하는곳까지 전달됨

링크레이어가 하는 일 : 충돌하지 않게 충돌이 발생했을 때 그것을 해결하는 일

Link layer, LANs: outline

5.1 introduction, services
5.2 error detection, correction
5.3 multiple access protocols
5.4 LANs
- addressing, ARP
- Ethernet
- switches
- VLANS

5.5 link virtualization: MPLS
5.6 data center networking
5.7 a day in the life of a web request

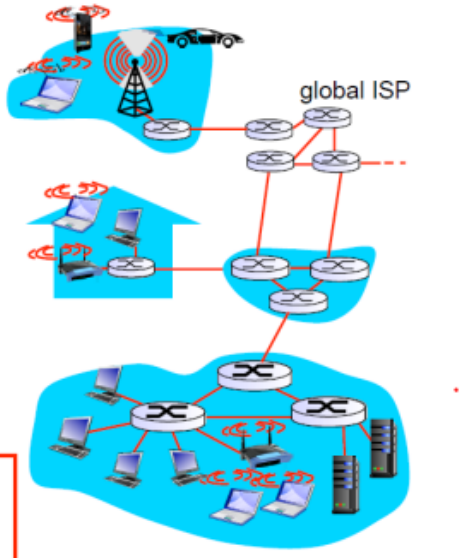
Link Layer 5-2

Link layer: introduction

terminology:

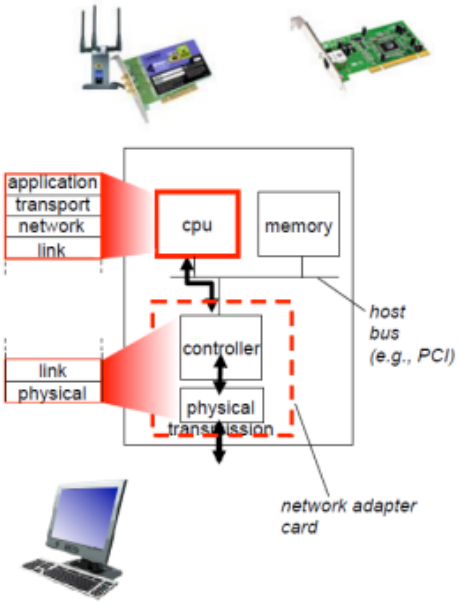
- hosts and routers: nodes
- communication channels that connect adjacent nodes along communication path: links
  - wired links
  - wireless links
  - LANs
- layer-2 packet: frame, encapsulates datagram

data-link layer has responsibility of transferring datagram from one node to *physically adjacent* node over a link

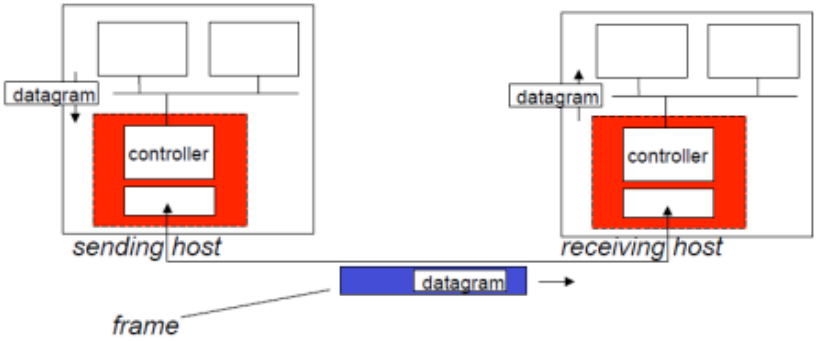


Where is the link layer implemented?

- in each and every host
- link layer implemented in "adaptor" (aka *network interface card* NIC) or on a chip
  - Ethernet card, 802.11 card; Ethernet chipset
  - implements link, physical layer
- attaches into host's system buses
- combination of hardware, software, firmware



Adaptors communicating



- sending side:
  - encapsulates datagram in frame
  - adds error checking bits, rdt, flow control, etc.
- receiving side
  - looks for errors, rdt, flow control, etc
  - extracts datagram, passes to upper layer at receiving side

Link Layer 5-8

Multiple access links, protocols

two types of "links":

- point-to-point
  - PPP for dial-up access
  - point-to-point link between Ethernet switch, host
- *broadcast (shared wire or medium)*
  - old-fashioned Ethernet
  - upstream HFC
  - 802.11 wireless LAN

shared wire (e.g., cabled Ethernet) | shared RF (e.g., 802.11 WiFi) | shared RF (satellite) | humans at a cocktail party (shared air, acoustical)

Link Layer 5-13

Medium (매체)에 Access(접근)할 때 Control을 잘해야함

MAC protocol : 충돌에 대한 해결책

ex) wifi - 두명이상이 말하지 않도록 잘 통제

An ideal multiple access protocol

given: broadcast channel of rate R bps

desire:

1. when one node wants to transmit, it can send at rate R.
2. when M nodes want to transmit, each can send at average rate R/M
3. fully decentralized:
   - no special node to coordinate transmissions
   - no synchronization of clocks, slots
4. simple

