DAT204 KRÆSJKURS

19.November 2019

2x Select Protocol (Application Layer/Link Layer) (2pts)
2x UDP sockets (UDP) (2pts)
TCP & UDP sockets (tcp vs udp true or false) (3pts)
TCP & UDP Statements (what is true regarding tcp & udp) (3pts)
2x HTTP Protocol (2pts)
2x E-mail transfer (http, smtp, imap) (3pts/2pts)
E-mail (Protokoller, kryptering) (4pts)
DHCP (utalleser og hvordan den fungerer) (3pts)
2x TCP congestion handling(how does tcp work?) (2pts)
TCP claims (claims about how congestion work) (2pts)
2x UDP Claims(how the UDP protocol works) (2pts)
TCP Quality Of Service (Which Service quality guarantees does TCP give) (2pts)
3x TCP Sequence (3pts/6pts/5pts)
3x TCP Congestion Window (5pts/2pts/5pts)
TCP Congestion window (5pts)
2x Routing Standards (2pts)
2x IP Address Assignment (2pts)
2x Packet Scheduling (2pts)
Routing Algorithms (5pts)
AS Routing (4pts)
3x Binary to IP (2pts/5pts)
3x IP og subnetting (4pts/6.5pts/6pts)
3x Routing Tables (5pts)
Routing Protocols (4.5pts)
TCP/IP switch layers (2pts)
TCP/IP router layers (2pts)
3x Link Layer (2pts/3pts)
Wireless Concepts (6pts)
2x Self-learning switches (6pts)
Email Encryption (2pts)
3x SSL statements (2pts)
3x SSL certificate (2pts/7pts)
3x SSL Quality Of Service (3pts/7pts/2pts)
2x Wireshark SSL (11pts)
Wireshark HTTP (16pts)
2x Link Utilisation (4pts)
2x Transmission and Propagation delay (10pts/ 8pts)
Routers and SDN (3pts)
ARP (wireshark screenshot, true or false) (3pts)
Ethernet LAN (Svar på følgende spørsmål) (3pts)
Ethernet Switch (what is true regarding the statements) (3pts)
2x SSL nonces (what is the purpose of nonces in SSL/TLS) (2pts)
2x Wireless Concepts (6pts)
SSL/TLS master secret encryption (2pts)
HTTP GET request (how many bytes data are returned to the application layet in the wireshark screenshot) (2pts)
Application Layer Protocol (Which protocols Belongs to application layer) (2pts)
Wireshark IPv4 vs IPv6 (2pts)
Link-state Algorithm (10pts)

3x TCP Sequence (3pts/6pts/5pts)

3x TCP Congestion Window (5pts/2pts/5pts)

3x Binary to IP (2pts/5pts)

3x IP og subnetting (4pts/6.5pts/6pts)

3x Routing Tables (5pts)

3x Link Layer (2pts/3pts)

3x SSL statements (2pts)

3x SSL certificate (2pts/7pts)

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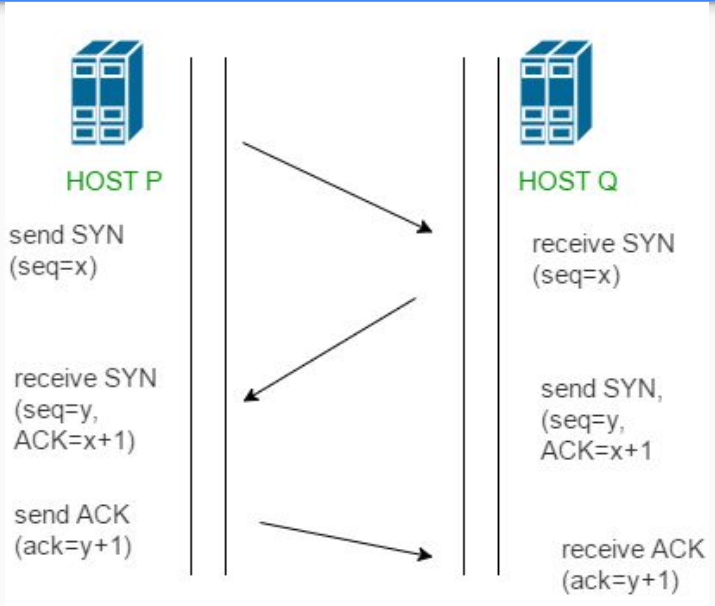
Spørsmål?

3x 3 Way Handshake (SYN, SYN-ACK, ACK)



