# Computer Networks Final (106/1)

1. Describe detailed operations of <u>HTTP cookie</u>, <u>web caching</u> and <u>conditional GET</u>. (6*3=18%)（說明其用處，並畫圖加解釋每步驟）

2. (a) How to run the tool to query specified DNS server to execute "Please send me the host names of the authoritative DNS for ncue.edu.tw" operation? (4%)

   (b) How to run the tool to query DNS server to execute "Please send me the host names of *www.ncue.edu.tw*, but we want to the query sent to the DNS server *dns.hinet.net* rather than to the default DNS server" operation? (4%)

   (c) What three services are provided by the domain name system? (6%)

   (d) Explain iterated query and recursive query (4%)

   (e) Authoritative DNS servers (2%) (20% total)

3. Draw the flow of the TCP three way handshake to explain its operations. Suppose the <u>initial sequence numbers of the client and the server are 1 and 90</u>, respectively. 必須在圖上分別清楚標示出 TCP 必要的 flag, sequence number, and ACK number. (10%)

4. List and compare two pipelined transport protocols with these two figures. (寫出 Window=? 與各標號處的動作 10%)
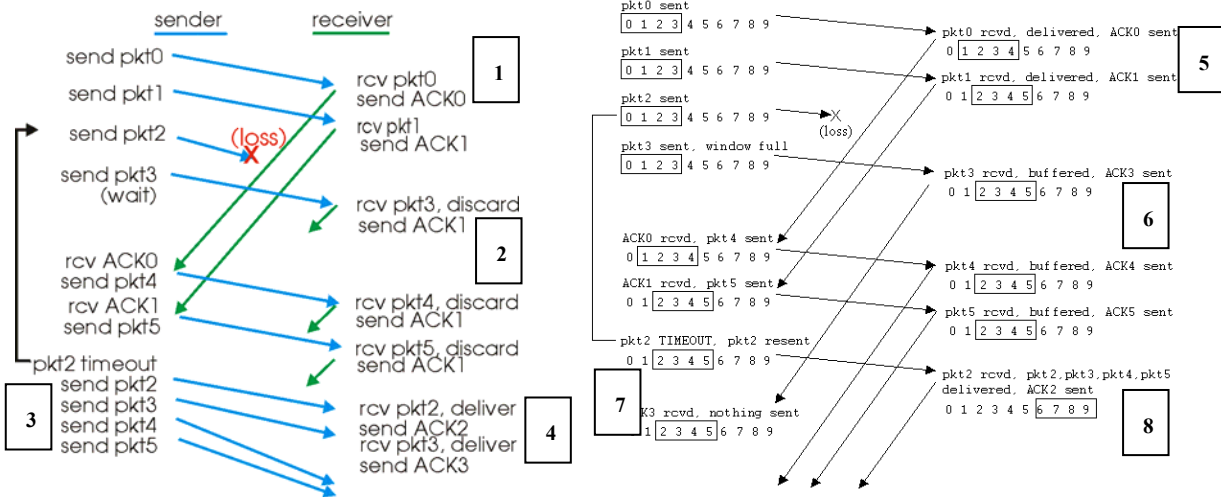
5. (a) UDP and TCP uses 1's complement for their checksums. What is the 1's complement for the sum of 00100011, 01001110, 01010100? Show all work. （要寫出過程6%） (b) With the 1's complement scheme, how does the receiver detect errors? (2%) Is it possible that 1-bit error will go undetected? (1%) How about a 2-bit error? (1%) (10% total)

6. Describe how TCP Reno does its congestion control. (8%)

7. Consider the TCP procedure for estimating RTT ($EstimatedRTT^n = \alpha \times SampleRTT^{n-1} + (1-\alpha) \times EstimatedRTT^{n-1}$).

