1. Reena has a Windows 8 computer set up with IP address 192.168.1.14 at her home. The computer has Internet connectivity and able to browse public websites - twitter.com, irctc.co.in, etc. without any issues. Reena has setup a file server in the computer to upload/download files,which she is able to do from other computers/laptops at her home. Reena has shared this IP address and file server credentials to her friend Santhosh who lives in next street from her home. But Santosh is unable to access Reena's file server, from his home computer which is Ubuntu 14.04, with IP address 192.168.1.24.
Reason out why this issue pops up.
Give a possible solution for this setup to work.
Solution
The issue is because Reena's computer and Santhosh computer are running on Private IP addresses which are not directly accessible/routable from Internet. To get this working, Reena can setup a IP/Port forwarding rule in her home LAN router such that all incoming Internet traffic directly gets to her computer. Also, Reena needs to share her home Public IP as provided by her Internet Service Provider (ISP) to Santhosh. Santhosh uses this Public IP instead of Reena's private IP to access Reena's computer.

2. Content-Length header is most commonly seen in HTTP messages but not in Email. Yes/No. Validate your claim. What happens if this header is missing in HTTP message.

Solution:
Yes. The need for Content-Length is to demarcate messages. As multiple HTTP request response happens most commonly on the same underlying persistent TCP connection., Content-Length is required and most commonly seen in HTTP responses with payload. Email messages are typically sent in SMTP and have their own delimiters mandated by SMTP mail servers - most commonly a Period/Dot. Also Email messages with MIME payloads have their own MIME boundaries serving as delimiters.Interestingly, Content-Length header though commonly seen in HTTP, is not a mandatory header in the HTTP Protocol. The other option commonly seen is Chunked encoding where webserver can send the response in bits and pieces and if it does not know the response length apriori.
eg. Think of a website serving Live Cricket scores to a browser.
- As the match progresses the responses are dynamically generated and sent to the browser, and the website server itself may not know the size of the entire response !

3. Which Application level protocol is used in the following activities ?
   a. Send an email from a mail client to a mail server/
   b. Download an email from mailbox server to a mail client.
   c. Checking email in a browser

Solution:
SMTP is typically used by user clients for sending mails.
Post Office Protocol is used by clients for receiving mails.
Checking mails in web browser is a simple HTTP process.

4. Consider this simple network where Ei indicate endpoints (computers) and Ri indicate IP Routers.   E1 --> R1 --> R2 ---> R3 ---> R4 ---> E2
A TCP Segment is sent from endpoint E1 to endpoint E2.   Say R3 is overloaded and drops the incoming IP packet carrying the TCP segment. Which of the following is a possible scenario ?
A) R3 sends back a negative acknowledgement directly to E1.
B) R3 sends back a negative acknowledgment to R1 and R1 in turn sends it to E1.
C) R3 sends back a negative acknowledgment to R2 and R2 in turn sends it to R1 which in turn sends it to E1.
D) Neither of the other options.
 Choose the correct option and reason it out.
Solution:
Correct option is D)

- Routers never send acknowledgements as it is not part of the IP Protocol and Routers are IP-level/layer devices. Acknowledgements work at TCP level/layer and in this case, it is the endpoints Ei which talk TCP.
 - In fact, in such scenarios where Routers drop packets, though not mandatory, routers may send ICMP error messages.Specifically a ICMP Source Quench message directly back to E1.

5. Show the format/structure of a email message sent by rahul@me.com to jay@you.com with the attachment 'myphoto.jpg'
Solution

This neatly fits into a Multi-part MIME email message. So, MIME based message structure MUST be shown with proper MIME boundaries.
 - Content-Type, Content-Disposition tags are MUST.

MIME-Version: 1.0
Date: Fri, 13 Oct 2017 01:36:11 +0000 (UTC)
Message-ID: <06634sG744543CqA@me.com>
Subject: My new photo
From: Rahul <rahul@me.com>
To: jay@you.com
Content-Type: multipart/alternative; boundary="089e0828c48ceaa6cc055c81812a"
--089e0828c48ceaa6cc055c81812a
Content-Type: image/jpg
Content-Disposition: attachment; filename="myphoto.jpg"

Content-Transfer-Encoding: base64

Content-Type: text/html; charset="UTF-8"
Content-Transfer-Encoding: quoted-printable

6. I am able to open this website - http://www.nexustechindia.com/ - in my browsers. I pinged this website domain and it resolves to IP: 198.15.109.91   But this URL - http://198.15.109.91/ -browser shows an error page. Reason out why this anomaly**.** Show the HTTP messages in both the cases.

