

5 Network Layer

≡ 태그

10주차

CSS



network layer service models, forwarding vs routing, how a router works, generalized forwarding concept

4.1 Overview of Network layer

- data plane
- control plane

Network layer

- 5계층 기준: transport layer 밑에 있는 것
- sending side: segments (from transport layer) → datagrams (encapsulation)
메시지를 편지 봉투로 싸는 것
- receiving side: datagrams → segments (to transport layer)
편지 봉투를 뜯어 메시지만 보냄
- 모든 host에 구현되어 있어야 함 (router 포함), transport는 router에 구현 안 되어 있음(end host)
그래서 실험해볼 수 있는 게 드뭄
- network layer까지만 패킷 헤더 볼 수 있음, transport layer부터는 볼 수 없음

Two key network-layer functions

- layer 간 독립성: transparency

$t \rightarrow n$, segment를 내려보냄

패킷이 경로에 잘 도착했는지 안 했는지만 확인

- network-layer functions
 1. forwarding: router input에서 output까지
 2. routing: 전체 sender에서 receiver까지 어떤 경로

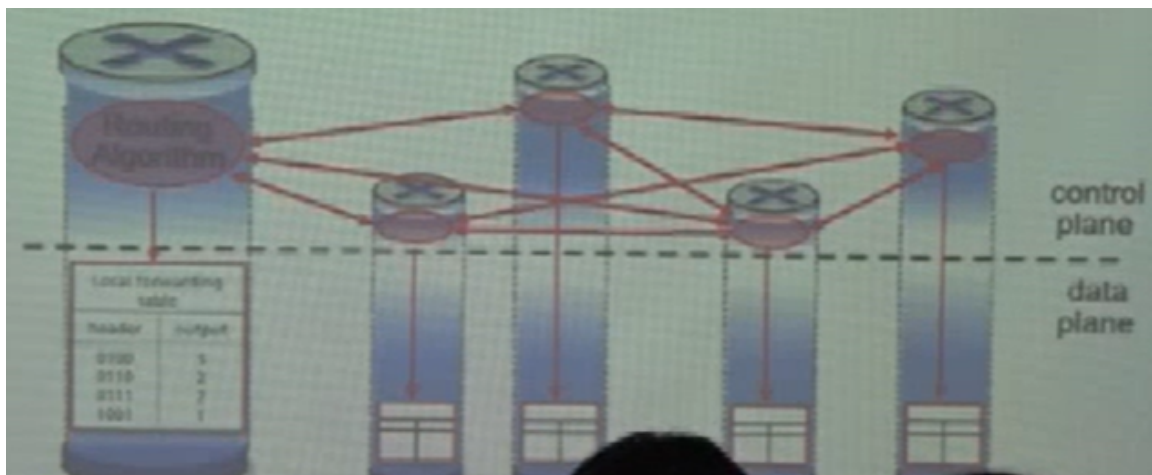
Data plane

plane: 논리적으로 구분되는 영역

- 로컬, router마다 있는 function
- forwarding function
- packet header에 따라 output port 결정
- hw 부분

Control plane

- network-wide login
- datagram이 어떤 경로를 선택할 지를 결정
- traditional routing algorithm

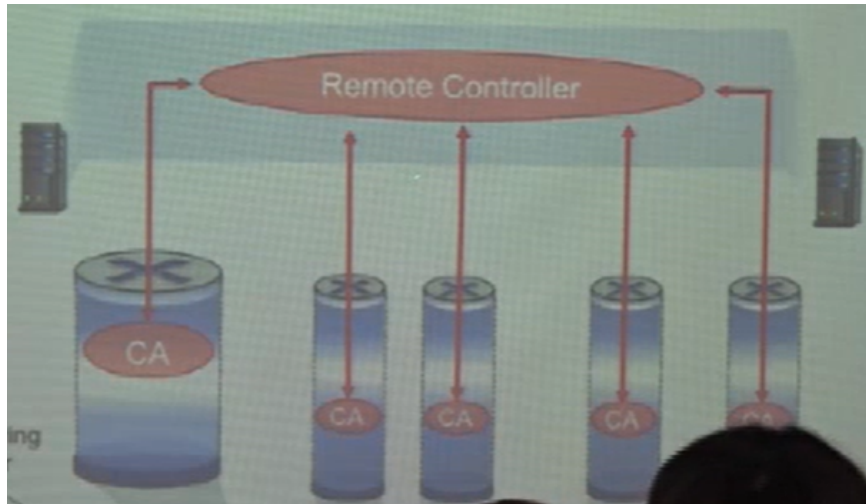


- software-defined networking

Per-router control plane

- 각각의 라우터에 구현이 되어 있고, 이것들이 서로 interaction
- 각 router에 algorithm 설치, 새로운 방법이 나오면 다시 적용하는게 쉽지 않음 (traditional 방법에서)

