HW#1 Part I
전자통신공학 34743-02
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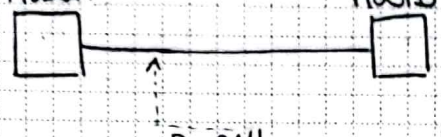
1.



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 = 64·2^{10} bps
L : 56 byte = 56 · 8 bit
1-packet convert time: $\frac{56 \cdot 8}{64 \cdot 2^{10}} = \frac{7}{2^{10}} \approx \frac{7}{10^3} = 0.007\,\text{sec} = 7\,\text{msec}$.

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

+) propagation delay : 10 msec

Total Time : 7 + 0.224 + 10 = 17.224 msec.
(A2D) (transmission delay) (propagation delay)

A. 17.224 msec

2. Link : 3Mbps User : 150 kbps 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 simultaniously.
$_{120}C_n \times (0.1)^n \times (0.9)^{(120-n)}$
↳ n users out of 120 transmitting ↳ 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) 21명 이상이 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

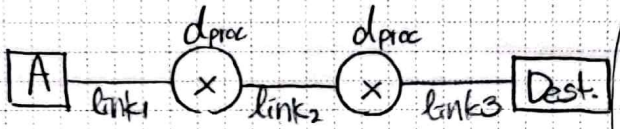
```
import math

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

$L = 1500\,bytes = 1500 \cdot 8\,bits$

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

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

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

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

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

$= \frac{18}{10^3} + \frac{40}{10^3} + \frac{6}{10^3} = \frac{64}{10^3}$

$= 0.064\,sec = 64\,msec$

A. 64 msec

4. Little's formula ⇒ $N = a \cdot d$

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

a = rate of packets arriving at link.

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