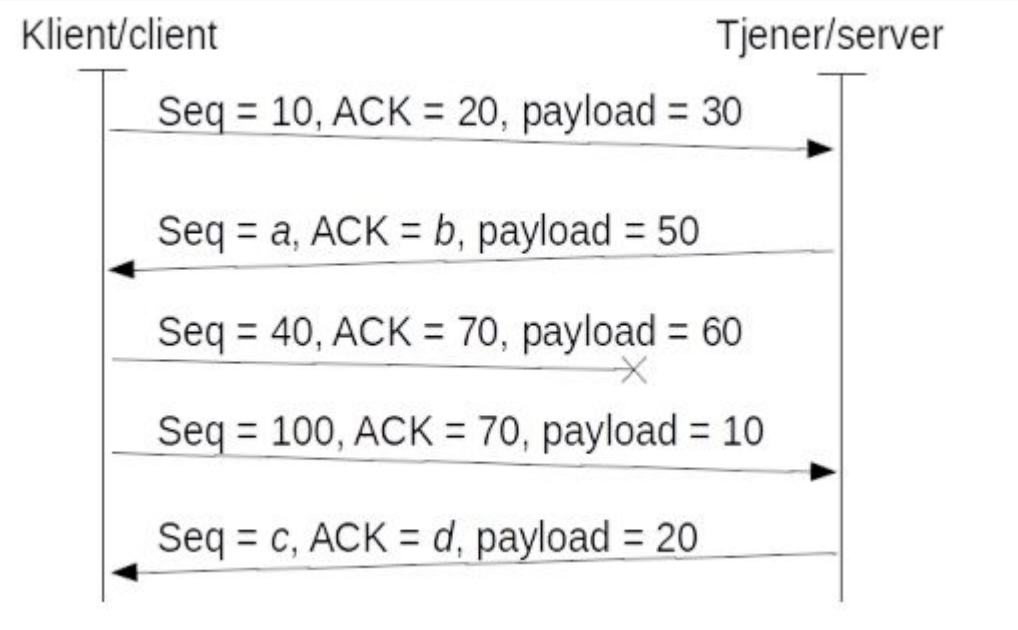
SYN: The active open is performed by the client sending a **SYN** to the server. The client sets the segment's sequence number to a random value A.

SYN-ACK: In response, the server replies with a **SYN-ACK**. The acknowledgment number is set to one more than the received sequence number i.e. A+1, and the sequence number that the server chooses for the packet is another random number, B.

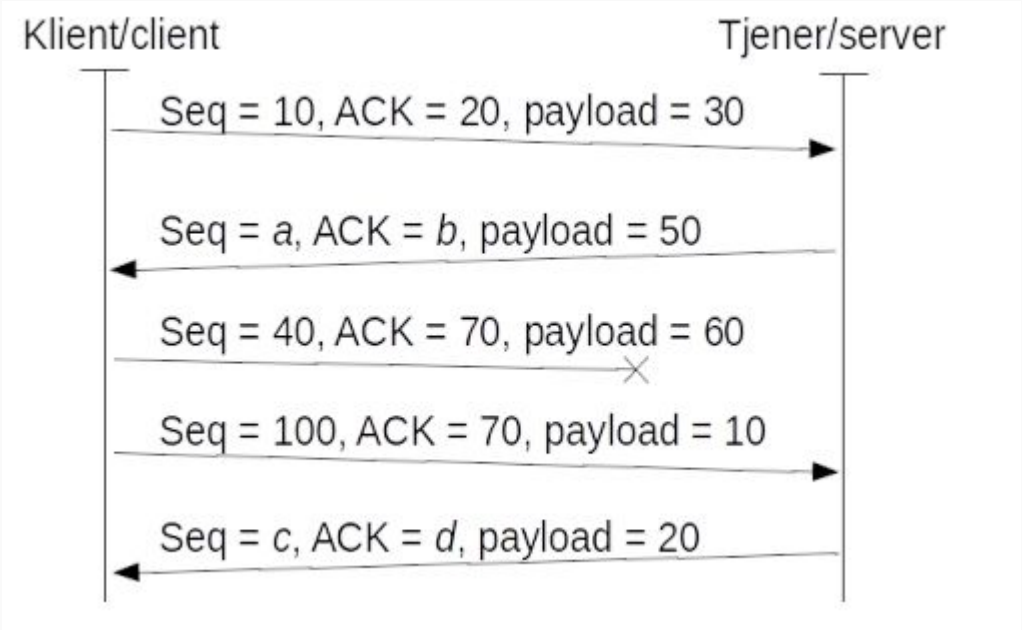
ACK: Finally, the client sends an **ACK** back to the server. The sequence number is set to the received acknowledgement value i.e. A+1, and the acknowledgement number is set to one more than the received sequence number i.e. B+1.

At this point, both the client and server have received an acknowledgment of the connection.

