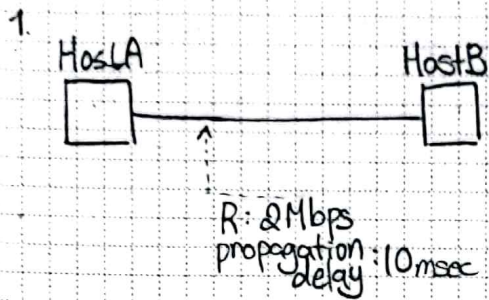


HW#1 Part I
전통통신공학 34743-02
2071035 이소민



Host A → A2D 변환: 64kbps
L: 56-byte
R: 2Mbps (propagation delay: 10msec)

- ① Host A: A2D 변환. 1 패킷 완성
- ② Host A에서 Link로 패킷 전송
- ③ Link에서 B로 패킷 전송
- ④ Host B에 패킷 1개가 온전히 도착
- ⑤ Host B에서 D2A 변환 시작

① A2D convert: 64kbps = $64 \cdot 2^{10}$ bps
L: 56-byte = $56 \cdot 8$ bit

1-packet convert time: $\frac{56 \cdot 8}{64 \cdot 2^{10}} = \frac{1}{2^{10}} \approx \frac{1}{10^3} = 0.001 \text{ sec} = 1 \text{ msec}$

②, ③ transmission delay: $\frac{L}{R}$ R: $2 \cdot 2^{20}$ bit/s $\frac{L}{R} = \frac{56 \cdot 8}{2 \cdot 2^{20}} = \frac{224}{2^{26}} \approx \frac{224}{10^6} = 0.000224 \text{ sec} = 0.224 \text{ msec}$

+ propagation delay: 10 msec

Total Time: 1 + 0.224 + 10 = 11.224 msec
(A2D) (transmission delay) (propagation delay)

A. 11.224 msec

2. Link: 3Mbps User: 150kbps when active
active 10% of time

1) 3Mbps = $3 \cdot 2^{20}$ bits/sec
150kbps = $150 \cdot 2^{10}$ bits/sec
 $\frac{3 \cdot 2^{20}}{150 \cdot 2^{10}} = \frac{2^{10}}{50} \approx \frac{10^3}{50} = 20$

A. 20 users

2) transmission: 10% of the time.
Probability: 0.1

A. 0.1

3) Total 120 users / Probability: 0.1 / n users transmit simultaneously

${}^{120}C_n \times (0.1)^n \times (0.9)^{120-n}$
↳ n users transmitting ↳ 120-n users not transmitting

A. ${}^{120}C_n \cdot (0.1)^n (0.9)^{120-n}$

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4) 21명이 동시에 접속할 확률: P

$$P = 1 - \sum_{n=0}^{20} {}^{120}C_n \cdot (0.1)^n (0.9)^{120-n}$$

⇒ 파이썬 코드로 계산

A. 0.00794 ...

```

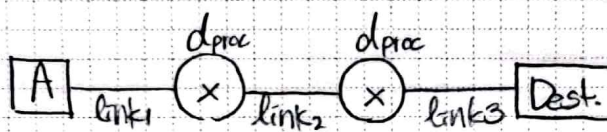
정통공 확률 계산.py - C:/Users/소민/Desktop/정통공 확률 계산.py (3.8.1)
File Edit Format Run Options Window Help

import math
sum = 0
for n in range(0,21):
    sum+=math.comb(120,n)*math.pow(0.1,n)*math.pow(0.9,120-n)
answer=1-sum
print(answer)

Python 3.8.1 Shell
File Edit Shell Debug Options Window Help
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 22:39:24) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:/Users/소민/Desktop/정통공 확률 계산.py =====
0.007941192248393625
>>>

```

3.



packet length: L
length of link: d_i
propagation speed: S_i
transmission rate: R_i
packet switch delay: d_{proc}
propagation delay: $\frac{d_i}{S_i}$

End-to-End delay: $\frac{L}{R_1} + \frac{L}{R_2} + \frac{L}{R_3} + \frac{d_1}{S_1} + \frac{d_2}{S_2} + \frac{d_3}{S_3} + 2 \cdot d_{proc}$