   (a) Why TCP uses this function? (2%)

   (b) Let *SampleRTT^n* be the most recent sample RTT, let *SampleRTT^{n-1}* be the next most recent sample RTT, and so on. Express *EstimatedRTT^n* in terms of n SampleRTTs if $EsitmatedRTT^1 = 0$. (要有兩次疊代過程(各 2%)後寫出通式(以 summation 總和符號表示)(2%)

   (c) Suppose the TCP sequence number space is of size k. What is the largest allowable sender window w? (4%) (12% total)

8. (a) What are the major differences between SMTP and POP3? (4%) Draw a figure to show the <u>mail-sending flow</u> and <u>all necessary modules</u> among two end users. (4%)

   (b) Why is it said that FTP sends control information "out-of-band"? (4%) (12% total)

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只寫答案而沒有解釋說明，扣一半分數

1. Describe detailed operations of HTTP cookie, web caching and conditional GET. (6*3=18%)（說明其用處，並畫圖加解釋每步驟）

Ans:

❑ cookie:

when a user <u>visits a specific web site for first time</u> and initial HTTP requests arrives at site, site <u>creates a unique ID</u> and <u>creates an entry in backend database</u> for recording user states of this ID. => <u>keep client's states</u> (cookie-specific action)!
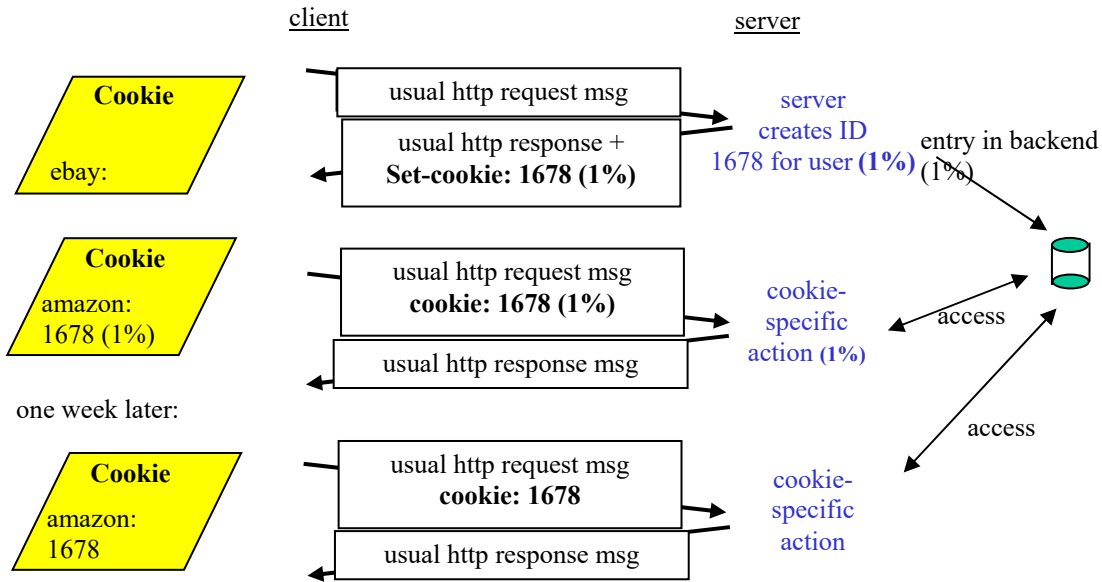
❑ web caching:
- user sets browser: Web accesses via cache
- browser sends all HTTP requests to cache (2%)
  - if object in cache
    - cache returns object (2%)
  - else
    - cache requests object from origin server, then returns object to client (2%)
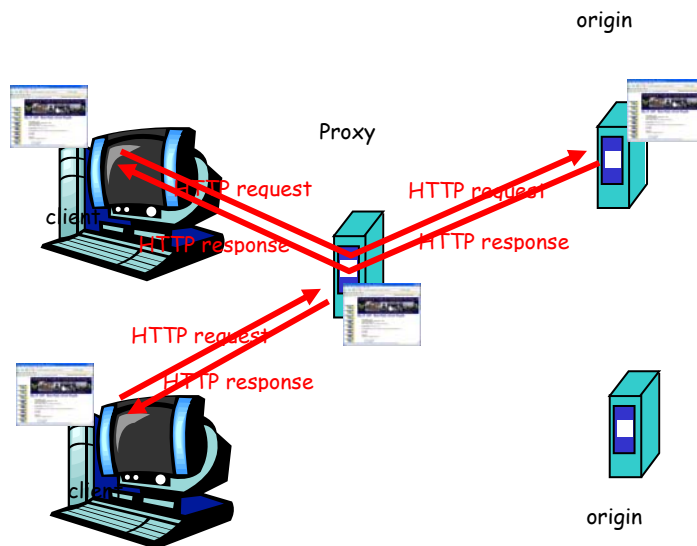
conditional GET (6%)
- Conditional GET: don't send object if cache has up-to-date cached version (1%) => reduce traffic loads (delays) on network links! (1%)

