

e.g. BSc Examination by course unit/ BA by Special Regulations/ MSc Examination

TBA

ECS524 Internet Protocols and Applications Duration: 2 hours 30 minutes

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INSTRUCTED TO DO SO BY AN INVIGILATOR**

<p>Answer FOUR questions</p>

Calculators are not permitted in this examination. Please state on your answer book the name and type of machine used.

Complete all rough workings in the answer book and cross through any work that is not to be assessed.

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Examiners: Steve Uhlig and Félix Cuadrado

Question 1

This question is about Application-level protocols:

- a) The following snippet shows an HTTP message

```
GET /mod/page/view.php?id=275932 HTTP/1.1
Host: qmplus.qmul.ac.uk
Connection: keep-alive
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8
User-Agent: Mozilla/5.0 (Windows NT 6.3; WOW64) AppleWebKit/537.36 (KHTML, like
Gecko) Chrome/32.0.1700.102 Safari/537.36
Accept-Encoding: gzip,deflate,sdch
Accept-Language: en-US,en;q=0.8,es;q=0.6
Cookie: MoodleSession=qgog2e9cvm6aa1t8kk3upsuk60;
_shibsession_64656661756c7468747470733a2f2f716d706c75732e716d756c2e61632e756
```

What is the type of this HTTP message? Explain the parts of the message and their purpose.

[7 marks]

This is an HTTP Request message. [2 marks]

An HTTP Message has an initial line, a set of headers and an optional body [1 marks].

The initial line of a request identifies the request method (GET), the path inside the server of the requested object, as well as the HTTP version [2 mark]

The following lines are headers with key value pairs that allow to provide further information about the request/response [1mark]

GET request messages have no body[1 mark]

- b) What does “state” mean in a protocol? Is the HTTP protocol stateful or stateless? Explain what HTTP cookies are and their relationship with HTTP state.

[6 marks]

A stateless protocol treats each request as being completely independent from the other incoming requests. In a stateful protocol there can be some shared state between client and server among multiple request-response cycles. [2 marks].

HTTP is stateless [2 marks].

Cookies are an HTTP extension that allows the client to store persistent state from the relationships with a server. Whenever a client sends requests to a web site supporting cookies, it sends all the relevant cookies, that allow the server to retrieve the state related to that specific user [2 marks]

- c) In Web browsing, a user types a url in the address bar (e.g. <http://qmplus.qmul.ac.uk>), and the browser presents the content of that web page. How does the browser machine find the network-wide address where the content is

located? Detail the involved protocols, and the agents involved in completing that function.

[6 marks]

The client uses the DNS (Domain Name Service) protocol for resolving the host name into a logical IP address. [2 marks, 1 mark, name, definition].

In order to achieve this, the client contacts its DNS resolver, which forwards the request over all the hierarchy of authoritative, TLD servers to resolve the IP from that name. [2marks]. Caching allows this process to be sped up if that address was requested recently at any point in the DNS infrastructure. [1 mark].

- d) Define the concept of sockets in computer networks. What is the purpose of a socket? In the case of HTTP communications, what types of sockets are used?

[6 marks]

*A socket is a **programming interface** that allows applications to establish **distributed communications** through transport-level protocols. Sockets **use** the **port** space available at the operating system, and allow processes to act as remote clients or servers through these transport-level communication channels. [4 marks]*

HTTP uses TCP sockets [2 marks]

Question 2

- a) Explain the 2 main characteristics that UDP provides as a transport protocol. Give one example of one application that takes benefit of these features, and another example of an application that is not suited to this protocol.

(1) Connection-less, (2) unreliable. Connection-less means a connection does not need to be established before data can be transferred. Unreliable means that losses will not be recovered. One example of application that relies on the features of UDP is voice over IP. P2P is an application that is not suited for UDP.

[10 marks]

- b) Describe the two phases of TCP congestion control. Use a diagram to illustrate your answer.

[15 marks]

The two phases used by TCP's congestion control are "slow-start" and "congestion avoidance". Slow start consists in doubling the window size every RTT, until congestion is reached (signalled by a timeout due to a loss). Once congestion is reached the first time (after a first slow start), `ss_thresh` is initialized to half the last value of `cwnd`, and `cwnd` will then only increase by 1 every RTT, i.e., linearly over time.

Question 3

a) Explain at least 3 major differences between distance vector and link state routing protocols.

[15 marks]

- 1) The underlying path computation algorithms are Bellman-Ford and Dijkstra respectively. The path computation differs widely, as well as the propagation of topological/reachability information.
- 2) One assumes local knowledge of the topology (through the path vectors) or global knowledge of the topology (through the link states).
- 3) DV relies on path vectors that provide path information to reach a given destination, while LS relies on purely topological information (link states) that reflect the state of adjacencies between routers.