$L = 1500 \text{ bytes} = 1500 \cdot 8 \text{ bits}$

$S_1 = S_2 = S_3 = 2.5 \cdot 10^8 \text{ m/s} = 2.5 \cdot 10^5 \text{ km/s}$

$R_1 = R_2 = R_3 = 2 \text{ Mbps} = 2 \cdot 2^{20} \text{ bits}$

$d_{proc} = 3 \text{ msec}$ $d_1 = 5000 \text{ km}$, $d_2 = 4000 \text{ km}$, $d_3 = 1000 \text{ km}$

End-to-End delay = $\frac{1500 \cdot 8}{2 \cdot 2^{20}} \cdot 3 + \frac{5 \cdot 10^3}{2.5 \cdot 10^5} + \frac{4 \cdot 10^3}{2.5 \cdot 10^5} + \frac{1 \cdot 10^3}{2.5 \cdot 10^5} + 2 \cdot 3 \cdot 10^{-3}$

$\approx \frac{1500 \cdot 8}{2 \cdot 10^6} \cdot 3 + \frac{10 \cdot 10^3}{2.5 \cdot 10^5} + 2 \cdot 3 \cdot 10^{-3} = \frac{6000}{10^6} + \frac{4}{10^2} + \frac{6}{10^3}$

$= \frac{18}{10^3} + \frac{40}{10^3} + \frac{6}{10^3} = \frac{64}{10^3}$
 $= 0.064 \text{ sec} = 64 \text{ msec}$

A. 64 msec

4. Little's formula $\Rightarrow N = a \cdot d$

N = average # of packets in buffer + packet being transmitted.

a = rate of packets arriving at link.

d = average total delay = (queueing delay + transmission delay)

$N = 10 \text{ (packets)}$ $d = 10 \text{ (msec)} + \frac{1}{100} \text{ (sec)} = 10 \text{ (msec)} + 10 \text{ (msec)} = 20 \text{ (msec)}$

↳ queueing delay ↳ transmission rate 100 packet/sec

$\Rightarrow 1 \text{ packet per } \frac{1}{100} \text{ sec}$

$N = a \cdot d$

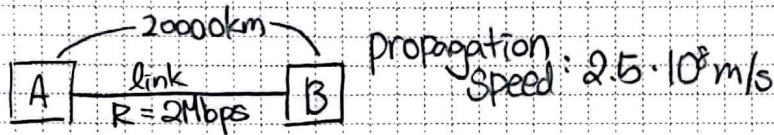
$a = \frac{N}{d} = \frac{10 \text{ (packets)}}{20 \text{ (msec)}} = 0.5 \text{ (packets/msec)}$

$\Rightarrow \text{transmission delay: } \frac{1}{100} \text{ sec}$

$= 500 \text{ (packets/sec)}$

A. 500 (packets/sec)

5



1) $\frac{2^3}{10^2}$ propagation delay: $\frac{2 \cdot 10^7 (\text{m})}{2.5 \cdot 10^8 (\text{m/sec})} = \frac{2^3}{10^2} (\text{sec})$

$R \cdot d_{\text{prop}} = 2 \cdot 2^{20} \cdot \frac{2^3}{10^2} \approx 2 \cdot 10^6 \cdot \frac{2^3}{10^2} = 2^4 \cdot 10^4 = 16 \cdot 10^4 (\text{bits}) = 160 \text{ Kb}$

A. 160 Kb

2) 800000 bits send. transmission rate: $R \approx 2 \cdot 10^6$
 $= 2^3 \cdot 10^5 \text{ bits}$

propagation delay: $\frac{2^3}{10^2}$

Max bits fit in link: $R \cdot d_{\text{prop}} = 2^4 \cdot 10^4 \text{ bits}$

$80 \cdot 10^4 (\text{bits}) > 16 \cdot 10^4 (\text{bits})$

\therefore maximum $16 \cdot 10^4 \text{ bits}$ are on link at given time when data sent continuously.

