NTNU
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TTM4150 NETTARKITEKTUR I INTERNETT

TTM4150 INTERNET NETWORK ARCHITECTURE

August 4, 2008
0900 - 1300

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Ingen hjelpemidler/No remedies.

Sensuren faller innen 3 uker/Results will be ready in 3 weeks.

N: Norsk/Norwegian
Se raskt over hele oppgavesettet før du starter å besvare oppgavene.
Pass på å fordele tiden mellom oppgavene! Oppgavene har samme vekting. Det er bedre å svare litt på alle oppgavene enn å svare mye på noen få oppgaver.

Dersom du føler informasjon mangler for å løse oppgaven, angi de antakelser du gjør deg.

E: English
Glance over all pages before you start answering the exercises.
Take care to share your time between the exercises.
It is better to answer a little on all the exercises than to answer a lot on a few.

If you feel there is a lack of information to solve an exercise, state the assumptions you make.

1 Ende-til-ende i internet arkitekturen/ End-to-end in the internet architecture

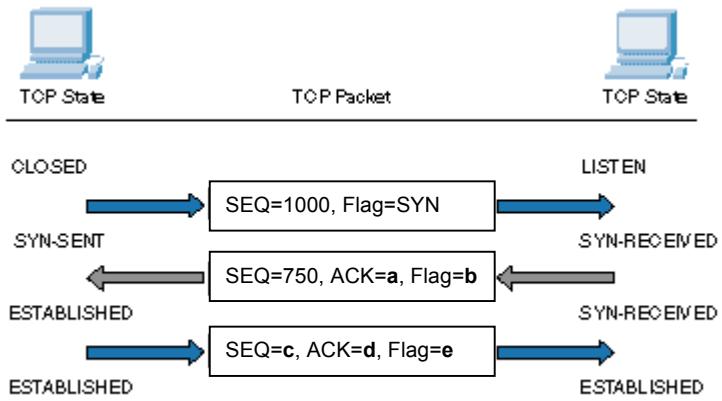
(a) **N:** Beskriv kort "ende-til-ende argumentet" i Internet arkitekturen.

E: Shortly describe the "end-to-end argument" of the Internet architecture.

The network's job is to transmit datagrams as efficiently and flexibly as possible. Everything else should be done at the fringes, ie intelligence in the end-systems.
Principle for placement of protocol functionality: The function in question can completely and correctly be implemented only with the knowledge and help of the applications standing at the endpoints of the communication system. Therefore providing that function as a feature of the communication system itself is not possible.

(b) **N:** Figuren under representerer en TCP pakkesekvens med TCP tilstand hos sender og mottaker. Hva illustrerer figuren?
Gi verdier for a, b, c, d, og e i figuren.

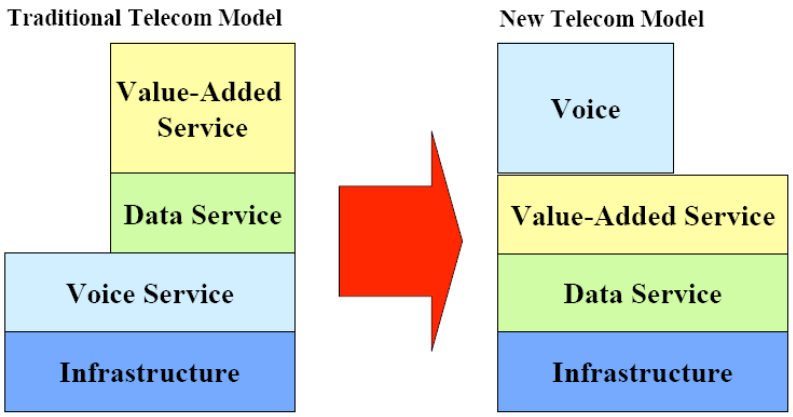
E: The figure below represents a TCP packet sequence and TCP state at a sender and receiver. What does the figure illustrate?
Give the values for a, b, c, d, and e in the figure



TCP connction set-up. A=1001, b=SYN, ACK, c=1001, d=751, e=ACK

(c) **N:** Kommenter på endringen fra den tradisjonelle telekom-modellen til den nye telekom-modellen i neste generasjons nettverk som illustrert i figuren under.

E: Comment on the change from the traditional telecom model to the new telecom model of next generation network as illustrated in the figure below.