3x TCP Sequence



3x TCP Sequence

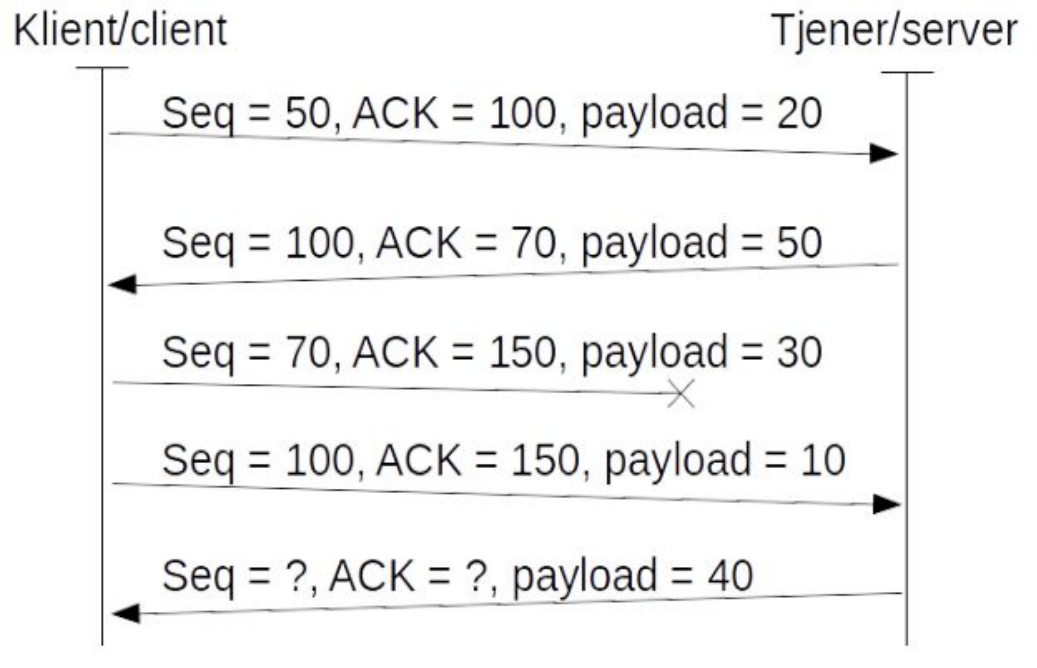


Next Seq = last_Ack
Next Ack = last_seq + last_payload

a = 20, b = 40

c = 70, d = 40

3x TCP Sequence



Next Seq = last_Ack

Next Ack = last_seq + last_payload

seq = 150, ack = 70

3x Binary To IP

Q: IP-adressen 01101001.00010000.01010000.10101011 kan skrives på punktum desimalform som

01101001.00010000.01010000.10101011

01101001 - 1.oktet
64 + 32 + 8 +1 = 105

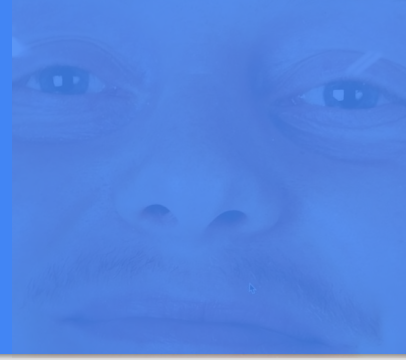
00010000 - 2.oktet
16 = 16

01010000 - 3.oktet
64 + 16 = 80

10101011 - 4.oktet
128 + 32 + 8 + 2 + 1 = 171

0	**1**	**1**	**0**	**1**	**0**	**0**	**1**
128	64	32	16	8	4	2	1

3x IP og Subnett



Anta at en ISP eier adresseblokken på formatet **105.16.80.0/23**. Anta at den vil skape **åtte** subnett fra denne blokken, hvor hver blokk har samme antall IP-adresser. (6,5 poeng)

/23 - Subnett
11111111.11111111.1111111**0.00000000**

2^9 == 512 Ledige IP addresser
512 / 8 == 64 addresser pr.nett

105.16.80.0/26	105.16.81.0/26
105.16.80.64/26	105.16.81.64/26
105.16.80.128/26	105.16.81.128/26
105.16.80.192/26	105.16.81.192/26

Subnet Mask Hierarchy

Subnet Mask	CIDR	Binary Notation	Available Addresses Per Subnet
255.255.255.255	/32	11111111.11111111.11111111.11111111	1
255.255.255.254	/31	11111111.11111111.11111111.11111110	2
255.255.255.252	/30	11111111.11111111.11111111.11111100	4
255.255.255.248	/29	11111111.11111111.11111111.11111000	8
255.255.255.240	/28	11111111.11111111.11111111.11110000	16
255.255.255.224	/27	11111111.11111111.11111111.11100000	32
255.255.255.192	/26	11111111.11111111.11111111.11000000	64
255.255.255.128	/25	11111111.11111111.11111111.10000000	128
255.255.255.0	/24	11111111.11111111.11111111.00000000	256
255.255.254.0	/23	11111111.11111111.11111110.00000000	512

3x IP og Subnett

Q: Hvor mange bits utgjør vertsdelen av prefiksene som er opprettet for de åtte subnettene?

A: 11111111.11111111.11111111.11**000000**
\...../
6

Q: Hvor mange verter kan tildeles en IP-adresse innenfor hvert av de åtte subnettene?

A: 64 - 62 Addresser.

3x Routing tables

Q: I denne oppgaven er målet å bestemme den riktige videresending linken gitt ruting tabellen nedenfor.

En ruter har følgende oppføringer i sin videresendingstabell:
Link1: 00001010.10101000.00000100.00000000/22
Link2: 00001010.10101000.00000110.00000000/23
Link3: 00001010.10101000.00000111.00000000/24
Link4: 00001010.10101000.00000000.00000000/16
Link5: Alle andre adresser

Anat at ruteren mottar datagramer med følgende destinasjonsadresser og bestem hvilken link de skal videresendes til:
A: 00001010.10101000.00000111.11111110
B: 00001010.10101000.00000011.00000000
C: 00001010.10101000.00000111.00000001
D: 00001010.10101000.00000110.10000000
E: 00001010.10111000.00000101.00000000

3x Routing tables - fiks

Q: I denne oppgaven er målet å bestemme den riktige videresending linken gitt ruting tabellen nedenfor.

