Högskolan i Halmstad Sektionen för Informationsvetenskap, Data- Och Elektroteknik (IDÉ)
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Written Exam in
Applied Advanced Routing

March 18, 2010.

Allowed aid:
Writing material.

Welcome to the exam!

READ THIS FIRST:

Motivate all answers. Insufficient motivations can give reduced points even if the answer is correct. Describe all calculations in detail. You will then have chance on points even if the calculations contain careless mistakes. If required, you are allowed to make your own (reasonable) assumptions. You are allowed to answer in either ENGLISH or SWEDISH.

GOOD LUCK!

Number of exercises: 10
Maximal numbers of points: 60

The grade limits are 30p to pass the exam (Grade 3), 42p for Grade 4, and 54p for Grade 5.

Assignment 1: BGP (8p)

Describe the BGP operation and the message types used in the BGP operation.

First the BGP routers establish a TCP enabled BGP connection. When the neighboring session is established, the BGP routers become BGP neighbors/peers. The peers initially exchange all candidate BGP routes. Incremental updates will be sent when the network changes.
OPEN: will be used to establish connections with peers and includes fields for BGP version number, AS number, hold time and Router ID
UPDATE: contain all the information BGP uses to construct a loop free picture of the network. Three basic components: NLRI (Network-Layer Reachability Information), path attributes and withdrawn routes.
NOTIFICATION: used to inform the receiving router of errors. Error codes can be used to troubleshoot BGP connections.
KEEPALIVE: sent periodically between peers to maintain the connection. Sent every 60 s, 19-bytes.

Assignment 2: IP Multicasting (6 p)

What is the difference between the forwarding of a multicast IP packet and a unicast IP packet? Give example of advantages and disadvantages with multicast transmissions.

Multicast = single copy of data to multiple receivers
Unicast = multiple copies of data, one for each receiver. Sent one at a time. Different address for each receiver

Advantages: less host/router processing, better bandwidth utilization (optimized performance), enhanced efficiency (single transmission, single address). Makes it possible to use distributed applications

Disadvantages: UDP- based leads to best-effort delivery, no congestion avoidance, out-of-sequence delivery

Assignment 3: IS-IS (6 p)

In IS-IS, what does Level 2 routing mean? Which information will be found in the LSDB (link state database) of a Level 2 router?

Level 2 routing is routing between different areas within the same domain, forms a routing backbone.

The LSDB for a Level 2 router consists of all routing information (LSPID) for the inter-area routing. No Level 1 routing information.

Assignment 4: OSPF (10 p)

In Multi-area OSPF, describe the different OSPF router types and area types.

Backbone router: attached to the backbone area with at least one interface
Internal router: all interfaces are in the same area
ASBR (Autonomous System Boundary Router): at least one interface attached to an external internetwork (another AS), such as a non-OSPF network. Redistribute routes between the OSPF network and other attached network.
ABR (Area Border Router): interfaces attached to multiple areas, separate link-state databases for each area. Route traffic between areas.

Standard area: can accept link state updates and route summaries.
Backbone area: central entity to which all other areas are connected. Has all the properties of a standard area.
Stub area: does not accept external routes.
Totally stubby area: does not accept external routes or summary routes from other internal areas.
(Not-so-stubby area: similar to stub area, but can import external routes and forward them to the backbone.)

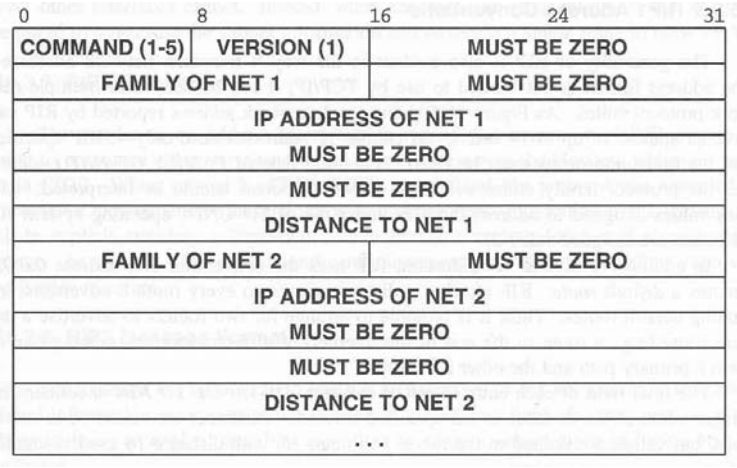
Assignment 5: IPv6 (6 p)

