CTH, GU Computer Science and Engineering

Computer Communication
EDA344, EDA343, DIT 420

Time and Place: Wednesday 16 March, 2016, 14.00-18.00 M

Course Responsible: Marina Papatriantafilou (Tel: 772 5413), Ali Salehson (Tel 772 5746)

Allowed material:

- English-X (X can be French, German, Swedish, etc) dictionary
- *No other books, no notes, no calculators, no electronic devices.*

Grading:

CTH students registered for the EDA344 or EDA343 course, 7.5 hp: 3: 30-40 p, 4: 41-50 p, 5: 51-60 p

GU (DIT 420): Godkänd 30-44, Väl godkänd 45-60 p

Instructions

- **Write clearly your course-code (EDA344/EDA343/DIT420)**
- **Start answering each assignment on a new page; use only one side of each sheet of paper; please sort the sheets according to the question-ordering and number them.**
- Write in a **clear manner** and **motivate** (explain, justify) your answers. If it is not clear what is written for some answer, it will be considered wrong. If some answer is not explained/justified, it will get **significantly** lower marking.
- If you make any **assumptions** in answering any item, do not forget to clearly state what you assume.
- A good rule-of-thumb for the extend of detail to provide, is to include enough information/explanation so that a person, whose knowledge on computer communication is at the level of our introductory lecture, can understand.
- Please answer in English, if possible. If you have large difficulty with that (with all or some of the questions) and you think that your grade might be affected, feel-free to write in Swedish.
- Results, inspection of exam: Monday April 4, 12.00-13.00, room 5128 (EDIT building, west wing)

Good Luck !!! Lycka till !!!!

1. General questions and applications (12 p)

   (a) (2p) Consider sending a packet from a source to a destination host over a fixed route. List the delay components in the end-to-end delay. Which of these are constant and which are variable?

   (b) (5p) Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that n DNS servers are visited before your host receives the IP address from DNS; this incurs an RTT (Round-trip-time)of D1 per DNS. Suppose also that the Web page associated with the link contains m very small objects. Suppose the HTTP running is nonpersistent and let D2 denote the RTT between the local host and the server for each object. Assuming zero transmission time of each object, how much time elapses from when the client clicks on the link until the client receives all the objects? Consider (i) Nonpersistent HTTP with no parallel TCP connections. (ii) Nonpersistent HTTP with the browser configured for m parallel connections?

   (c) (5p) A popular social network site can become overwhelmed if it has only one server handling all its requests. How is this tackled in practice? Explain carefully, including both end-server approaches and network-infrastructure-based approaches.

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Answer hints
- Transmission, propagation, queuing, processing: cf slides chapter Introduction,
 section 1.4

- cf excercise session for chapter 2, Applications

- From lecture on multimedia and p2p networking:
overlays, data-centers, CDN infrastructures with DNS support.
It replicates to proxy servers, or CDNs.
DSN is needed to translate the addresses appropriately
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2. Transport layer, reliable data transfer and congestion control(12p)

   (a) (4p) In reliable data transfer methods, why are sequence numbers needed when retransmissions can occur due to timeouts? Explain what can go wrong without them and illustrate that with a figure.

   (b) (4p) (i) What is end-to-end and what network-assisted congestion control? Which of the two types is applied in the Internet? (ii) What is the basic assumption for TCP's congestion control?

   (c) (4p) Consider a pipelined protocol for reliable data transfer between two hosts (for simplicity we assume that they are directly connected with each other). Show how to compute the sending window size in order to have effective throughput greater than $0.8 * 10^9$ bits/sec, supposing that the packet size is 1200 bytes, that transmission rate is 10^9 bits/sec and the one-way propagation delay is 20 msec. Make sure to also use a space-time diagram in your answer.

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HINTS
- If not, same packet can be percieved for another one
(a retransmitted one, cf section 3.4) even in the simple stop-and-wait protocol

- Section 3.6; slide 33 in lecture 5-chapter3B;
Internet has TCP's end-to-end CC; assumes that loss/long delays are
mainly due to congestion
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- Similar ex. done in exercise session for chapter 3,
reliable data transfer and pielined protocols
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3. Data Link Layer and Wireless (12p)

   (a) (5p) Consider partitioning-based methods and random access methods for medium access:
   (i) Explain in which cases the former can be preferable over the latter and vice-versa.
   (ii) Describe one method from each of these types and comment on its properties with respect to the previous question.

   (b) (2p) Explain the differences between link layer switches and network-layer routers.

   (c) (2p) Each host and router has an ARP (Address Resolution Protocol) table in its memory. What are the contents of this table?