Link1: 10.168.4.0
Link2: 10.168.6.0
Link3: 10.168.7.0
Link4: 10.168.0.0
Link5: Alle andre addresser

A: 10.168.7.254
B: 10.168.3.0
C: 10.168.7.1
D: 10.168.6.128
E: 10.184.5.0

OSI Model

	OSI Layer	TCP/IP	Datagrams are called
Software	**Layer 7** Application	HTTP, SMTP, IMAP, SNMP, POP3, FTP	Upper Layer Data
	Layer 6 Presentation	ASCII Characters, MPEG, SSL, TSL, Compression (Encryption & Decryption)	
	Layer 5 Session	NetBIOS, SAP, Handshaking connection	
	Layer 4 Transport	TCP, UDP	**Segment**
	Layer 3 Network	IPv4, IPv6, ICMP, IPSec, MPLS, ARP	**Packet**
Hardware	**Layer 2** Data Link	Ethernet, 802.1x, PPP, ATM, Fiber Channel, MPLS, FDDI, MAC Addresses	**Frame**
	Layer 1 Physical	Cables, Connectors, Hubs (DLS, RS232, 10BaseT, 100BaseTX, ISDN, T1)	**Bits**

3x Link Layer

The link layer is the place in the protocol stack where software meets hardware.

The link layer performs error detection.

In computer networking, the link layer is the lowest layer in the Internet Protocol Suite, the networking architecture of the Internet. It is described in RFC 1122 and RFC 1123.

The link layer is the group of methods and communications protocols that only operate on the link that a host is physically connected to.

Link layer performs the framing of datagrams

3x SSL Statements

Secure Sockets Layer

SSL allows agreeing on cryptographic algorithms during the handshake phase.

3x SSL Certificate

Authenticate the server.

Use public key to encrypt master secret

I typiske klient/server sesjoner, SSL bruker et digitalt sertifikat for å **autentisere serveren**

I typiske klient/server sesjoner, SSL bruker et digitalt sertifikat for å **kryptere master secret med serverens offentlige nøkkel**

SSL sockets vil typisk utveksle applikasjons meldinger kryptert med en **symmetrisk-nøkkel blokk chiffer**
AES er et eksempel på en slik algoritme

For å sikre at en melding ikke blir endret, vil SSL vanligvis bruke en **kryptografisk hash algoritme** til å lage et avtrykk av meldingen.
SHA er et eksempel på en slik algoritme
Ved å inkludere en autentiseringsnøkkel til avtrykket, blir en Message Authentication Code (MAC) laget og utvekslet sammen med den krypterte meldingen

SSL Quality Of Service

Hvilken socket type forbedrer secure socket layer (SSL) med sikkerhetstjenester

- TCP

Hva heter den oppdaterte, sikrere og i dag mest brukte versionen av SSL protokollen ?

- TLS (Transport Layer security)

Hvilke Service garantier gir SSL sockets?

- I rekkefølge data leveringer
- Server Autentisering
- Data konfidensialitet
- Pålitelig data overføring
- Data integritet

Spørsmål?

Select Protocol

Which of the following protocols run as a service on the application layer?

DNS

Which of the following protocols identify the MAC addresses on the LAN corresponding to the IP addresses of hosts on the LAN to allow link layer frames being sent from sender to receiver on the LAN segment?

ARP

UDP sockets

UDP traffic towards the same application in a server uses a common socket even if the traffic comes from different clients.

HTTP Sockets

Several Web pages can be sent over the same persistent connection.

Two distinct Web pages can be sent over the same persistent connection.

E-mail transfer

Alice sends an e-mail to Bob using a Web-based e-mail account

HTTP

Bob reads email using his e-mail client which uses a mail access protocol for presenting the emails that are stored on his e-mail server.

SMTP

This mail access protocol keeps e-mails and email folders on the server also after they have been downloaded.

IMAP

Mallory reads their email, as soon it has downloaded email folders on the server it is deleted from the server.

POP3

TCP congestion handling

Congestion avoidance denotes the phases in a TCP transmission where the congestion window increases linearly.

Transmission Control Protocol (TCP) uses a network congestion-avoidance algorithm that includes various aspects of an additive increase/multiplicative decrease (AIMD) scheme, along with other schemes including slow start and congestion window, to achieve congestion avoidance.

The TCP congestion-avoidance algorithm is the primary basis for congestion control in the Internet

UDP Claims

When UDP is used, then any fault correction is up to the application.

Routing Standards

What is the de-facto standard for inter-AS routing?

BPG - Border Gateway Protocol

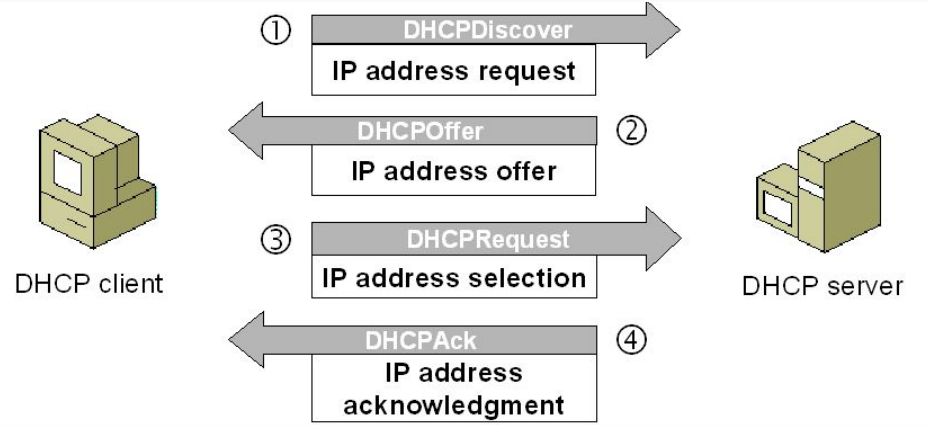
Border Gateway Protocol (**BGP**) is a standardized exterior gateway protocol designed to exchange routing and reachability information among autonomous systems (**AS**) on the Internet.