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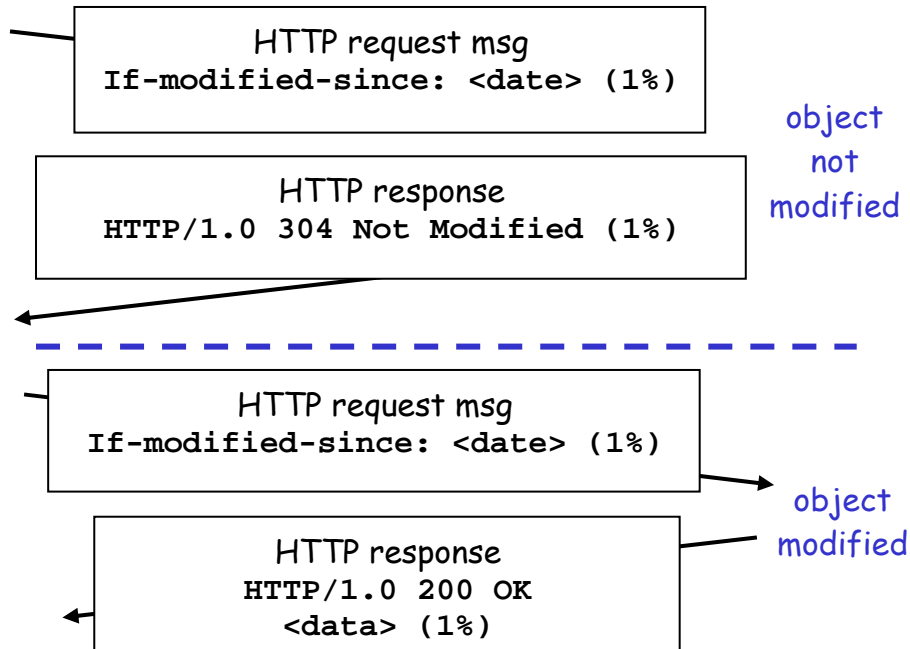cache: specify date of cached copy in HTTP request (1%)

If-modified-since: \<date\> (1%)

server: response contains no object if cached copy is up-to-date: (1%)

HTTP/1.0 304 Not Modified (1%)

<u>cache</u>   <u>server</u>

```
┌─────────────────────────────────────┐
│         HTTP request msg            │
│ If-modified-since: <date> (1%)      │
└─────────────────────────────────────┘
```
object
not
modified

```
┌─────────────────────────────────────┐
│         HTTP response               │
│ HTTP/1.0 304 Not Modified (1%)      │
└─────────────────────────────────────┘
```

- - - - - - - - - - - - - - - - - - - -

```
┌─────────────────────────────────────┐
│         HTTP request msg            │
│ If-modified-since: <date> (1%)      │
└─────────────────────────────────────┘
```
object
modified

```
┌─────────────────────────────────────┐
│         HTTP response               │
│       HTTP/1.0 200 OK               │
│          <data> (1%)                │
└─────────────────────────────────────┘
```

2. (a) How to run the tool to query specified DNS server to execute "Please send me the host names of the authoritative DNS for ncue.edu.tw" operation? (4%)

   (b) How to run the tool to query DNS server to execute "Please send me the host names of *www.ncue.edu.tw*, but we want to the query sent to the DNS server *dns.hinet.net* rather than to the default DNS server" operation? (4%)

   (c) What three services are provided by the domain name system? (6%)

   (d) Explain iterated query and recursive query (4%)

   (e) Authoritative DNS servers (2%) (20% total)