In the traditional model the voice network is used as an access (dial-up) to the data network. In the new model voice is an application transported on top of a multi-service data network.

(d) **N:** Hva er et "provider-provisioned" VPN sammenliknet med et "customer-provisioned" VPN. Gi et eksempel på hver av disse VPN-typene.

E: What is a provider-provisioned VPN compared to a customer-provisioned VPN? Give an example on each of these VPN types.

Provider provisioned: Provider provisions and remotely manages the customer edge device. In provider-provisioned VPNs the service provider

participates in management and provisioning E.g. BGP/MPLS IPVP, Virtual router based VPNs.

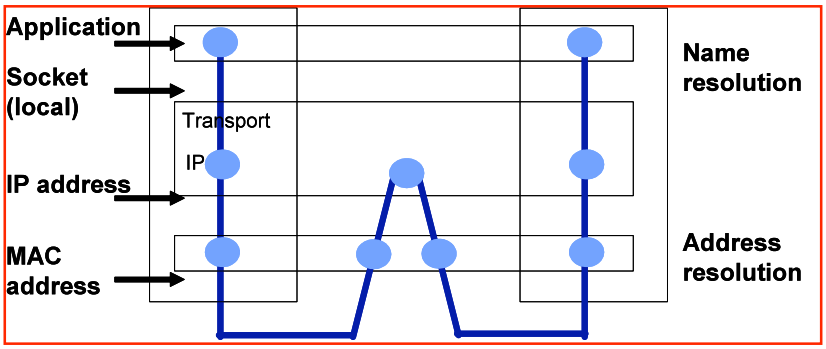
Customer provisioned: Customer edge routers managed by private network administrator. In customer-provisioned VPNs all VPN-specific procedures are performed in the CE devices. The shared service provider network is not VPN aware. CE-based VPNs are pure overlays and can be used for both site-to-site and remote access VPNs. Eg. IPSEC tunnels across internet, VPN client in PC.

2 Internett adressering / Internet addressing

(a) **N:** Oversetting ("resolution") av internett navn og internett adresser gjøres på ulike lag i protokollstakken av ulike protokoller. Skisser en internett protokollstakk og indiker hvor og hvilken protokoll som oversetter navn og adresser.

E: Resolution of Internet names and Internet addresses are done at different layers in the protocol stack by different protocols. Sketch an Internet protocol stack and indicate where and by which protocol name and protocol resolution are done.

DNS translates internet names to IP addresses, e.g. www.ntnu.no = 129.241.56.206 (from what to where) Address Resolution Protocol (ARP)



converts logical IP addresses to physical MAC addresses.

(b) **N:** Hva er Network Address Translation (NAT), og hvorfor benyttes dette i dagens internett?

E: What is Network Address Translation (NAT), and why is it used in the internet today?

NAT is used by both service providers and users to get around the problem of not having enough IP addresses. NAT = an Internet standard that enables a local-area network (LAN) to use one set of IP addresses for internal traffic and a second set of addresses for external traffic. A NAT box located where the LAN meets the Internet makes all necessary IP address translations. (Not

required for full score: NAT provides a type of firewall by hiding internal IP addresses.)

(c) **N:** Beskriv kort to typer NAT (Network Address Translation).

E: Shortly describe two types of NAT (Network Address Translation).

Full cone NAT: anyone from the public Internet that wants to reach a client behind a NAT need only know the mapping scheme in order to send packets to it. Security concerns: susceptible to port scan attacks.
Restricted cone NAT: the external address:port pair is only opened up once the internal computer sends out data to a specific destination IP.
Port restricted cone NAT: NAT will block all packets unless the client had previously sent out a packet to the IP and port that is sending to the NAT.
Symmetric NAT: specific mapping of internal address:port pair to the NAT's public address:port pair is dependant on the destination IP address that the packet is sent to.

(d) **N:** "Provider-independent" addresser er IP-adresser tildelt av en regional internett registrator direkte til en sluttbrukerorganisasjon, uten å gå via en internett nettverksoperatør (internet network provider). Hva er fordelen med slike adresser for sluttbrukeren? Hva er ulempen for nettoperatørene?

E: Provider-independent addresses are IP addresses assigned by regional internet registries directly to an end-user organization, without going through an internet network provider. What is the advantage of such addresses for the end-user? What is an disadvantage for the network providers?