The protocol is classified as a path vector protocol. The Border Gateway Protocol makes routing decisions based on paths, network policies, or rule-sets configured by a network administrator and is involved in making core routing decisions.

IP Address Assignment

How does a host usually get an IP address when it connects to a network?

DHCP



Packet Scheduling

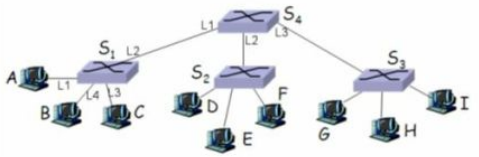
Which packet scheduling discipline ensures that a data flow gets a defined fraction (of arbitrary size) of the total bandwidth?

Weighted Fair Queueing

Which packet scheduling discipline ensures that each data flow gets an equal share of the total bandwidth, but does not support assigning different bandwidth shares?

Round Robin (RR)

Self-learning switches - fiks



The figure above shows a network with four self-learning Ethernet switches and nine hosts. The switches have just been started, and the switch table is empty. (6 points)

Assume the following frames are being sent:
D to H
H to B
C to H
Then A to B.

How will the switch table in S_4 be after this sequence?

Switch table for S_4

Address	Interface
D	(L4, L3, L1, L2)
H	(L3, L1, L4, L2)
C	(L4, L3, L1, L2)
(A, I, D, E, H, C, B)	(L4, L2, L1, L3)

Which hosts receive the last frame? (Only B, A, B and C, A and B, All except sender)

Wireshark SSL2

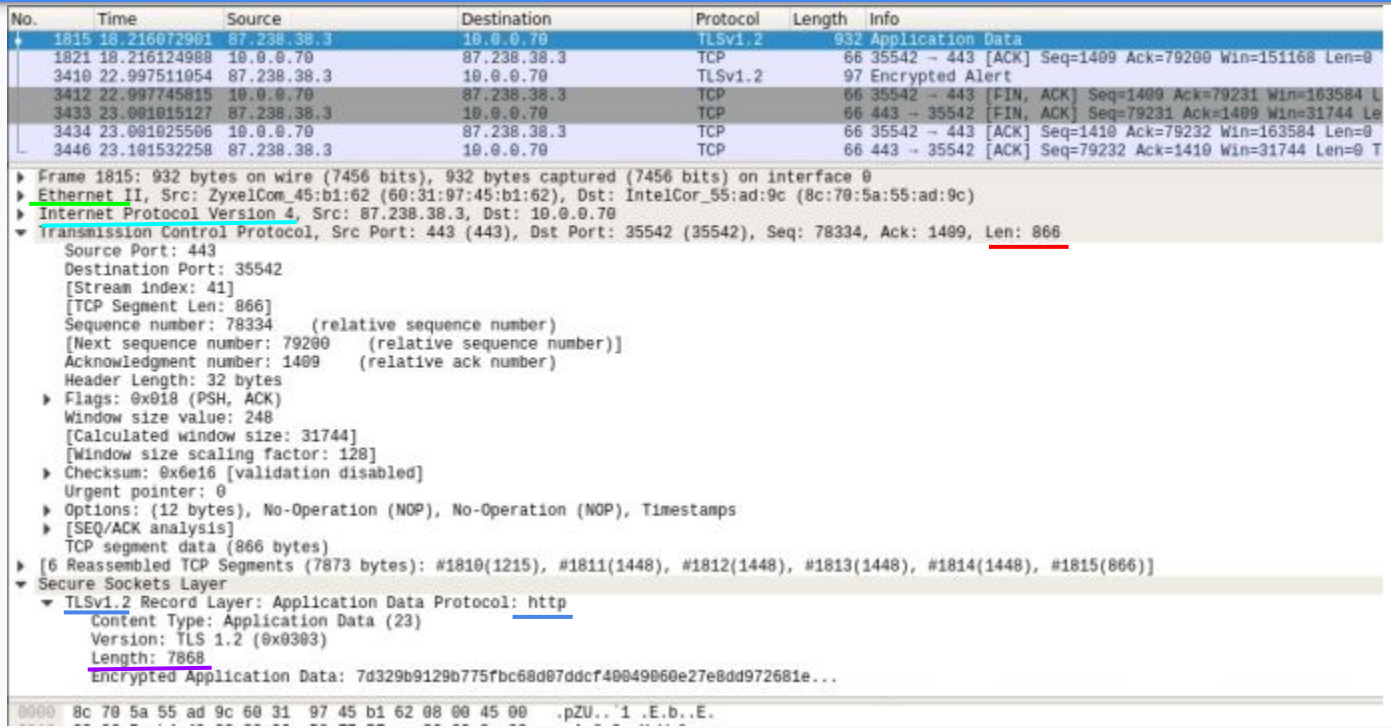
Which link layer protocol is used here?
Which protocol is encapsulated in the link layer frame?
How many bytes payload are sent in segment 1815?
How many bytes data are sent in the current SSL record?

Packet 1821 shows "Win=151168". What type of window is this? **Reciving**

Which phase of a TCP connection do packets 3412 - 3446 belong to? **Disconnect**

Who sends packet 1815? **Server**

How many bytes payload have been sent and received in total from the start of the session and until inclusive packet 3433?
Sent: 1408
Recived: 79230
Which application layer protocol(s) are used here? Select any that apply:



Link Utilisation

Consider an intercontinental fibre link between two hosts, where the round-trip propagation delay between these two end systems, RTT, is 200 ms. Suppose that the size of a packet is 625 bytes, including both header fields and data, and that the transmission rate is 100 Mbit/s. (4 points)

What is transmission delay in microseconds?