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

↳ queueing delay ↳ transmission rate 100 packet/sec ⇒ 1 packet per $\frac{1}{100}$ sec. ⇒ transmission delay : $\frac{1}{100}$ sec

$N = a \cdot d$

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

$= 500\,(packets/sec)$

A. 500 (packets/sec)

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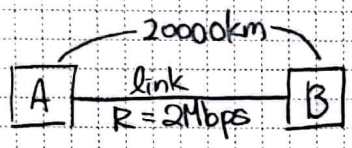

propagation speed : $2.5 \cdot 10^8$ m/s

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

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

A. 160 Kb

2) 800000 bits send. $= 2^3 \cdot 10^5$ bits

transmission rate : $R \approx 2 \cdot 10^6$

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

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

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

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

A. 160Kb

3) $R \cdot d_{prop}$는 시간당 전송되는 비트 수와 한 비트가 다른 끝에 도달하는 시간(지연)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 bit수이다

A. 링크가 한번에 최대로 담을 수 있는 비트 수

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

A. 125 (m)

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

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

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

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

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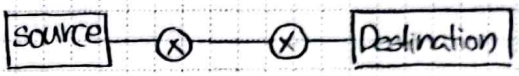
6. end-end delay : $n \cdot \frac{L}{R}$ (sec)

n : # of links
L : length of packet(message) (bits)
R : transmission rate (bits/sec)



$L: 8 \cdot 10^6$ (bits)
$R: 2$Mbps
$n = 3$

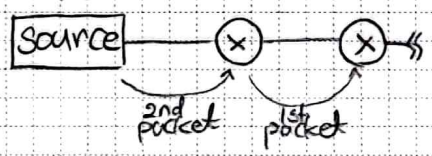