Ans:

   (a) nslookup <u>–type=NS</u> <u>ncue.edu.tw</u> (4%)

   (b) nslookup <u>www.ncue.edu.tw</u> <u>dns.hinet.net</u> (4%)

   (c) DNS services (6%)
   - hostname to IP address translation (2%)
   - host aliasing (Canonical, alias names)
   - mail server aliasing

   (d) iterated query: (2%)
   - contacted server replies with name of server to contact

   recursive query: (2%)
   - contacted server forwards the DNS query to next server and waits for the reply

   (e) authoritative DNS server (2%)
   - organization's DNS servers, providing authoritative hostname to IP mappings for organization's servers

3. Draw the flow of the TCP three way handshake to explain its operations. Suppose the <u>initial sequence numbers of the client and the server are 1 and 90</u>, respectively. 必須在圖上分別清楚標示出 TCP 必要
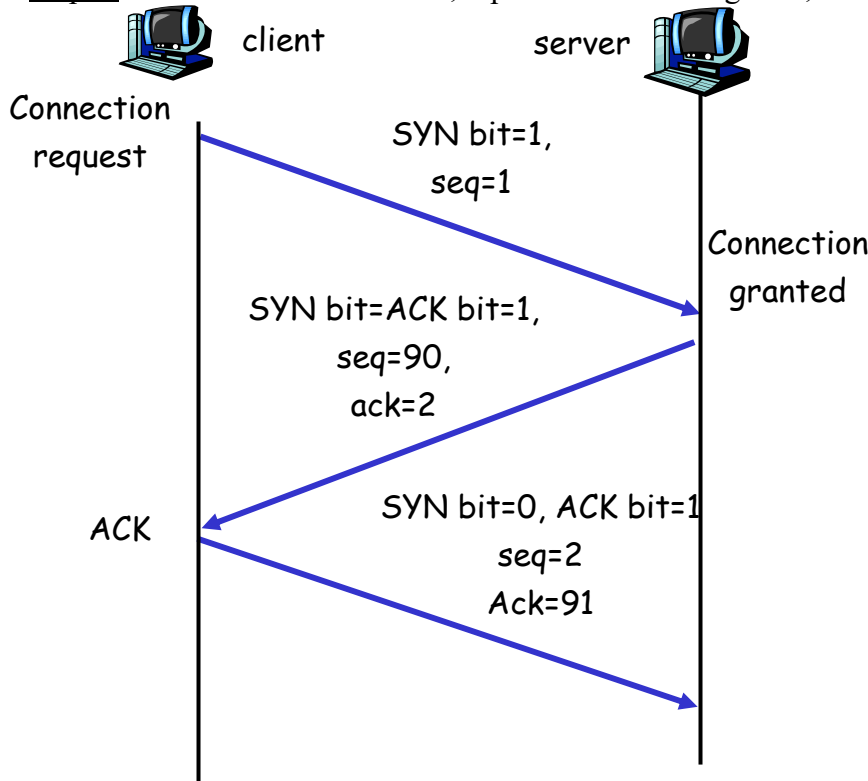
的 flag, sequence number, and ACK number. (10%)

Ans: Three way handshake:

> Step 1: client host sends TCP SYN segment to server (搭配圖要正確 2%)
> Step 2: server host receives SYN, replies with SYNACK segment (4%)
> Step 3: client receives SYNACK, replies with ACK segment, which may contain data (4%)

上圖每個符號含內容 1 分，標示不全者，視狀況扣分，共 10 分

4. List and compare two pipelined transport protocols with these two figures. (寫出 Window=? 與各標號處的動作 10%)

Ans:

Go-back-N (5%)