Transmission and Propagation delay

SSL nonces

Beskytte mot "replay" angrep

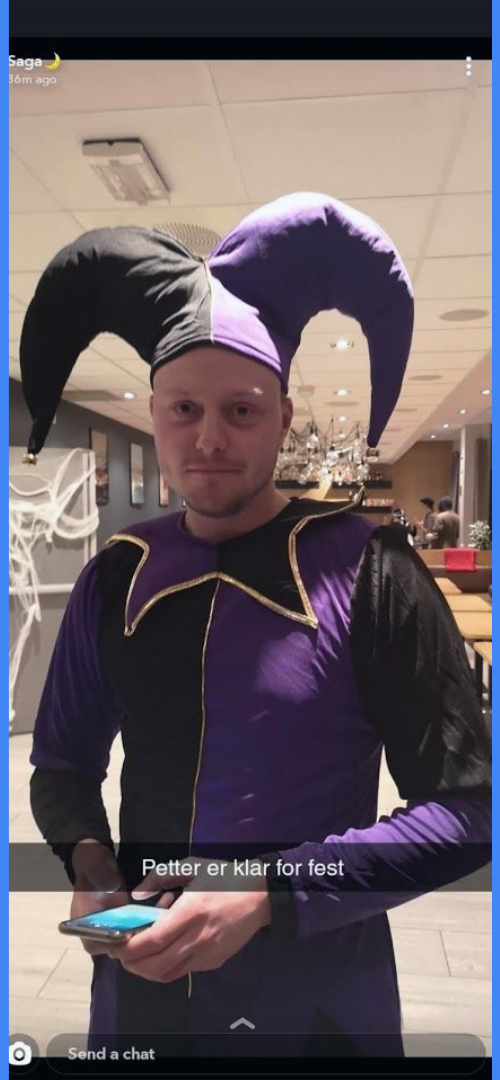
The primary reason why SSL is used is to keep sensitive information sent across the Internet encrypted so that only the intended recipient can access it.

This is important because the information you send on the Internet is passed from computer to computer to get to the destination server.

Any computer in between you and the server can see your credit card numbers, usernames and passwords, and other sensitive information if it is not encrypted with an SSL certificate.

When an SSL certificate is used, the information becomes unreadable to everyone except for the server you are sending the information to. This protects it from hackers and identity thieves.

Spørsmål?



TCP & UDP sockets

TCP

TCP bruker to sockets for å opprette en forbindelse, en som mottar oppkobling forespørsler og en for datautveksling.
TCP provides a connection oriented service, since it is based on connections between clients and servers.
TCP provides reliability. When a TCP client send data to the server, it requires an acknowledgement in return. If an acknowledgement is not received, TCP automatically retransmit the data and waits for a longer period of time.
We have mentioned that UDP datagrams are characterized by a length. TCP is instead a byte-stream protocol, without any boundaries at all.

UDP

UDP is a simple transport-layer protocol. The application writes a message to a UDP socket, which is then encapsulated in a UDP datagram, which is further encapsulated in an IP datagram, which is sent to the destination.
There is **no guarantee that** a UDP will reach the destination, that the order of the datagrams will be preserved across the network or that datagrams arrive only once.
The problem of UDP is its lack of reliability: if a datagram reaches its final destination but the checksum detects an error, or if the datagram is dropped in the network, it is not automatically retransmitted.

TCP & UDP Statements

For en TCP forbindelse kan antallet ubekreftede bytes ikke være større enn mottakerens annonserte vindusstørrelse.

UDP tilbyr kun en upålitelig dataoverføringstjeneste over et upålitelig internett

TCP tilbyr en pålitelig dataoverføringstjeneste over et upålitelig internett.

Når UDP brukes, må eventuell feilkorreksjon gjøres i applikasjonen.

E-mail

Hvilken protokoll er vist i eksemplet ovenfor og ansett som hjertet av Internett elektronisk post?

```
S: 220 hamburger.edu
C: HELO crepes.fr
S: 250 Hello crepes.fr, pleased to meet you
C: MAIL FROM: <alice@crepes.fr>
S: 250 alice@crepes.fr ... Sender ok
C: RCPT TO: <bob@hamburger.edu>
S: 250 bob@hamburger.edu ... Recipient ok
C: DATA
S: 354 Enter mail, end with "." on a line by itself
C: Do you like ketchup?
C: How about pickles?
C: .
S: 250 Message accepted for delivery
C: QUIT
S: 221 hamburger.edu closing connection
```

E-mail

Hvilken protokoll er vist i eksemplet ovenfor og ansett som hjertet av Internett elektronisk post?