A. 160 Kb

3) $R \cdot d_{\text{prop}}$ 는 시간당 전송되는 비트 수와 한 비트가 다른 끝에 도달하는 시간(차원)을 곱한 값으로, 처음 전송된 비트가 다른 끝(목적지)에 도달할 때까지 source 호스트에서 보낸 신호의 비트수를 나타내고, 이는 곧 link가 한번에 최대로 담을 수 있는 비트수이다

A. 링크가 한번에 최대로 담을 수 있는 비트 수

4) (width of a bit) = $\frac{\text{Length of the link}}{\text{Max bits in link}} = \frac{2 \cdot 10^7 (\text{m})}{16 \cdot 10^4 (\text{bits})} = \frac{10^3}{8} = 125 (\text{m})$

A. 125 (m)

5) propagation speed: s , transmission rate: R , length of the link: m

max bits in link: $R \cdot d_{\text{prop}} = R \cdot \frac{m}{s}$

(width of a bit) = $\frac{m}{\text{Max bits in link}} = \frac{m}{R \cdot d_{\text{prop}}} = \frac{m}{R \cdot \frac{m}{s}} = \frac{s \cdot m}{R \cdot m} = \frac{s}{R}$

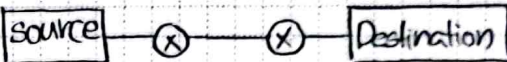
A. (width of a bit) = $\frac{s}{R}$

6. end-end delay: $n \cdot \frac{L}{R}$ (sec)

n : # of links

L : length of packet(message) (bits)

R : transmission rate (bits/sec)



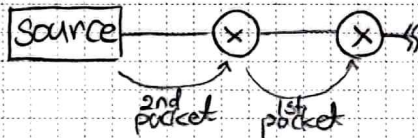
1) without segmentation: $n \cdot \frac{L}{R}$ (sec) to get to destination

$$n \cdot \frac{L}{R} = 3 \cdot \frac{8 \cdot 10^6}{2 \cdot 2^{20}} \approx 3 \cdot \frac{8 \cdot 10^6}{2 \cdot 10^6} = 12 \text{ (sec)}$$

A. 12 sec

2) length of a packet: $\frac{8 \cdot 10^6}{8 \cdot 10^2} = 10^4$ (bits)

first packet to first host: $n=1$, $n \cdot \frac{L}{R} = 1 \cdot \frac{10^4}{2 \cdot 10^6} = \frac{5}{10^3} = 0.005 \text{ sec} = 5 \text{ msec}$



1st packet: source - 1st link $\Rightarrow 5 \text{ msec}$

1st packet: 1st link - 2nd link
2nd packet: source - 1st link $\Rightarrow 5 \text{ msec}$

tot: 10 msec

A. 5 msec, 10 msec

3) source — (X) — (X) — Destination

arrival at:
1st packet: 15 msec
2nd: 20 msec
800th: 800 * 5 = 4010 (msec) = 4.01 (sec)

A. 4.01 (sec), segmentation을 하지 않는 것 보다 훨씬 장점이 없다

7. 1) <http://gaia.cs.umass.edu/cs453/index.html>

2) HTTP version 1.1

3) persistent connection (Connection: keep-alive)

4) 접속자의 IP 주소는 명시되어있지 않다. (transport layer에 명시)

5) Browser: Mozilla/5.0

브라우저마다 다른 형식의 message를 요구할 수도 있기 때문

8. 1) 성공적으로 연결 (200 OK), reply 시간: 2008/3/7 (화) 12시 39분 45초 GMT

2) 마지막 수정 시각: 2005년 12월 10일 (토) 18시 27분 46초 GMT.

3) Content-Length: 3874 B

4) <!doc (<cr></f> 가 내용의 앞에 오면 (연속으로 2번 나타내면) header의 끝을 알림)

HW#1 Part2

정보통신공학 34743-02

2071035 이소민

과제 수행시 접속한 웹사이트: www.ff14.co.kr

IP address: 183.111.190.9

```
명령 프롬프트 - ping www.ff14.co.kr
Microsoft Windows [Version 10.0.19045.2728]
(c) Microsoft Corporation. All rights reserved.

C:\Users\소민>ping www.ff14.co.kr

Ping www.ff14.co.kr [183.111.190.9] 32바이트 데이터 사용:
요청 시간이 만료되었습니다.
요청 시간이 만료되었습니다.
```

1. GET message

The image shows a Wireshark packet capture of an HTTP GET request. The packet list pane shows a GET request at sequence 3168. The packet details pane shows the HTTP request structure, including Host, User-Agent, Accept, and Cookie. The packet bytes pane shows the raw data of the request.