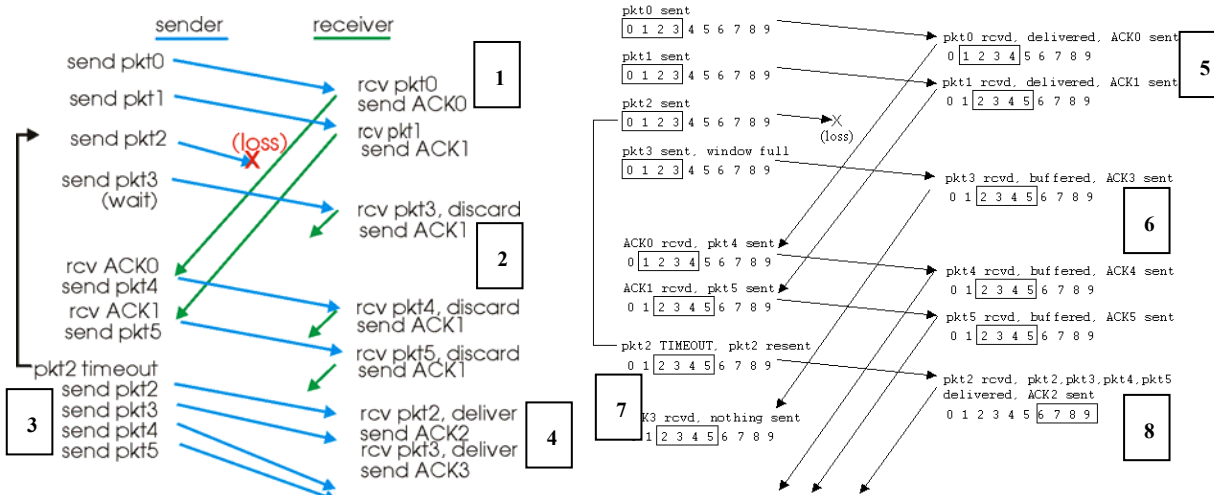➢ "window" of up to N, consecutive unack'ed pkts allowed (window = 4) (1%)

(1) ACK-only: always send ACK for correctly-received pkt with highest *in-order* seq # (1%)

(2) out-of-order pkt:
- discard (don't buffer) -> no receiver buffering! (1%)
- Re-ACK pkt with highest in-order seq # (1%)

(3) timeout(n): retransmit pkt n and all higher seq # pkts in window (1%)

(4) deliver in-order segments to upper layer. (1%)

Selective Repeat (4%)

(5) receiver *individually* acknowledges all correctly received pkts (1%)

(6) buffers out-of order pkts (1%)

(7) sender only resends pkts for which ACK not received when timeout (1%)

(8) deliver total in-order pkts to upper layer (1%)

5.   (a) UDP and TCP uses 1's complement for their checksums. Suppose you have the following three 8-bit bytes: 00100011, 01001110, 01010100. What is the 1's complement for the sum of these 8-bit bytes? Show all work. （要寫出過程 6%） (b) With the 1's complement scheme, how does the receiver detect errors? (2%) Is it possible that 1-bit error will go undetected? (1%) How about a 2-bit error? (1%) (10% total)

Ans:

```
        00100011
   +    01001110
      ---------------------------
        01110001    (2%)


        01110001
   +    01010100
      ---------------------------
        11000101    (2%)
```

One's complement = <u>00111010</u> (2%)

(b) <u>To detect errors, the receiver adds the four words (the three original words and the checksum). If the sum contains a zero, the receiver knows there has been an error</u>. OR <u>check if computed checksum equals checksum field value. If NO, error is detected</u>. (2%)

<u>All one-bit errors will be detected </u>(1%), but <u>two-bit errors can be undetected</u> (1%) (e.g., if the last digit of the first word is converted to a 0 and the last digit of the second word is converted to a 1).

6. Describe how TCP Reno does its congestion control. (8%)

   Ans: (8%)

   When **CongWin** is below **Threshold** (1%), sender in slow-start phase, window grows exponentially (1%).

   When **CongWin** is above **Threshold** (1%), sender is in congestion-avoidance phase, window grows linearly (1%).

   When a triple duplicate ACK occurs (1%), **Threshold** set to **CongWin/2** and **CongWin** set to **Threshold** (1%).

   When timeout occurs (1%), **Threshold** set to **CongWin/2** and **CongWin** is set to 1 MSS (1%).

7.   Consider the TCP procedure for estimating RTT ($EstimatedRTT^{n} = \alpha \times SampleRTT^{n-1} + (1-\alpha) \times EstimatedRTT^{n-1}$).