SMTP
Simple Mail Transfer Protocol

HELO – Identifies the client to the server, fully qualified domain name, only sent once per session
MAIL – Initiate a message transfer, fully qualified domain of originator
RCPT – Follows MAIL, identifies an addressee, typically the fully qualified name of the addressee and for multiple addressees use one RCPT for each addressee
DATA – send data line by line

```
S: 220 hamburger.edu
C: HELO crepes.fr
S: 250 Hello crepes.fr, pleased to meet you
C: MAIL FROM: <alice@crepes.fr>
S: 250 alice@crepes.fr ... Sender ok
C: RCPT TO: <bob@hamburger.edu>
S: 250 bob@hamburger.edu ... Recipient ok
C: DATA
S: 354 Enter mail, end with "." on a line by itself
C: Do you like ketchup?
C: How about pickles?
C: .
S: 250 Message accepted for delivery
C: QUIT
S: 221 hamburger.edu closing connection
```

E-mail

POP3(**P**ost **O**ffice **P**rotocol)

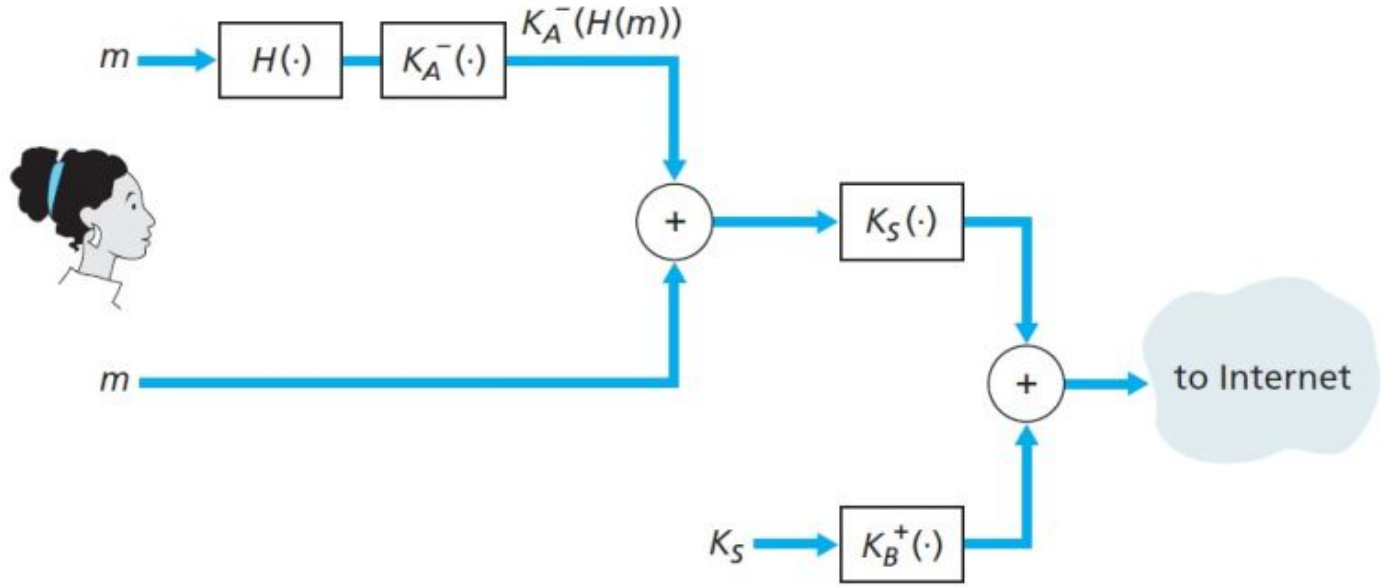
Laster ned email-mappene fra serveren, for å så slette de fra serveren

IMAP(**I**nternet **M**essage **A**ccess **P**rotocol)

Beholder email-mappene fra serveren etter at de har blitt lastet ned

E-mail

Hvilken protokoll er illustrert i figuren under og betraktet som de-facto standard e-post krypteringsmetode?



E-mail

PGP (Pretty Good Privacy)