Link Layer 5-15

MAC protocols: taxonomy

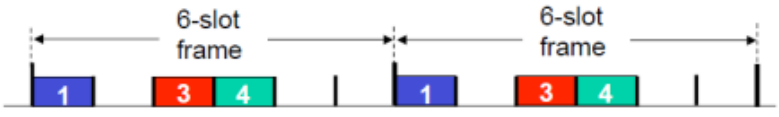
three broad classes:

- *channel partitioning*
  - divide channel into smaller "pieces" (time slots, frequency, code)
  - allocate piece to node for exclusive use
- *random access*
  - channel not divided, allow collisions
  - "recover" from collisions
- *"taking turns"*
  - nodes take turns, but nodes with more to send can take longer turns

Channel partitioning MAC protocols: TDMA

TDMA: time division multiple access

- access to channel in "rounds"
- each station gets fixed length slot (length = pkt trans time) in each round
- unused slots go idle
- example: 6-station LAN, 1,3,4 have pkt, slots 2,5,6 idle



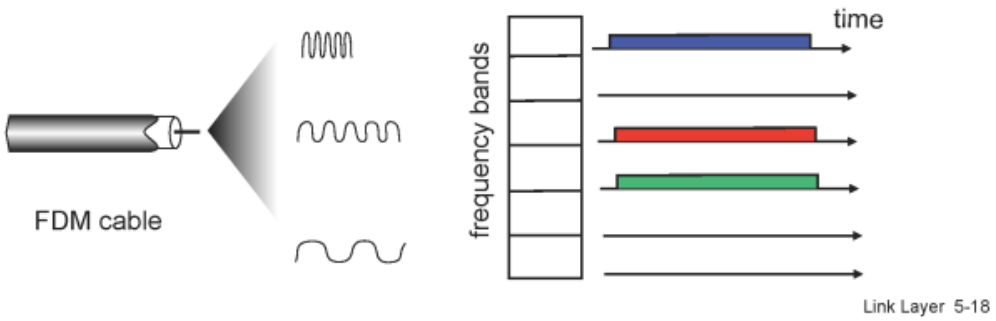
TDMA : 각 사람 별로 시간을 쪼개서 타임 슬라이스를 assign해서 각자의 타임슬라이스가 돌아왔을 때만 사용할 수 있게 함

문제 : 유저 1만 있다 낭비 이가 빠져있음

Channel partitioning MAC protocols: FDMA

FDMA: frequency division multiple access

- channel spectrum divided into frequency bands
- each station assigned fixed frequency band
- unused transmission time in frequency bands go idle
- example: 6-station LAN, 1,3,4 have pkt, frequency bands 2,5,6 idle



Link Layer 5-18

FDMA : TDMA랑 같지만, 각자 자기 자신의 주파수가 결정되어있다

TDMA랑 같은 문제점

Random access protocols

- when node has packet to send
  - transmit at full channel data rate R.
  - no *a priori* coordination among nodes
- two or more transmitting nodes ➜ "collision",
- random access MAC protocol specifies:
  - how to detect collisions
  - how to recover from collisions (e.g., via delayed retransmissions)
- examples of random access MAC protocols:
  - slotted ALOHA
  - ALOHA
  - CSMA, CSMA/CD, CSMA/CA

Link Layer 5-19

자기가 보내고 싶을 때 보내자

충돌을 어떻게 탐지하고 발생하면 어떻게 처리될 것인가

CSMA (carrier sense multiple access)

CSMA: listen before transmit:

if channel sensed idle: transmit entire frame

- if channel sensed busy, defer transmission

- human analogy: don't interrupt others!

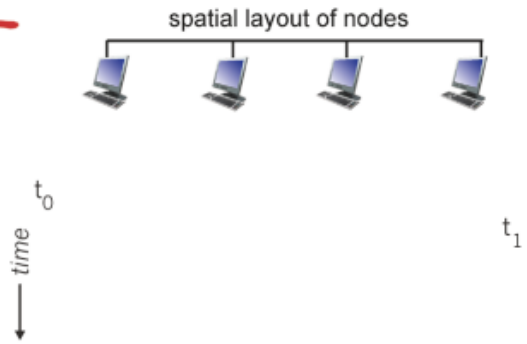
Link Layer 5-25

CSMA : 듣고 있다가 끊기면 전송

누군가 얘기가 끝나고 동시에 치고오면 충돌

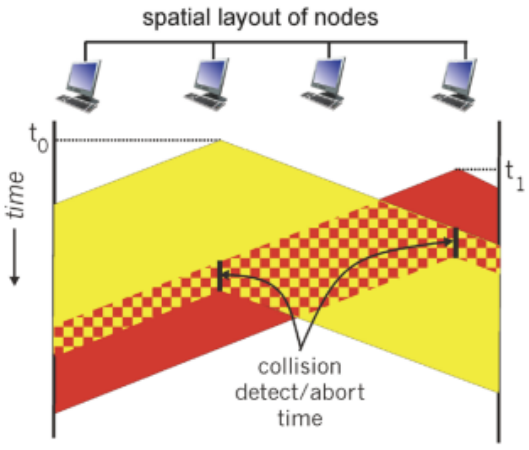
CSMA collisions

- collisions *can* still occur: propagation delay means two nodes may not hear each other's transmission
- collision: entire packet transmission time wasted
  - distance & propagation delay play role in in determining collision probability