Solution:
- There is no anomaly here. This is a very common behavior seen today (2017) in Internet. Though there is a very good chance it might even work for many other websites.
 - HTTP URLs as we enter in the browser, can either be IP address based or domain based, though the latter is preferred.
   In this scenario, though the IP :198.15.109.91 is the correct IP of the website domain www.nexustechindia.com, it could be the case that the webserver running on this IP/machine may be serving many other websites as well. Think Cloud-based Virtual Private Servers. So, in this case by browsing with IP address, the webserver does not know which website to serve. Hence most likely the error.
 - This is not a NETWORK issue, but rather a HTTP level issue only. The magic lies in the HTTP 'Host' header., which indicates to the webserver which website to serve.
 See below for the actual HTTP GET messages in both the scenarios
 and the difference in the Host Header.

GET / HTTP/1.1
Host: www.nexustechindia.com
Connection: keep-alive
User-Agent: Mozilla/5.0 (X11; Linux x86_64) Chrome/51.0.2223.27
Accept: text/html,application/xhtml+xml,application/xml;q=0.9
Accept-Encoding: gzip, deflate, sdch
Accept-Language: en-GB,en-US;q=0.8,en;q=0.6

GET / HTTP/1.1
Host: 198.15.109.91
Connection: keep-alive
User-Agent: Mozilla/5.0 (X11; Linux x86_64) Chrome/51.0.2223.27
Accept: text/html,application/xhtml+xml,application/xml;q=0.9
Accept-Encoding: gzip, deflate, sdch
Accept-Language: en-GB,en-US;q=0.8,en;q=0.6

7. A common scenario we observe in the web (www), is website redirection. eg. Typing www.google.com may redirect automatically to www.google.co.in. Show how this redirection works with HTTP Messages .

Solution

There are different ways this redirection could happen,
- HTTP messages based redirection Message response with 3xx code. with the 'Location' header indicating the new website URI where to be redirected.This 'Location' header indicates the to-be-redirected-to-URI to the web-client (browser) and it looks like automatically the browser moves to the new URI. though internally it is a 2 request-response cycle.
301 Moved permanently or 302 Found

Request:
GET / HTTP/1.1
Host: www.google.com
Connection: keep-alive
User-Agent: Mozilla/5.0 (KHTML, like Gecko) Chrome/51.0.2223.27
Accept: text/html,application/xhtml+xml,application/xml;q=0.9
Accept-Encoding: gzip, deflate, sdch
Accept-Language: en-GB,en-US;q=0.8,en;q=0.6

Response:
HTTP/1.1 302 Found
Location: www.google.co.in
- Javascript based redirection
- window.location.href = "http://newsite.com";
- HTML webpage based redirection
eg. <meta http-equiv="refresh" content="0; url=http://newsite.com/" />

8. Browsers have a in-built caching mechanism for a better user experience. How do websites indicate if a web resource needs to be cached or not ? Show HTTP messages in transit for both scenarios.
Solution

HTTP Response message typically contain a Last-Modified header with the absolute time of the webresource eg. an image file. also optionally server may indicate an unique identifier eg. ETag for the webresource
Webserver's HTTP response includes a Cache-Control header which will be Cache-Control: no-cache to indicate the browser that the webresource cannot be cached. More commonly, these other headers are also added to force uniform no-caching behavior across browsers.
Cache-Control: no-cache, no-store, must-revalidate Pragma: no-cache Expires: 0

HTTP Message sequence showing a cached resource
and how the browser revalidates with the server again.