   (d) (3p) Describe the indirect method for routing to mobile hosts; draw a figure explaining how it works in mobile IP or GSM networks.

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HINTS

- (i) continuous load from all users, known set of users: the former is better;
dynamic set of users, uneven load, light load: the latter better;
(ii) e.g. TDMA/FDMA, ALOHA/CSMA; description details in the book, section 5.3

- In book , ch 5.4; selective forwrading vs optimized routing

- Mapping from IP addr to MAC addr in the same LAN, cf section 5.4 or even 6.3.

- when host is at another cell (not home), route to host through
home mobile switching-center/base-station, slides 49, 62 lecture 10, sections 6.5-6.7
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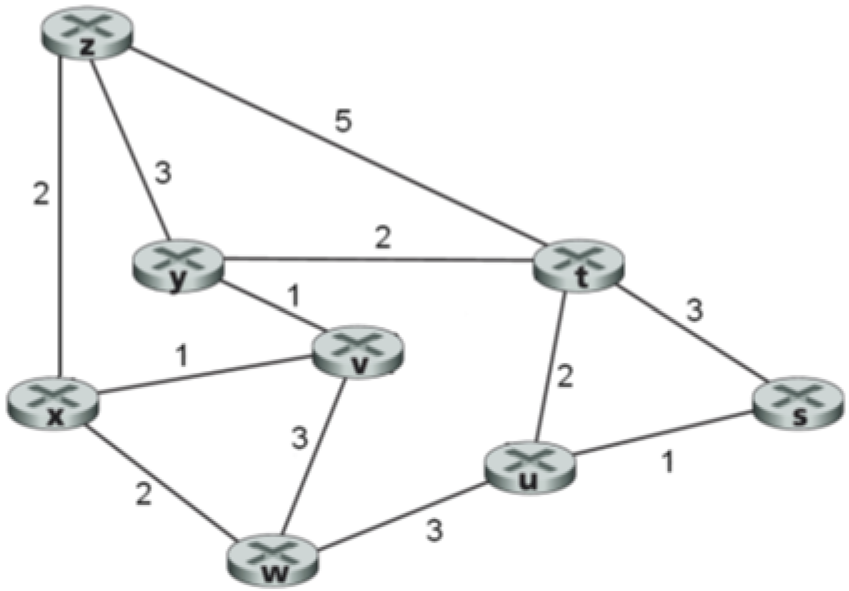
4. Network core and routing (12 p)

   (a) (8p: 2+4+2) The figure is showing the topology of an IP network, which consists of eight nodes (routers) marked with s, t, u, v, w, x, y and z. The nodes are connected to each other by links shown in the figure, where the numbers beside indicate the current link costs. The following sub-questions are about the routing algorithms used by common routing protocols within an autonomous system.
   (i) Which information is advertised as "link-state"? Describe the content of such information when used by Internet routing protocols.
   (ii) Suppose that routing between nodes in the above figure is based on the "link-state" approach. Use Dijkstra's algorithm only, (no other methods) to find out the shortest path (with minimal cost) from node "v" to every other node in the network. Present your results with a table and according to the algorithm, step by step until the final solution.
   (iii) Make use of the results from the above questions to construct the routing table for node v.

   (b) (4p) It has become usual that a home network connecting many devices through a home router, can provide Internet access using only one global address. However, the devices (laptops, smart phones, etc.) will be configured with private IPv4 addresses and can have access to the Internet simultaneously. Describe clearly how this is possible and how it works in practice so that the devices will be able to have access to the Internet at the same time.

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HINT
- cf appendix

- section 4.4.2
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5. Media-streaming and Security-related topics (12 p)

   (a) (4p) Symmetric and asymmetric encryption methods are two different categories of encryption systems. Explain (with a figure) the principles of *asymmetric* encryption. Why are both encryption methods needed in networking?

   (b) (2p) In implementing video streaming applications, why can TCP-based streaming be prefered compared to UDP-based streaming?

   (c) (4p) What is FEC (Forward Error Correction)? Describe a method to achieve that.

   (d) (2p) Explain the role of playout delay in taking care of jitter in media-streaming traffic.

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HINT
- Figure 8.6 (or slide 8-19).
Symmetric encryption is much faster then asymmetric encryption,
however asymmetric encryption solves the key distribution problem of
symmetric encryption.

- Security issues (large number of UDP segments might not go through firewalls).