Compare the IPv4 and IPv6 addresses. Give one example of a transition method from IPv4 to IPv6.

IPv6 increases the number of address bits from 32 bits for IPv4 addresses to 128 bits. Solves the problem of lack of IP addresses. Larger address space enables address aggregation and results in an efficient and scalable routing table. The representation of an IPv6 address is x:x:x:x:x:x:x:x, where x is a 16-bit hexadecimal field.
Many transition mechanisms enable smooth integration from IPv4 to IPv6. The most common techniques are:
Dual Stack: routers and switches are configured to support both protocols, with IPv6 being the preferred protocol.
Tunneling (Manual Tunnel, 6to4 tunnel etc): IPv6 packets encapsulated within the IPv4 protocol.
NAT-PT (Protocol Translation): translates IPv6 packets into IPv4 packets (and vice versa) on a device between a IPv6 and IPv4 network

Assignment 6: RIP (4 p)

The figure below shows a RIP message. Please state which pair of fields that will be used in the decision of how to update the routing table.



The pair of fields that will be used for each decision of how to update the routing table is the destination network address and distance (IP address of net x and Distance to net x fields).

Assignment 7: IP Multicasting (4 p)

What is IGMP? Give a **brief** explanation of how this protocol works.

Internet Group Management Protocol (IGMP) is a host-to-router protocol, used when hosts wants to join a multicast group. The router sends periodic queries (to multicast address 224.0.0.1). Hosts can send a group-specific query to join a group, and a leave message when it wants to leave the group. This reduces the leave latency, and the routers get faster information on where the forwarding of multicast packets is needed.

Assignment 8: BGP (4 p)

How does BGP prevent routing loops? Give an example and draw a picture.

BGP constructs a graph of Autonomous Systems (AS) based on the information exchanged between BGP peers. The connections between any two AS's forms a path and the sequence of AS numbers is called AS-path. If the router finds its own AS number in the AS path, the packet will be discarded.
See picture from the lecture slides.

Assignment 9: Path-vector routing protocols (6 p)

Explain how a path-vector routing protocol (like BGP) differs from a distance-vector protocol regarding the information exchanged between the routers, the main advantage of this and why.

A path-vector protocol uses destination network, next router and path to reach to a destination to find out the best path to a destination. It does not use the distance and cost-estimate as in distance-vector protocols. Policies can be used to specify how to reach to a destination. By knowing the exact path to a destination, routing loops can be avoided, by discarding paths including two identical ASs.

Assignment 10: Routing protocols (6 p)

Assume that Router X has the following routing table:

Destination	***Distance***	***Next hop***
Net 4	1	Direct
Net 5	9	Router A
Net 6	1	Direct
Net 67	9	Router H
Net 72	4	Router B
Net 83	5	Router G

Moreover, assume that Router X get the following routing updates from Router B:

Destination	***Distance***
Net 2	1
Net 5	12
Net 6	2
Net 67	4
Net 72	12
Net 83	5

Show the complete routing table in Router X after the update. All entries in the table must be motivated.

Router X will have the following routing table after the update:

Destination	***Distance***	***Next hop***	
Net 2	2	Router B	New destination
Net 4	1	Direct	Not changed
Net 5	9	Router A	Not changed
Net 6	1	Direct	Not changed
Net 67	5	Router B	Lower cost via Router B
Net 72	13	Router B	Changed cost
Net 83	5	Router G	Not changed