Logically centralized control plane



- 각각의 router에 들어가야 할 forwarding table을 CA(Control Agent)에 알려줌
- 업데이트하는 것이 더 쉬움

Network service model

individual datagrams

- guaranteed delivery (with less than 40 ms delay) → 실제로 x, best effort

a flow of datagrams

- guaranteed
- in-order datagram delivery
- minimum bandwidth to flow
- inter-packet spacing (패킷 간 간격, delay jitter가 일정 간격 넘지 않게)

Network Architecture	Service Model	Guarantees ?				Congestion feedback
		Bandwidth	Loss	Order	Timing	
Internet	best effort	none	no	no	no	no (inferred via loss)
ATM	CBR	constant rate	yes	yes	yes	no congestion
ATM	VBR	guaranteed rate	yes	yes	yes	no congestion
ATM	ABR	guaranteed minimum	no	yes	no	yes
ATM	UBR	none		yes	no	no

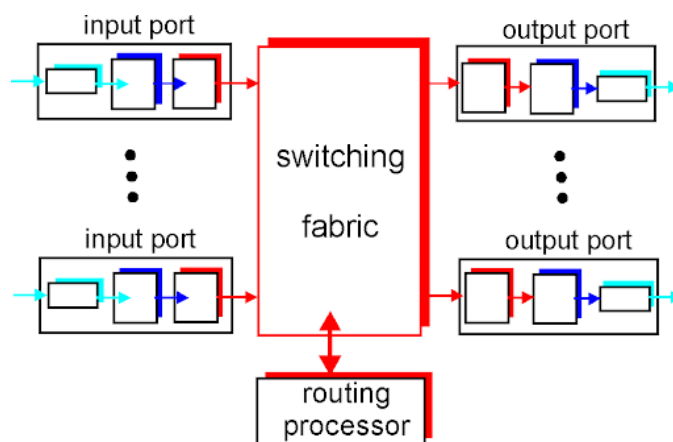
→ 인터넷에서 보장해주는 건 아무것도 없다. 그냥 packet switching

Asynchronous Transfer Mode

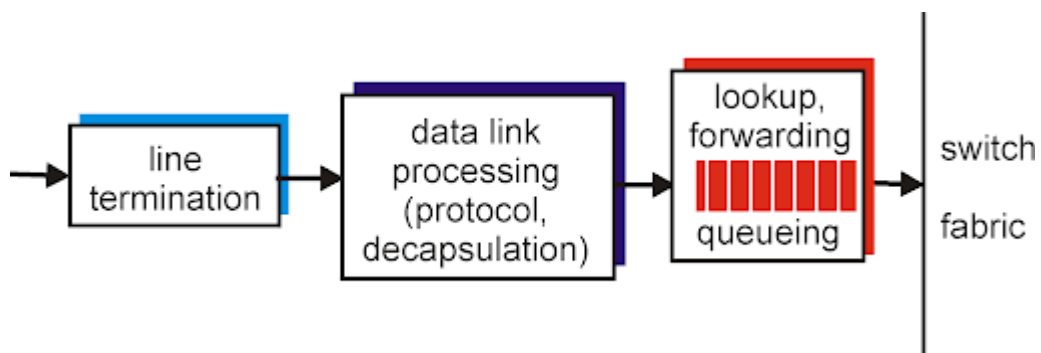
- 90's 말 packet switching vs circuit switching
- 장점만 조합한 network architecture

4.2 What's inside a router

Router architecture



Input port functions



physical layer

- bit-level로 받음
- link layer로 올려보냄

data link layer

- packet error check

queueing

- 어느 output port로 내보낼건지
- destination 기반 forwarding

목적지만 보고 결정 (traditional)

- generalized forwarding

header 보고 output port 결정이 아니라 xxcast도 보고 여러가지를 종합적으로...

Destination-based forwarding

Destination-based forwarding

<i>forwarding table</i>	
Destination Address Range	Link Interface
11001000 00010111 00010000 00000000 through 11001000 00010111 00010111 11111111	0
11001000 00010111 00011000 00000000 through 11001000 00010111 00011000 11111111	1
11001000 00010111 00011001 00000000 through 11001000 00010111 00011111 11111111	2
otherwise	3

Longest prefix matching

longest prefix matching

when looking for forwarding table entry for given destination address, use *longest* address prefix that matches destination address.

Destination Address Range	Link interface
11001000 00010111 00010*** *****	0
11001000 00010111 00011000 *****	1
11001000 00010111 00011*** *****	2
otherwise	3

examples:

DA: 11001000 00010111 00010110 10100001 which interface?

DA: 11001000 00010111 00011000 10101010 which interface?

- ternary content addressable memories에 저장 (0, 1, d)
- 훨씬 빠르고, 비싸다.