- Non-ack-based; eg methods slides 13-14 lecture 11, section 7.3

- Extra delay added at receiver to  (in combination with buffering) adjust playtime,
in order to "play" packets at the desired rate
(rather than the rate of arrival, which contains jitter); section 7.3
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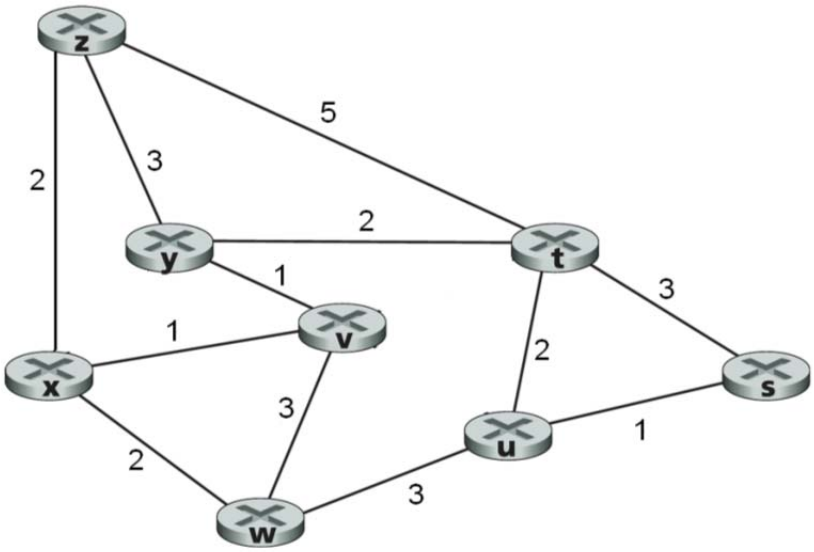
Appendix

4. Routing 12p

4a) (2 + 4 + 2) points

Refer to sub-section 4.5.1 of the text book

(i) ”link state” is the information about the node’s identity, neighbor routers, status, type and cost of each active directly-connected link.



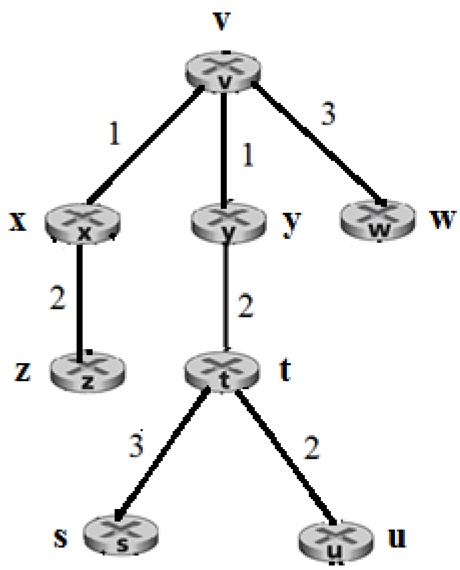
(ii)
Results of computation according to Dijkstra’s algorithm:

Steg	N’	D(s),p(s)	D(t),p(t)	D(u),p(u)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0	v	∞	∞	∞	3,v	1,v	1,v	∞
1	vx	∞	∞	∞	3,v	----	1,v	3,x
2	vxy	∞	3,y	∞	3,v		----	3,x
3	vxyw	∞	3,y	6,w	----			3,x
4	vxywz	∞	3,y	6,w				----
5	vxywzt	6,t	----	5,t				
6	vxywztu	6,t		----				
7	vxywztus	----						

(iii) Based on results from (ii)
Routing table of nod ”v”:

Destination	Next hop	Cost
s	y	6
t	y	3
u	y	5
w	v	3
x	v	1
y	v	1
z	x	3

Graf: node ”v” is rot:



4b) (4) points

Refer to sub-section 4.4.2 of the text book

The private addresses may be used and reused within private network. Packets with private addresses (source or destination) must not be routed to the global Internet. The routers ensure blocking forwarding such packets to the Internet otherwise a router using NAT has to translate addresses into global addresses.

Home-network devices are usually assigned IP addresses from a private CIDR address block (e.g. 192.168.0.0/24). Home router reserves the first available address of its own interface to the local network and thus this becomes an internal "default gateway". Home computers communicate directly with this interface to send and receive IP packets to and from the Internet. The home router will be typically assigned a global address of the second interface connected to the ISP towards the Internet.

The home router will be using the NAT function to replace the private source address of each outgoing packet with its own global address and replace the source port number with a NAT-port number. This translation is repeated for all packets coming from the same source address with the same source port number. NAT function stores this information (source address and source port number + NAT port number) and creates a table to be used to be used also in the opposite direction when the incoming packet addressed to the home router (which really should be to the computers on your home network) re-directed and forwarded to the local network. With more port numbers, NAT can translate packets from more devices simultaneously and keep track of the translations using the NAT-table.