GET /~allimages/pictures/swaimage.jpg HTTP/1.1
Host: newnew.com
Connection: keep-alive
User-Agent: Mozilla/5.0

HTTP/1.1 200 OK
Date: Fri, 27 Oct 2017 05:43:54 GMT
Server: Apache
Accept-Ranges: bytes
ETag: "1000000040809-1b0bf-3987295db4333"
Last-Modified: Sat, 26 Jan 2002 11:00:38 GMT
Content-Type: image/png
Content-Length: 81522

The browser when it wants to display the image again, it can check again with the server with a
conditional GET message which includes a header 'If-Modified-Since' where it can send the
last-modified time to the server. If in the interim time the image file had changed on the server,
the server may send the new file again or if the file (webresource) remains the same, it will
 respond with a HTTP 304 Not Modified message.

GET /~allimages/pictures/swaimage.jpg HTTP/1.1
Host: newnew.com
Connection: keep-alive
Cache-Control: max-age=0
User-Agent: Mozilla/5.0
Accept: text/html;q=0.9,image/webp,*/*;q=0.8
Accept-Encoding: gzip, deflate, sdch
Accept-Language: en-GB,en-US;q=0.8,en;q=0.6
If-None-Match: "1000000040809-1b0bf-3987295db4333"
If-Modified-Since: Sat, 26 Jan 2002 11:00:38 GMT

HTTP/1.1 304 Not Modified
Date: Fri, 20 Oct 2017 05:21:20 GMT
Server: Apache/2.2.29 (Win32) PHP/5.4.45
Connection: Keep-Alive
Keep-Alive: timeout=5, max=100
ETag: "1000000040809-1b0bf-3987295db4333"

9. Host A sends a UDP datagram containing 8880 bytes of user data to host B over an Ethernet LAN. Ethernet frames may carry data up to 1500 bytes (i.e. MTU = 1500 bytes). Size of UDP header is 8 bytes and size of IP header is 20 bytes. There is no option field in IP header. How may total number of IP fragments will be transmitted and what will be the contents of offset field in the last fragment?
Solution:
UDP data = 8880 bytes
UDP header = 8 bytes
IP Header = 20 bytes
Total Size excluding IP Header = 8888 bytes.
Number of fragments = ⌈ 8888 / 1480 ⌉ = 7
 (Offset is always scaled by 8)   Offset of last segment = (1480 * 6) / 8 = 1110

10. A host was given the 192.168.2.64 /25 IP address, indicate:
* Netmask of the network.
* The network address to which the host belongs.
* The network broadcast address to which the host belongs.
* The total number of hosts available in the network.
Solution:

Netmask: 255.255.255.128
If we apply the AND function to the binary representation of the IP address and the network mask (255.255.255.128) we will obtain the network address:
Network address: 192.168.2.0
 The broadcast address is represented by putting as 1s all the bits belonging to the host portion: 192.168.2.127
 The total number of hosts is given by the following formula: 2n – 2, where n represents the number of bits available in the host portion. In this case n = 6, which means that we have 27 – 2 hosts or 126.

11. Suppose an application layer entity wants to send an L-byte message to its peer process, using an existing TCP connection. The TCP segment consists of the message plus 20 bytes of header. The segment is encapsulated into an IP packet that has an additional 20 bytes of header. The IP packet in turn goes inside an Ethernet frame that has 18 bytes of header and trailer. What percentage of the transmitted bits in the physical layer correspond to message information, if L = 100 bytes, 500 bytes, 1000 bytes?
Solution:
TCP/IP over Ethernet allows data frames with a payload size up to 1460 bytes. Therefore, L = 100, 500 and 1000 bytes are within this limit.
The message overhead includes:
* TCP: 20 bytes of header
* IP: 20 bytes of header
* Ethernet: total 18 bytes of header and trailer.
Therefore

L = 100 bytes, 100/158 = 63% efficiency (1).
L = 500 bytes, 500/558 = 90% efficiency (1).
L = 1000 bytes, 1000/1058 = 95% efficiency (1).

12. Suppose a computer is moved from one department to another. Does the physical address need to change? Does the IP address need to change? Does it make a difference if the computer is a laptop?
    Solution:
    The physical address does not change (1). It is globally unique to the computer's NIC card.
    The IP address may need to be changed (1) to reflect a new subnetwork id and host id.

    The situation is the same for laptops.(1)