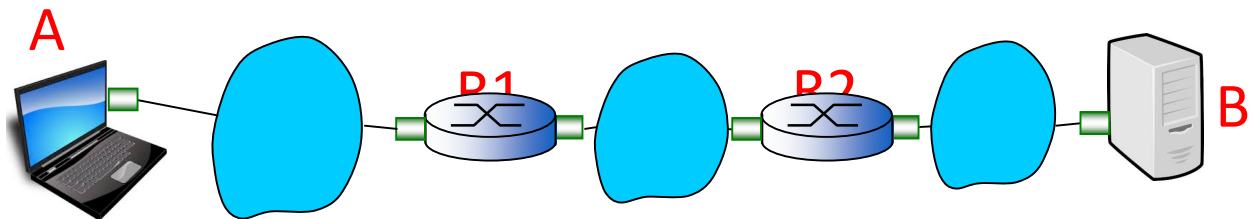
b) Describe the purpose of intradomain routing (i.e., IGP protocols) and of interdomain routing (i.e., BGP), including what specific service they provide in terms of paths. Explain how they relate to each other and complement each other to provide end-to-end paths across the Internet.

[10 marks]

Answer: interdomain routing is based on a path vector protocol (BGP), that propagates reachability in the form of paths to reach all destinations in the Internet. Therefore, interdomain routing provides only reachability service. Intradomain routing protocols on the other hand compute shortest paths between any pair of routers inside the domain, using Dijkstra's algorithm and link-state information. Interdomain routing chooses the AS-level (domain-level) part of the end-to-end path, while intradomain routing protocols find the paths segments from an ingress router inside an AS to the exit router inside that AS. They complement each other

Question 4

In this part of the lab we will reason about what happens in the lower layers when a laptop (A) joins a wifi network, and sends a HTTP request to www.google.com (B). The routing configuration of the Internet elements will make requests from A to B to go through R1, and R2.



- a) The subnetwork where both A and R1 are connected is defined by the following CIDR address: 192.168.0.0/24. Give two valid IP address for the interfaces of A and R1 connected to the subnetwork. How many interfaces can be connected to the subnetwork?

[3 marks]

It is a /24 prefix, so the last 8 bits are free. Any two addresses are valid (actually .0 and .255 are not as these are broadcast addresses but we'll accept even these answers as it is not in the notes) [1 mark per correct address]

256 addresses (or 254), so 254 interfaces (removing subnet address and broadcast one). [1mark]

- b) When the laptop joins the network, how will it initially assign both its IP and MAC addresses? Explain any additional protocol used in this process.

[6 marks]

The laptop joins the network with its physical MAC address, as that one does not change from the moment the NIC is manufactured. [2 marks]

The laptop needs to assign an IP that falls under the subnet range. In order to do that, it will probably use DHCP [2marks].

With DHCP, the client first sends a broadcast message asking for a free address to any DHCP server. The server replies with an offer of an IP, client sends request to get that one, and is finally acknowledged by the server [2 marks].

- c) Which layer of the communications stack allows the laptop to send messages **INSIDE** the wireless subnetwork? Explain the mechanism of this layer that allows the laptop to send messages to a local machine before knowing its address.

[5 marks]

The data link layer (wifi in this case) is the one in charge of physically delivering the packets inside the wireless network. [2 marks]

Broadcast is the mechanism through which a layer 2 interface can send a message to the local network and target a specific machine on that network before learning its MAC address. [3 marks].

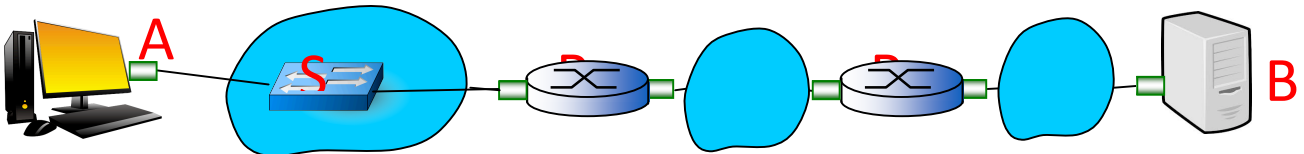
- d) What happens to the IP and MAC address fields in the request packet as it travels along the network? (A -> R1 -> R2 -> B)

[4 marks]

Source and destination IP addresses do not change along the path. [2 marks]

Source and destination MAC addresses change at each hop, to be the ones belonging to the physical interfaces connected to that subnetwork [2 marks].

Let's suppose now that instead of using a laptop, we send the same request through one of the ITL machines (A), which is connected in an Ethernet network through switch S.



- e) How does the switch S know how to correctly forward request and responses between A and B?

[4 marks]

Switches use the self-learning protocol to learn automatically the forwarding behaviour that is required in the network where they are plugged. Whenever a packet comes, they record the MAC of the sender. [3 marks].

If they don't know what is the right interface for destination, they broadcast to all the other interfaces. [1 mark]

- f) Which destination MAC address needs to be set by A in order for the packet to arrive correctly?

[3 marks]

Switches are completely transparent for the other network elements. Therefore, A needs to set again the MAC address of router R as destination. [3marks]

End of Paper