1) without segmentation : $n \cdot \frac{L}{R}$ (sec) to get to destination.

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

A. 12sec

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

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



1st packet : source – 1st link ⇒ 5msec
1st packet : 1st link – 2nd link
2nd packet : source – 1st link → 5msec
tot : 10msec

A. 5 msec, 10msec

3) source — Destination

	arrival at:
1st packet	15msec
2nd	20msec
⋮	⋮
800th	$802 \cdot 5 = 4010$ (msec) $= 4.01$(sec)

A. 4.01(sec), segmentation을 하지 않는 것 보다 훨씬 전송이 빠르다

7. 1) http://gaia.cs.umass.edu/cs453/index.html
2) HTTP version 1.1
3) persistent connection (Connection: Keep-alive)
4) 접속자의 IP주소는 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) 마지막수정시각 : 2005년 12월 10일 (토) 18시 27분 46초 GMT.
3) Content-Length : 3874 B
4) <!doc (<CR><lf>가 내용의 끝이 아닌 앞에 오면 (연속으로 2번 나타나면) header의 끝을 의미)

HW#1 Part2
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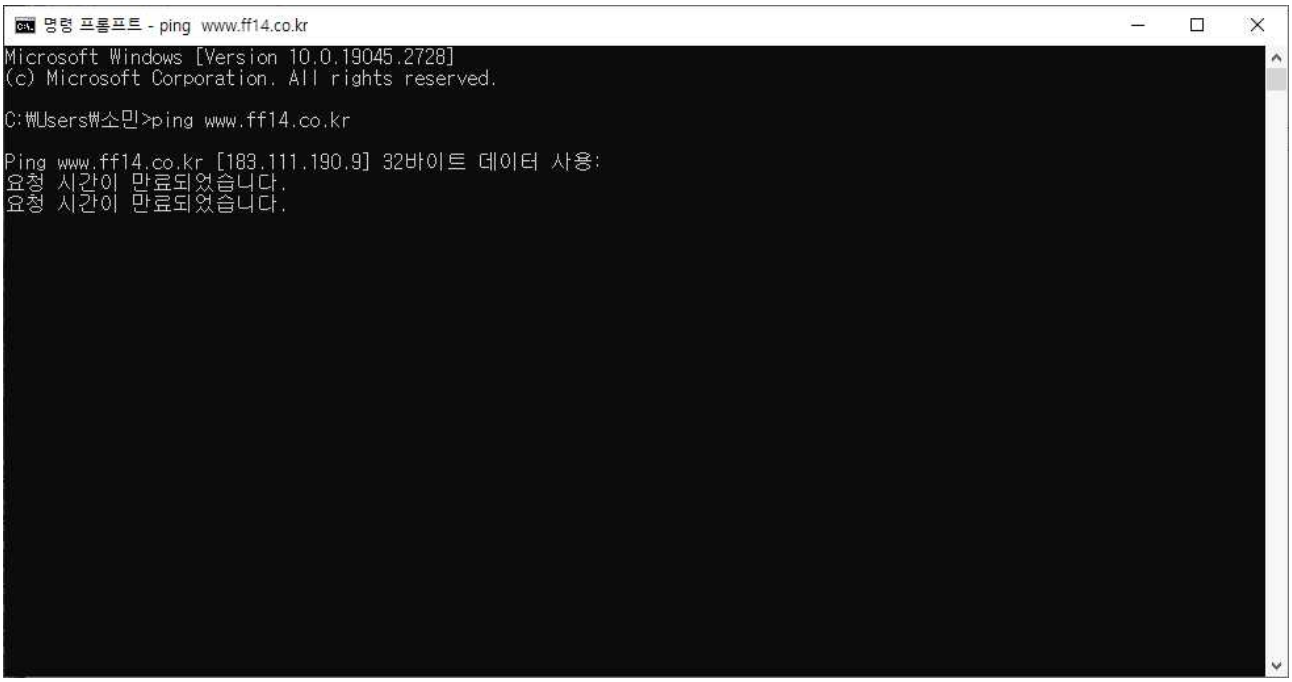
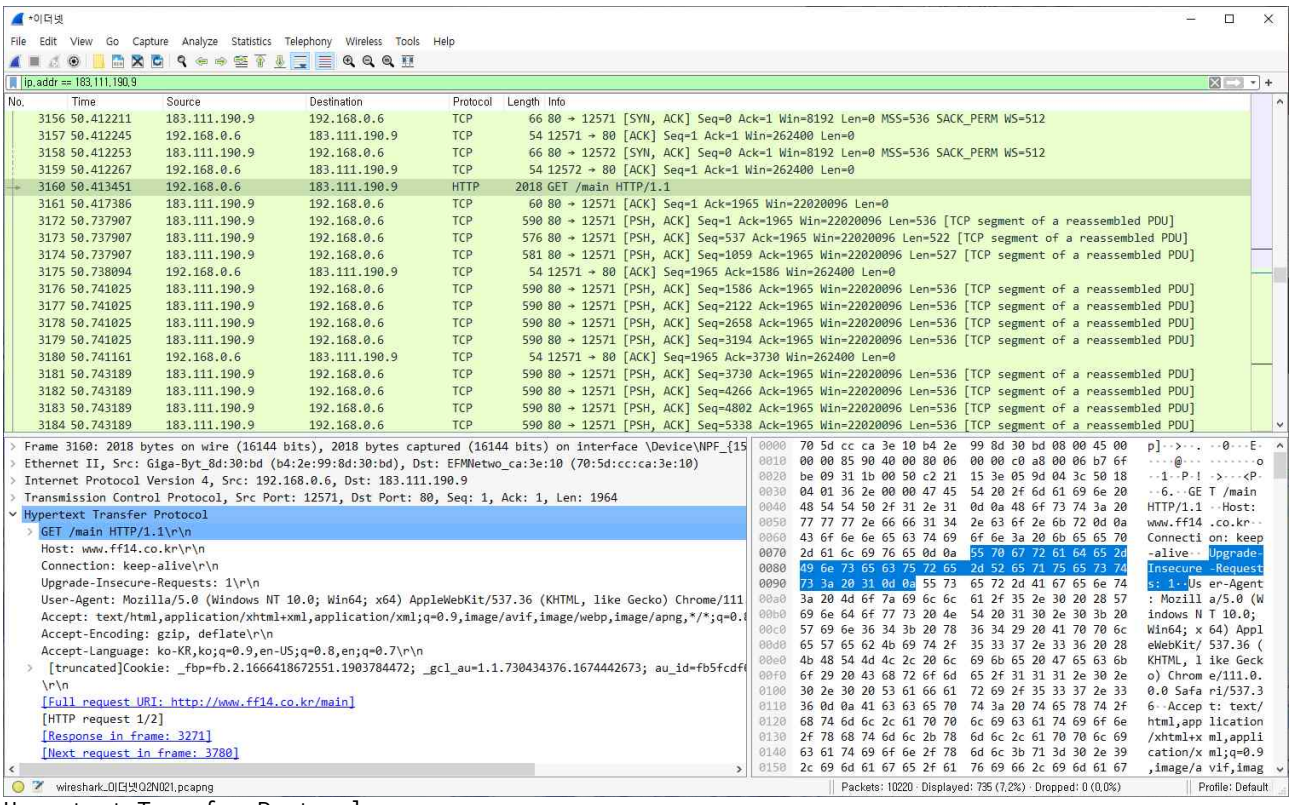
과제 수행시 접속한 웹사이트: www.ff14.co.kr
IP address: 183.111.190.9



1. GET message



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=fb5fcdf6acad9a36d76948e183fe485df8-2c6b; password_noview=password_noview; _gid=GA1.3.1911570828.1680450722; ASP.NET_SessionId=kn30qppq3hz5mqkz　　//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

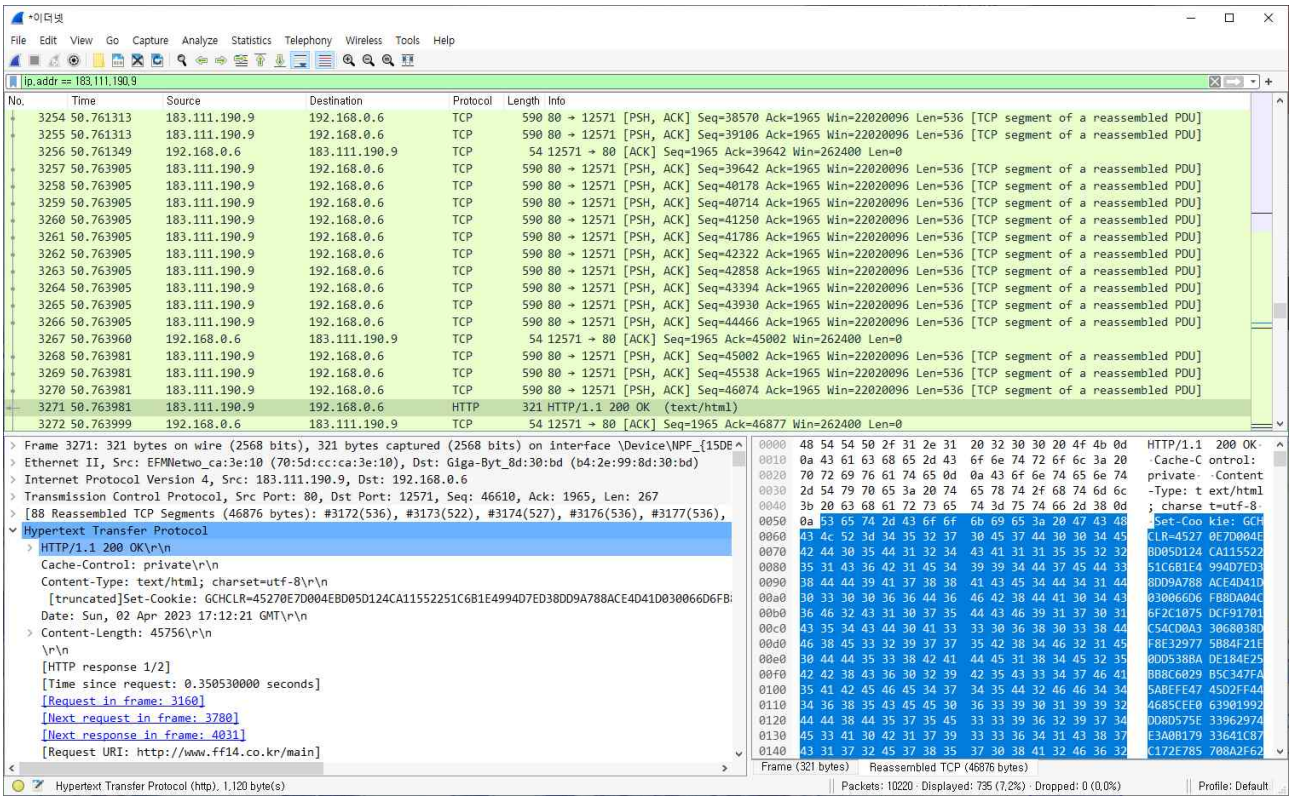
[Full request URI: http://www.ff14.co.kr/main]

[HTTP request 1/2]

[Response in frame: 3271]

[Next request in frame: 3780]

2. Response message



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
```