Switching fabrics

memory

- 1세대 방식
- port가 memory 공유

bus

- 모든 output port가 패킷을 받음
- 해당 되는 곳에만 buffering

crossbar

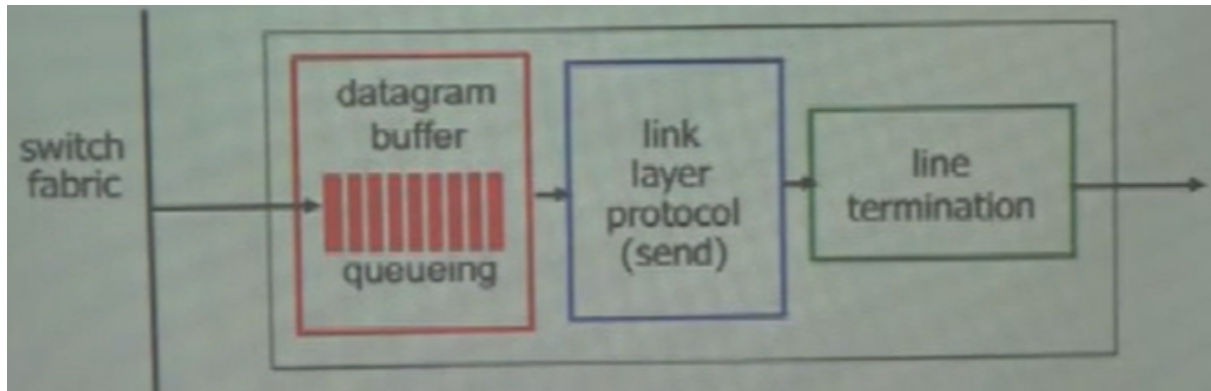
- 해당 되는 곳만 switch가 열림

Input port queuing

- 빠져나가는 속도 < 들어오는 속도 → queue에 쌓인다. (queuing)
- packet loss

- Head-of-the-Line blocking
- Virtual Output Queue(VOQ)

Output ports



- input port 거꾸로
- buffering: switching에서 들어오는게 더 빠르면
- scheduling

Output port queueing

How much buffering?

- 크기가 클수록

Scheduling mechanisms

FIFO scheduling discard policy

- tail drop
- priority
- random

Round Robin scheduling

Weighted Fair Queueing (WFQ)

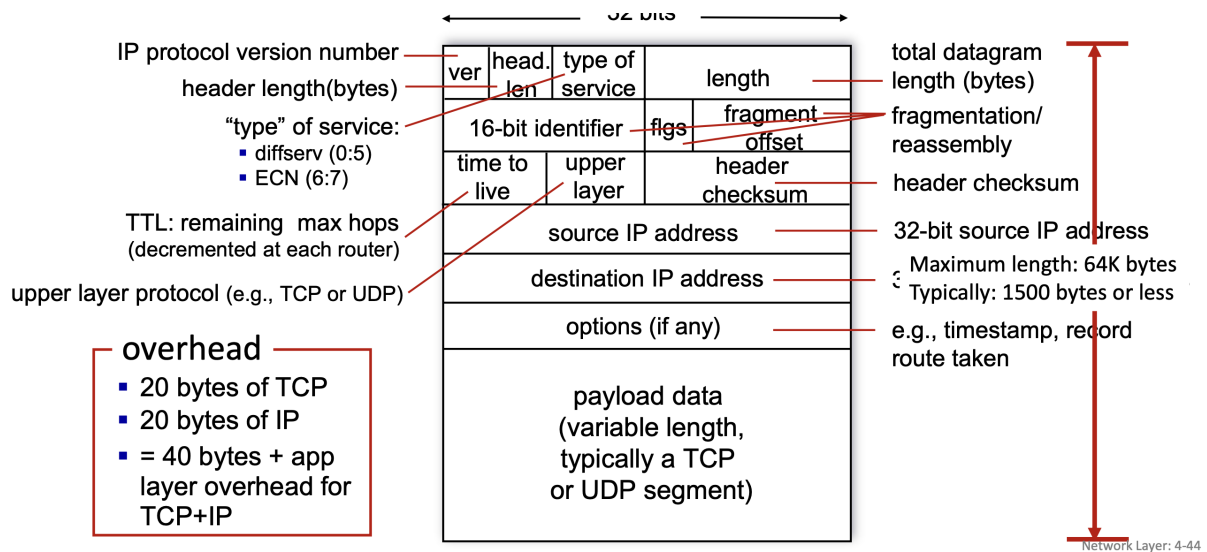
- 내 차례에 weight에 따라 패킷 수가 달라짐
- priority와 round robin의 중간...? 합한?

4.3 IP: Internet Protocol

모든 host, router에 network layer가 구현되어 있음

- routing protocols
- IP protocol
- ICMP protocol

IP datagram format



IP fragmentation, reassembly

- MTU: maximum transfer size

예제 설명해 줄 천사 구함