

50380778

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Problem1

Given Link Transmission rate $R = 2\text{Mbps} = 2 \times 10^6 \text{ bps}$

Propagation speed $s = 2.5 \times 10^8 \text{ m/sec}$

Length between hosts = $2000\text{km} = 2 \times 10^6 \text{ m}$

- Propagation delay $d_{\text{prop}} = d/s = (2 \times 10^6)/(2.5 \times 10^8) = 2/250 = 0.008 \text{ sec}$
- Bandwidth-delay product = $R \times d_{\text{prop}} = 2 \times 10^6 \times 0.008 = 16000 \text{ bits}$
- Bandwidth-delay product = $R \times d_{\text{prop}} = 10^2 \times 10^6 \times 0.008 = 800000 \text{ bits}$

Problem2

01001100 01101001

01101110 01101011

10111010 11010100

00100000 01001100

11011101 00100000

01100001 01111001

1 00111100 10011001

Since there are 17bits, the MSB needs to be wraparound

00111100 10011001

1

00111100 10011010

01100101 01110010

10100010 00001100

The checksum is obtained by taking 1's compliment of above. The result is 01011101 11110011

Problem3

RTT is time for a small packet to travel from client to server and back

Non persistent

Client initiates TCP connection for every object including the html file, meaning it requires 2 RTTs for one object. Client needs to access the HTML file which references 4 objects on same server.

Hence 1 TCP connection and 1 HTTP connection for HTML page => 2 RTT

1TCP and 1 HTTP for each if the 4 objects => $2 \times 4 \Rightarrow 8$ RTT

Total RTTs needed are 10.

Persistent

TCP connection is established only once and then one RTT for each object when there is no pipelining.

Hence 1 TCP connection and 1 HTTP connection for HTML page => 2 RTT

1 HTTP for each if the 4 objects => $1 \times 4 \Rightarrow 4$ RTT

Total RTTs needed are 6.

Problem 4

a. connection type here for the HTTP get request packet is keep-alive.

The image shows a Wireshark packet capture window. The top pane displays a list of captured packets. Packet 4781 is selected, showing an HTTP GET request to /nservice/. The bottom pane shows the details of this packet, including the Hypertext Transfer Protocol section where 'Connection: keep-alive' is highlighted in yellow. The packet list shows the following details:

No.	Time	Source	Destination	Protocol	Length	Info
4770	25.661114	10.28.9.231	10.28.24.233	HTTP	237	GET /ssdp/device-desc.xml HTTP/1.1
4781	25.664085	10.28.9.231	10.28.17.232	HTTP	226	GET /nservice/ HTTP/1.1
4784	25.665098	10.28.9.231	10.28.7.33	HTTP	222	GET /dd.xml HTTP/1.1
4785	25.665314	10.28.9.231	10.28.21.179	HTTP	224	GET /dd.xml HTTP/1.1
4786	25.665445	10.28.9.231	10.28.14.211	HTTP	224	GET /dd.xml HTTP/1.1
4788	25.666753	10.28.24.233	10.28.9.231	HTTP/X...	1284	HTTP/1.1 200 OK

The details pane for packet 4781 shows the following structure:

- > Frame 4781: 226 bytes on wire (1808 bits), 226 bytes captured (1808 bits) on interface 0
- > Ethernet II, Src: Intel_e7:33:3a (68:34:21:e7:33:3a), Dst: SamsungElect_...
- > Internet Protocol Version 4, Src: 10.28.9.231, Dst: 10.28.17.232
- > Transmission Control Protocol, Src Port: 61542, Dst Port: 7678, Seq: 1, Len: 100
- > Hypertext Transfer Protocol
 - > GET /nservice/ HTTP/1.1\r\n
 - User-Agent: Spotify/125700463 Win32_x86_64/0 (PC laptop)\r\n
 - Host: 10.28.17.232:7678\r\n
 - Keep-Alive: 0\r\n
 - Accept-Encoding: gzip\r\n
 - Connection: keep-alive\r\n

The packet bytes pane shows the raw data of the packet, including the HTTP request line and headers.

b. Source port 403

Destination port 60762

Sequence number 1

ACK number 440

Header length 20 bytes

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*Wi-Fi

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TCP

No.	Time	Source	Destination	Protocol	Length	Info
288	3.787271	10.28.8.74	224.0.0.251	MDNS	1457	Standard query 0x0000 PTR _companion-link._tcp.local, "QM" question PTR Elizabeth's iPad...
289	3.787271	10.28.9.251	224.0.0.251	MDNS	257	Standard query response 0x0000 TXT, cache flush NSEC, cache flush Samhita's MacBook Pro...
290	3.787271	10.28.8.74	224.0.0.251	MDNS	167	Standard query 0x0000 PTR _rdlink._tcp.local, "QM" question PTR Bree's iPad_rmlink._tcp...
291	3.787271	10.28.7.72	224.0.0.251	MDNS	399	Standard query response 0x0000 PTR UR DAD._companion-link._tcp.local TXT TXT, cache flus...
292	3.810970	10.28.9.231	13.107.42.16	TLSv1.2	493	Application Data
293	3.828015	13.107.42.16	10.28.9.231	TCP	60	443 → 60762 [ACK] Seq=1 Ack=440 Win=16382 Len=0
294	3.899581	10.28.40.165	224.0.0.251	MDNS	412	Standard query response 0x0000 PTR Zack (2)._companion-link._tcp.local TXT AAAA, cach...
295	3.899581	10.28.34.221	224.0.0.251	MDNS	1386	Standard query response 0x0000 TXT, cache flush PTR assistant coaches._companion-link._t...
296	3.899581	10.28.14.149	224.0.0.251	MDNS	127	Standard query 0x0000 TXT boo boo the fool._companion-link._tcp.local, "QU" question TXT...
297	3.899581	10.28.9.183	224.0.0.251	MDNS	461	Standard query response 0x0000 TXT PTR DJ's MacBook Pro (2)._companion-link._tcp.local T...
298	3.899581	10.28.40.176	239.255.255.250	SSDP	167	M-SEARCH * HTTP/1.1
299	3.899581	10.28.5.198	224.0.0.251	MDNS	422	Standard query response 0x0000 PTR Box's iPad (4)._companion-link._tcp.local TXT TXT, ca...
300	3.899581	10.28.16.170	224.0.0.251	MDNS	423	Standard query response 0x0000 PTR Matt's iPhone._companion-link._tcp.local TXT AAAA, ca...

Transmission Control Protocol, Src Port: 443, Dst Port: 60762, Seq: 1, Ack: 440, L...

Source Port: 443
Destination Port: 60762
[Stream index: 3]
> [Conversation completeness: Incomplete (12)]
[TCP Segment Len: 0]
Sequence Number: 1 (relative sequence number)
Sequence Number (raw): 1654901982
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 440 (relative ack number)
Acknowledgment number (raw): 1241866408
0101 ... = Header Length: 20 bytes (5)
> Flags: 0x010 (ACK)

0000 68 34 21 e7 33 3a b4 0c 25 e0 40 4f 08 00 45 00 h4! 3:~ %@-E
0010 00 28 98 57 40 00 76 06 20 fb 0d 6b 2a 10 0a 1c -(W@v- ..k*..
0020 09 e7 01 bb ed 5a 62 a3 cc de 4a 05 60 a8 50 10Zb- ..J-..P
0030 3f fe 5b 13 00 00 00 00 00 00 00 00 00 00 00 00 ?[.....