Link Layer 5-26

CSMA/CD (collision detection)



Link Layer 5-28

노란색 frame과 빨간색 frame 이 충돌이 일어남 겹치는 시간 : 낭비

완전히 동일 시간 이었을까? 그럴 수 없음

핵심 : 딜레이를 해결할 방법 x 충돌은 나기 마련=

충돌 났지만 frame으로 전송은 이미 완료

충돌 감지 : 멈추기

Ethernet CSMA/CD algorithm

1. NIC receives datagram from network layer, creates frame
2. If NIC senses channel idle, starts frame transmission. If NIC senses channel busy, waits until channel idle, then transmits.
3. If NIC transmits entire frame without detecting another transmission, NIC is done with frame !
4. If NIC detects another transmission while transmitting, aborts and sends jam signal
5. After aborting, NIC enters *binary (exponential) backoff:*
   - after *m*th collision, NIC chooses *K* at random from $\{0, 1, 2, \ldots, 2^m-1\}$. NIC waits K·512 bit times, returns to Step 2
   - longer backoff interval with more collisions

Link Layer 5-29

binary backoff : 이야기를 시작했는데 충돌 나면 두 숫자 중에 랜덤하게 골라서 기다린 다음에 또 충돌 , 만약 재충돌 숫자 리스트가 늘어남

따라서 충돌이 늘어날수록 더 오래 기다리게 됨

충돌이 많이 날 때 사람들이 늘어날 때 backoff 시간이 길어져서 지연되는 것임

"Taking turns" MAC protocols

channel partitioning MAC protocols:

- share channel *efficiently* and *fairly* at high load
- inefficient at low load: delay in channel access, 1/N bandwidth allocated even if only 1 active node!

random access MAC protocols

- efficient at low load: single node can fully utilize channel
- high load: collision overhead

"taking turns" protocols

look for best of both worlds!

Link Layer 5-31

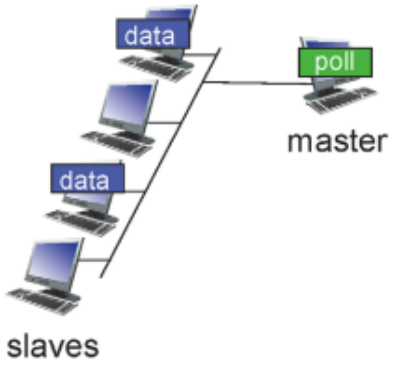
channel partitioning : 사람이 많으면 많을 수록 유리 사용자가 적으면 효용성 떨어짐

random access : 사람이 많을 수록 시간이 늘어남

"Taking turns" MAC protocols

polling:

- master node "invites" slave nodes to transmit in turn
- typically used with "dumb" slave devices
- concerns:
  - polling overhead
  - latency
  - single point of failure (master)



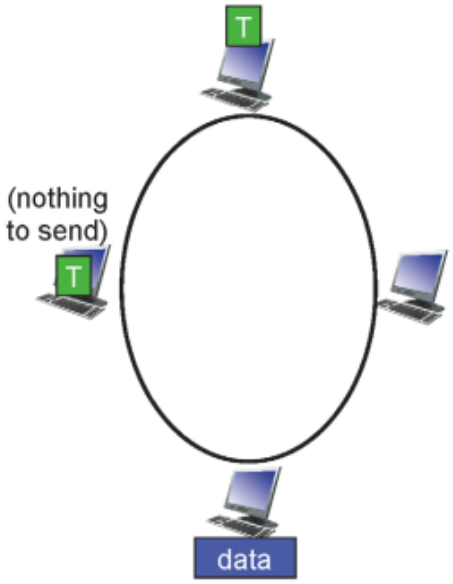
Link Layer 5-32

많이 나오지는 않음 single point of failure 다 같이 망한다는 치명적인 단점

"Taking turns" MAC protocols

token passing:

- control *token* passed from one node to next sequentially.
- token message
- concerns:
  - token overhead
  - latency
  - single point of failure (token)



Link Layer 5-33

토큰을 가지고 있는 host만이 전송할 수 있음

토큰을 한 바퀴 돌림

하지만 누군가가 토큰을 잃어버린다면 큰 문제

Summary of MAC protocols

- *channel partitioning,* by time, frequency or code
  - Time Division, Frequency Division
- *random access* (dynamic),
  - ALOHA, S-ALOHA, CSMA, CSMA/CD
  - carrier sensing: easy in some technologies (wire), hard in others (wireless)
  - CSMA/CD used in Ethernet
  - CSMA/CA used in 802.11
- *taking turns*
  - polling from central site, token passing
  - bluetooth, FDDI, token ring

Link Layer 5-34

random access방식을 패킹 스위칭에 제일 잘 맞기 때문에 제일 많이 사용

wifi는 CSMA/CA 방식 사용