Frame 3168: 2018 bytes on wire (16144 bits), 2018 bytes captured (16144 bits) on interface \Device\NPF_{15...}

Ethernet II, Src: Giga-Byt_8d:30:bd (b4:2e:99:8d:30:bd), Dst: EFMnetwo_ca:3e:10 (70:5d:cc:ca:3e:10)

Internet Protocol Version 4, Src: 192.168.0.6, Dst: 183.111.190.9

Transmission Control Protocol, Src Port: 12571, Dst Port: 80, Seq: 1, Ack: 1, Len: 1964

Hypertext Transfer Protocol

GET /main HTTP/1.1

Host: www.ff14.co.kr

Connection: keep-alive

Upgrade-Insecure-Requests: 1

User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/111.0.0.0 Safari/537.3

Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8

Accept-Encoding: gzip, deflate

Accept-Language: ko-KR,ko;q=0.9,en-US;q=0.8,en;q=0.7

[truncated]Cookie: _fbp=fb.2.1666418672551.1903784472; _gcl_a=1.1.730434376.1674442673; au_id=fb5fcd...

[Full request URI: http://www.ff14.co.kr/main]

[HTTP request 1/2]

[Response in frame: 3271]

[Next request in frame: 3780]

Hypertext Transfer Protocol


```

GET /main HTTP/1.1\r\n      //get message: 호스트의 /main으로 들어감, HTTP 버전은 1.1
Host: www.ff14.co.kr\r\n    //전체 연결 URL: www.ff14.co.kr/main
Connection: keep-alive\r\n  //끝난 후 반복 통신을 위해 연결 유지
Upgrade-Insecure-Requests: 1\r\n
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/111.0.0.0 Safari/537.36\r\n  //유저가 사용하고있는 브라우저 정보
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8
,application/signed-exchange;v=b3;q=0.7\r\n
Accept-Encoding: gzip, deflate\r\n
Accept-Language: ko-KR,ko;q=0.9,en-US;q=0.8,en;q=0.7\r\n
[truncated]Cookie: _fbp=fb.2.1666418672551.1903784472; _gcl_au=1.1.730434376.1674442673;
au_id=fb5fcd6f6acad9a36d76948e183fe485df8-2c6b; password_noview=password_noview;
_gid=GA1.3.1911570828.1680450722; ASP.NET_SessionId=kn30qqpq3hz5mqkz  //HTTP는 이전 통신을
기억하지 않기 때문에 정보를 쿠키를 통해 서버에 저장, 사용자는 쿠키라고 불리는 고유한 ID를 발급받음
\r\n  /\r\n이 라인의 맨 첫부분에 나오면 header line의 종료를 알림
[Full request URI: http://www.ff14.co.kr/main]
[HTTP request 1/2]
[Response in frame: 3271]
[Next request in frame: 3780]

```

2. Response message

The image shows a Wireshark packet capture of an HTTP response. The packet list on the left shows a reassembled TCP segment (frame 3271) and the packet details pane on the right shows the HTTP response structure.

Packet List:

No.	Time	Source	Destination	Protocol	Length	Info
3254	50.761313	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=38570 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3255	50.761313	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=39106 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3256	50.761349	192.168.0.6	183.111.190.9	TCP	54	12571 → 80 [ACK] Seq=1965 Ack=39642 Win=262400 Len=0
3257	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=39642 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3258	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=40178 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3259	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=40714 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3260	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=41250 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3261	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=41786 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3262	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=42322 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3263	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=42858 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3264	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=43394 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3265	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=43930 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3266	50.763905	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=44466 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3267	50.763906	192.168.0.6	183.111.190.9	TCP	54	12571 → 80 [ACK] Seq=1965 Ack=45002 Win=262400 Len=0
3268	50.763981	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=45002 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3269	50.763981	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=45538 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3270	50.763981	183.111.190.9	192.168.0.6	TCP	590	80 → 12571 [PSH, ACK] Seq=46074 Ack=1965 Win=22020096 Len=536 [TCP segment of a reassembled PDU]
3271	50.763981	183.111.190.9	192.168.0.6	HTTP	321	HTTP/1.1 200 OK (text/html)
3272	50.763999	192.168.0.6	183.111.190.9	TCP	54	12571 → 80 [ACK] Seq=1965 Ack=46877 Win=262400 Len=0