It offers the end-user the opportunity to change service providers without changing addresses, and in particular to use multiple service providers at once in a multi-homed configuration (but creates problems for address aggregation as described in Classless Inter-Domain Routing (CIDR).

3 Mobilitet / Mobility

(a) **N:** Forklar hvordan pakker blir sendt mellom korresponderende node og mobil node i Mobil IP v4.

E: Explain the packet forwarding between corresponding node and mobile node in Mobile IP v4.

HA (home agent) sets up a tunnel to FA (foreign agent), and packets to Mobile node is tunneled to FA, outer header is stripped and packet is forwarded towards mobile node. The other way packets are sent to FA and then forwarded directly to corresponding node

(b) **N:** Beskriv mekanismer som HA (home agent) benytter for å snappe opp (intercept) en pakke adressert til en mobil node.

E: Describe the mechanisms used by a HA to intercept a packets addressed to a mobile node.

No mechanism is standardized. HA needs to intercept packet destined for MN only when the mobile node is not in its standard subnet. HA is typically located in the same subnet as the MN. When the MN does not respond to arp req, the HA responds to arp req for MN with its own MAC address (proxy ARP). All packets addressed to the MN will then be intercepted by the HA. When the MN returns to the subnet it issues ***gratuitous ARP*** *i.e same src and dst address in arp req to signal that it is ack (the latter is not required for correct answer)*

(c) **N:** Hva er felles og hva er forskjellene mellom mobil IP for IPv4 og IPv6?

E: What is the commonality and the difference between mobile IP v4 and IPv6?

Common is the HA for forwarding of the first packet in a flow. In MIPv4 all packets are forwarded over the HA, while in MIPv6 the mobile node exchanges a temporary address with the corresponding node. If one includes options there are additional points. MIPv4 can use the same mechanism in route optimization. Mobile IP v4 may need a FA or a co-located FA (same as MIPv6).

(d) **N:** Både SIP og DNS er katalogsystem som kan bli brukt til å holde orden på lokasjonen til en bruker mens han/hun flytter på seg (map userid to IP address as the user is moving around). Diskuter hva som er mest egnet for å håndtere mobilitet.

E: Both SIP and DNS are catalogue systems and can be used to map userid to IP address as the user is moving around. Discuss which one is the most suitable for handling mobility.

DNS is strict hierarchal system where requests that cannot be answered are forwarded up towards the root. For efficiency DNS is based on caching and long time intervals before the cached data times out. SIP is a distributed system where each server only has knowledge of a limited set of the address space. DNS can be used to resolve the SIP server to question for a particular user. NO or limited caching. SIP is therefore more suitable.

4 Multikast / Multicast

(a) **N:** Hva er problemet med multikast-adressene i kommersiell bruk av multikast?

E: What is the problem with multicast addresses for commercial deployment of multicast?

No control over addresses, risk of hijacking, collision of sessions.

(b) **N:** Relatert til problemet med multikast adressering i forrige oppgave, diskuter om det er forskjell mellom multikast basert på ”source specific trees” og multikast basert på ”shared trees”.

E: Discuss whether there is a difference between multicast based on source specific trees and multicast based on shared trees regarding the deployment problem in the previous exercise.

In source specific trees the multicast address only needs to be coordinated locally on the source. It is therefore no deployment risk, since the source has full control over the address

(c) **N:** Hvordan blir ”multicast scoping” gjort i IPv6?

E: How is scoping done in IPv6 multicast?

Scoping i.e setting the boundaries for how a multicast packet should be distributed is part of the address. The field is 4 bits long, 5 patterns have a predetermined meaning, the rest can be used for local policies.

(d) **N:** Hva er forskjellen i hvordan scoping blir gjort i IPv4 og IPv6?

E: What is the difference in how scoping in multicast is done in IPv4 and IPv6?

In IPv6 scoping is part of the multicast address. There is a separate field in the address to signal this. In IPv4 there is a very limited address range reserved for scoping. Typically the TTL field is used for scoping. The TTL field is set in the packet. For each interface on an organizational boundary a limit is set and only packet with a larger TTL is forwarded.