   (a) Why TCP uses this function? (2%)

   (b) Let *SampleRTT*^{n} be the most recent sample RTT, let *SampleRTT*$^{n-1}$ be the next most recent sample RTT, and so on. Express *EstimatedRTT*^{n} in terms of n SampleRTTs if $EsitmatedRTT^{1} = 0$. (要有兩次疊代過程(各 2%)後寫出通式(以 summation 總和符號表示)(2%)

   (c) Suppose the TCP sequence number space is of size k. What is the largest allowable sender window w? (4%) (12% total)

Ans: (a) Exponential weighted moving average => influence of past sample decreases exponentially fast. 據測量出來的 SampleRTT，估計下一次的 EstimatedRTT，用來設定下一次的 Timeout 時間 (2%)

(b)

$$EstimatedRTT^n = \alpha \times SampleRTT^{n-1} + (1-\alpha) \times EstimatedRTT^{n-1}$$

$$= \alpha \times SampleRTT^{n-1} + (1-\alpha) \times [\alpha \times SampleRTT^{n-2} + (1-\alpha) \times EsitmatedRTT^{n-2}]$$

$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} + (1-\alpha)^2 \times EsitmatedRTT^{n-2}$$

$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} + (1-\alpha)^2 \times$$

$$[\alpha \times SampleRTT^{n-3} + (1-\alpha) \times EsitmatedRTT^{n-3}]$$

$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} + \alpha(1-\alpha)^2 \times$$

$$SampleRTT^{n-3} + (1-\alpha)^4 \times EsitmatedRTT^{n-3}$$

$$= ......$$

$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} +$$

$$\alpha(1-\alpha)^2 \times SampleRTT^{n-3} + ... + \alpha(1-\alpha)^{n-2} \times SampleRTT^{n-(n-1)}$$

$$+ (1-\alpha)^{n-1} \times EsitmatedRTT^{n-(n-1)}$$

$$== \alpha \sum_{j=1}^{n-1} (1-\alpha)^{j-1} SampleRTT^{n-j} + (1-\alpha)^{n-1} EsitmatedRTT^1$$

$$= \alpha \sum_{j=1}^{n-1} (1-\alpha)^{j-1} SampleRTT^{n-j} (\because EsitmatedRTT^1 = 0)$$

(c) The sequence number space must be <u>at least twice as large as the window size</u>, $k \geq 2w$. (4%)

8. (a) What are the major differences between SMTP and POP3? (4%) Draw a figure to show the <u>mail-sending flow</u> and a<u>ll necessary modules</u> among two end users. (4%)
   (b) Why is it said that FTP sends control information "out-of-band"? (4%) (12% total)
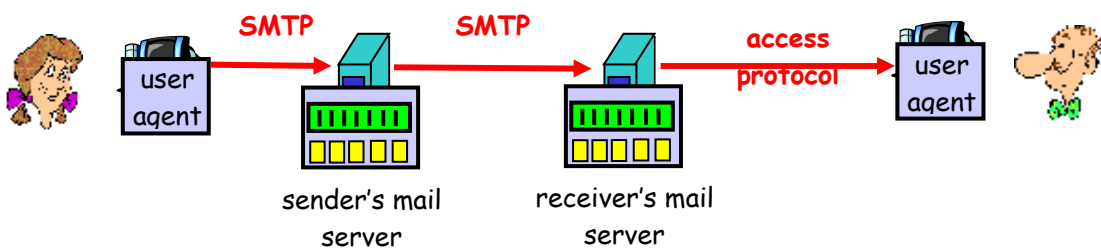
Ans:

(a)

POP: Mail access protocol: retrieval from server (說明 2%)

SMTP:

- direct transfer between mail servers to send email messages (說明 2%)

sender's mail server   receiver's mail server   (1% each, 7% total)

(b) FTP uses two parallel TCP connections, <u>one connection for sending control information</u> (2%) (such as a request to transfer a file) and <u>another connection for actually transferring the file</u>. (2%) Because the control information is not sent over the same connection that the file is sent over, FTP sends control information out of band. (4% total)