Packet Details:

- Frame 3271: 321 bytes on wire (2568 bits), 321 bytes captured (2568 bits) on interface \Device\NPF...
 - Ethernet II, Src: EFMNetwo...ca:3e:10 (70:5d:cc:ca:3e:10), Dst: Giga-Byt_8d:30:bd (b4:2e:99:8d:30:bd)
 - Internet Protocol Version 4, Src: 183.111.190.9, Dst: 192.168.0.6
 - Transmission Control Protocol, Src Port: 80, Dst Port: 12571, Seq: 46610, Ack: 1965, Len: 267
 - [88 Reassembled TCP Segments (46876 bytes): #3172(536), #3173(522), #3174(527), #3176(536), #3177(536), ...]
 - Hypertext Transfer Protocol**
 - HTTP/1.1 200 OK\r\n
 - Cache-Control: private\r\n
 - Content-Type: text/html; charset=utf-8\r\n
 - [truncated]Set-Cookie: GCHCLR=45270E7D004E8005D124CA11552251C681E499407ED38DD9A788ACE4D41D0300606DFB;
 - Date: Sun, 02 Apr 2023 17:12:21 GMT\r\n
 - Content-Length: 45756\r\n
 - \r\n
 - [HTTP response 1/2]
 - [Time since request: 0.358530000 seconds]
 - [Request in frame: 3160]
 - [Next request in frame: 3780]
 - [Next response in frame: 4031]
 - [Request URI: http://www.ff14.co.kr/main]

Hypertext Transfer Protocol

HTTP/1.1 200 OK\r\n //200 OK는 성공적 연결을 의미

Cache-Control: private\r\n
Content-Type: text/html; charset=utf-8\r\n
[truncated]Set-Cookie:

GCHCLR=45270E7D004EBD05D124CA11552251C6B1E4994D7ED38DD9A788ACE4D41D030066D6FB8DA04C6F2C1075DCF91
701C54CD0A33068038DF8E329775B84F21E0DD538BADE184E25BB8C6029B5C347FA5ABEFE4745D2FF444685CEE063901
992DD8D575E33962974E3A

Date: Sun, 02 Apr 2023 17:12:21 GMT\r\n //연결 일시
Content-Length: 45756\r\n //response message의 크기 (Bytes)
\r\n //\r\n이 라인의 맨 첫부분에 나오면 header line의 종료를 알림
[HTTP response 1/2]
[Time since request: 0.350530000 seconds]
[Request in frame: 3160]
[Next request in frame: 3780]
[Next response in frame: 4031]
[Request URI: http://www.ff14.co.kr/main]
File Data: 45756 bytes

//response의 내용이 이어짐

[Request URI: http://www.ff14.co.kr/main]
File Data: 45756 bytes

▼ Line-based text data: text/html (803 lines)

```
\r\n
<!DOCTYPE html>\r\n
<html lang="ko">\r\n
<head>\r\n
  <title>파이널판타지14(FINAL FANTASY XIV)</title>\r\n
  <meta charset="UTF-8">\r\n
  <meta name="viewport" content="width=1280">\r\n
  <meta name="format-detection" content="telephone=no" />\r\n
  <meta name="description" content="파이널판타지14(FINAL FANTASY XIV)" />\r\n
  \r\n
  <link href="/favicon.ico" rel="shortcut icon" type="image/x-icon">\r\n
  <link rel="stylesheet" href="//image.ff14.co.kr/html2/css/style.min.css?202304030212">\r\n
  <link rel="stylesheet" href="//image.ff14.co.kr/html2/css/sprites.css?202304030212">\r\n
  <link rel="stylesheet" href="//image.ff14.co.kr/html2/libs/fancybox/jquery.fancybox.min.css">\r\n
  \r\n
  \r\n
```