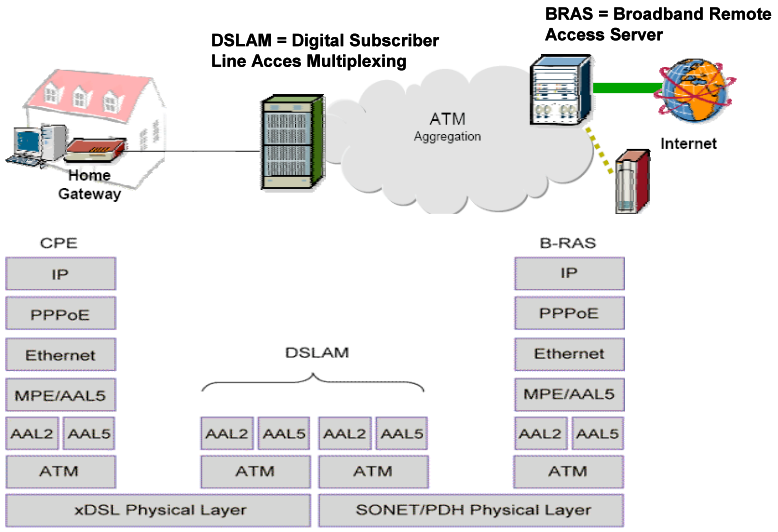
(e) **N:** Kommenter på om de to QoS-arkitekturene, Differentiated Services (DiffServ) og Integrated Services (IntServ), er egnet/ikke egnet for multicast.

E: Describe whether the two QoS architectures, Differentiated Services (DiffServ) and Integrated Services (IntServ) are suitable/not suitable for multicast.

Both are suitable. A multicast packet is a regular IP packet with a code point. The challenge is adaptation of SLA since the distribution tree is dynamic (this is not expected in a correct answer). IntServ use RSVP for signaling. RSVP was specified for multicast with explicit merge rules.

N: Figuren under viser nettverksarkitekturen med protokollstakk for et xDSL-basert aksessnettverk. Den offentlige IP-adressen deles ut via PPPoE (Point-to-point Protocol over Ethernet).

E: The figure below shows the network architecture and protocol stack for an xDSL-based access network. The public IP-address is handed out by PPPoE (Point-to-point Protocol over Ethernet).



(f) **N:** Hvilken utfordring ser du ved å implementere TV-delen av 3-play (internett aksess, VoIP og TV-kringkasting) med bruk av protokollene i denne arkitekturen?

E: Which challenge do you see in implementing the TV component of 3-play (internet access, VoIP, and TV broadcast) using the protocols of this architecture?

There is a virtual point-to-point link between the BRAS and the home gateway. There can be no IP multicast from BRAS and out and this will give bandwidth and performance challenges.

(g) **N:** Operatøren oppgraderer sitt nett ved å erstatte ATM-teknologien i aggregeringsnettet med ethernet-teknologi. Hvilke protokollstakker ville du som operatør benyttet i henholdsvis CPE, DSLAM og B-RAS? Hvordan implementeres TV-kringkasting mest effektivt i denne arkitekturen?

E: The operator upgrades its network by substituting the ATM technology in the aggregation network by Ethernet technology. Which protocol stack would you as an operator use in CPE, DSLAM and B-RAS respectively? How would TV broadcast be implemented most efficiently?

IP/ETH/MPE/AAL/ATM/phys, ETH/MPE/AAL/ATM/phys – ETH/phys, IP/ETH/phys. Multicast needs to be based on layer two to have one multicastlink from B-RAS to DSLAM. (A protocol stack in more detail – not required for full score:)

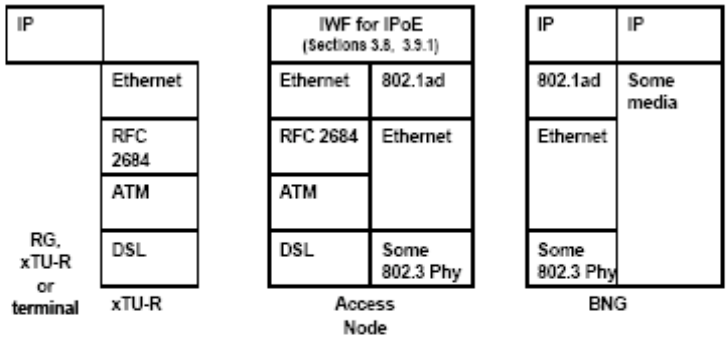


Figure 16 - End-to-end protocol processing for IPoE access

http://www.broadband-forum.org/technical/download/TR-101.pdf

If the DSLAM is upgradet to an IP-DSLAM: IP/ETH/MPE/AAL/ATM/phys, IP/ETH/MPE/AAL/ATM/phys – IP/ETH/phys, IP/ETH/phys, then IP multicast can be handled within the IP-DSLAM itself.

To optimally produce TV broadcast one need multicast between dslam and BRAS. DSLAM to HG is a single wire and the dslam must copy all packets to the wires.

5 Ad-hoc nettverk / Ad-hoc networks

(a) **N:** Forklar begrepene "exposed node problem" og "hidden node problem" i trådløs datakommunikasjon.

E: Explain what is meant by the exposed node problem and the hidden node problem in wireless data communication.

OVERSETT:
Exposed node: to noder sender til to forskjellige noder uten at det vil være interference hos mottaker. Men fordi begge nodene kan høre hverandre vil de feilaktig tro det blir interference og avstår ifra å sende.

Hidden node: to noder sender til samme node hvor det oppstår interference mellom sendingene. Fordi nodene ikke kan høre hverandre sender begge samtidig.

(b) **N:** Hvordan kan "the hidden node problem" påvirke AODV (Ad-hoc On-Demand Distance Vector) ruting? Beskriv en mekanisme som er egnet for å minimere effekten av "the hidden node problem".

E: How can the hidden node problem potentially affect the AODV (Ad-hoc On-Demand Distance Vector) routing? Describe a mechanism that can minimize the effect of the hidden node problem.

Each node in AODV broadcasts Route Request (RREQ) it has received. These broadcasts may collide due to hidden node. Nodes on the best path may therefore not receive the RREQ. ADOV adds a jitter for when a RREQ is broadcast and the likelihood of two nodes sending a request at the same time is reduced. Also full score if the link level mechanism of choosing a random start point (like in 802.11) is described.

(c) **N:** Ad-hoc ruting-protokoller er vanligvis klassifisert i 4 grupper. Hvilken av disse gruppene er best egnet i et nettverk med medium nodetetthet og med et peer-to-peer trafikkmønster? Anta 40 noder innen 400*300 m.

E: Ad-hoc routing protocols are normally classified into 4 groups. Which is the preferred group for a medium dense network with mobility and typically a peer-to-peer traffic pattern? Assume 40 nodes in 400*300 m.

1 point if Reactive, proactive, hierarchal and geographical is mentioned. The most suitable is proactive, since most nodes will communicate with most others. Reactive is ruled out on the combination of mobility and communication pattern. Medium, dense best suited for proactive. Medium rules out hierarchical. Geographic only used in special cases.

(d) Oversatt 4e, samt ny 4f figure:

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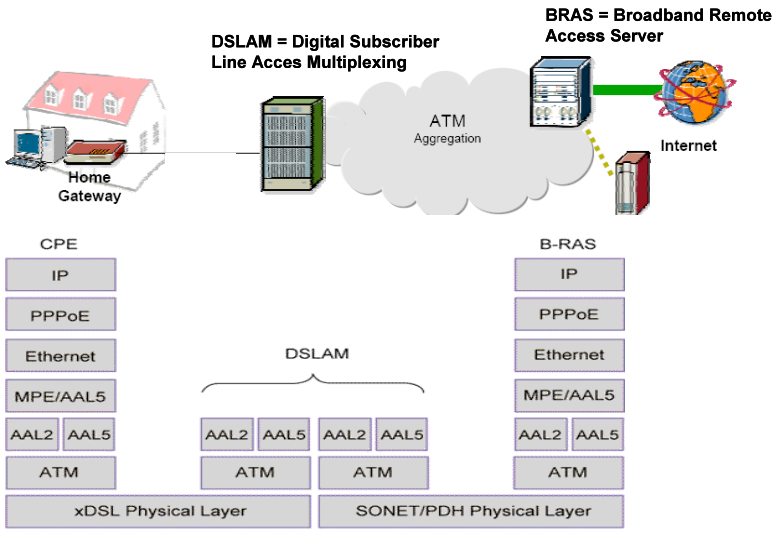

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