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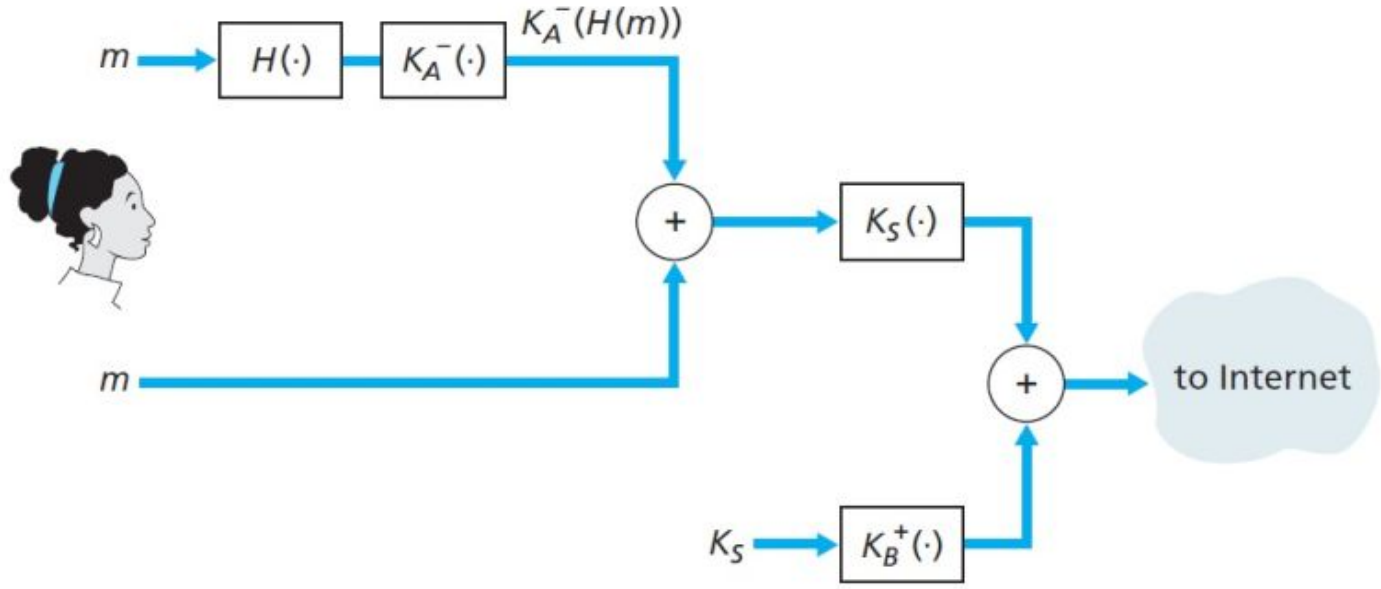
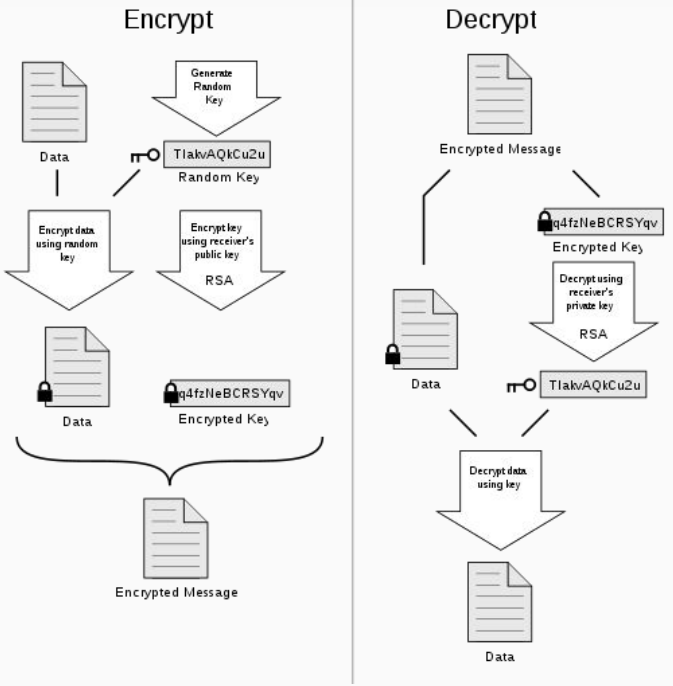


E-mail


Encrypt
Data
Generate Random Key
TlakvAQkCu2u
Random Key
Encrypt data using random key
Encrypt key using receiver's public key
RSA
Data
q4fzNeBCRSYqv
Encrypted Key
Encrypted Message
Decrypt
Encrypted Message
q4fzNeBCRSYqv
Encrypted Key
Decrypt using receiver's private key
RSA
Data
TlakvAQkCu2u
Decrypt data using key
Data

DHCP

DHCP tillater en vert å skaffe en IP-adresse automatisk.

DHCP er en applikasjonslags protokoll.

DHCP er en applikasjonslags protokoll.

DHCP gir IP-adresser til lokale DNS servere.

DHCP er en klient-server protokol

DHCP gir LAN nettverks maske.

TCP Claims

For a TCP connection, the number of unacknowledged bytes can not be larger than the receiver buffer.

Quality of Service

SSL Quality of Service

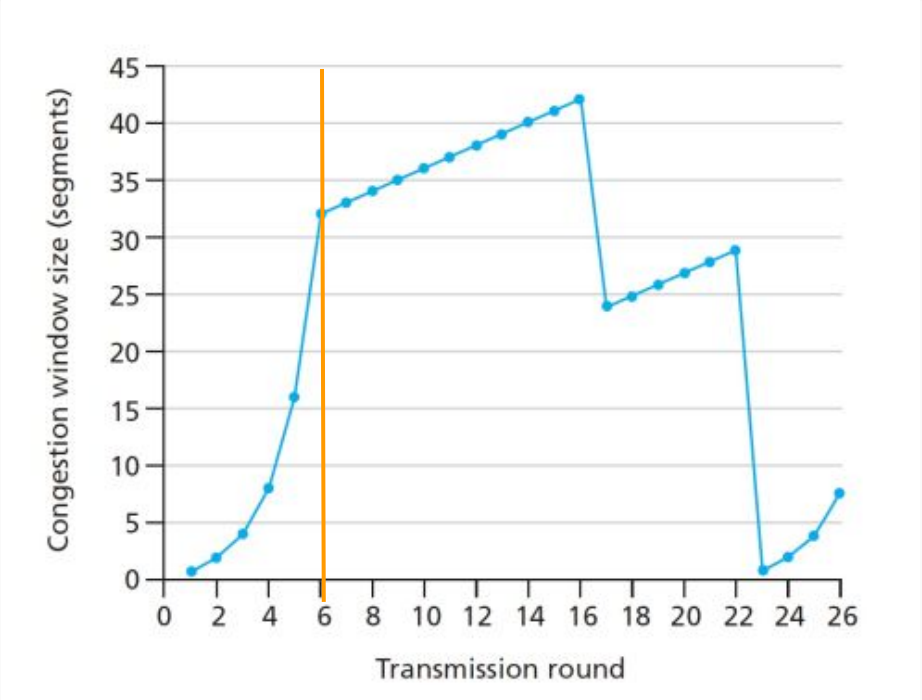
- Data transfer are done in order
- Data integrity
- Server authentication
- Data confidentiality
- **Pålitelig data overføring**

TCP Quality of Service

- In-order data delivery
- Reliable data transfer

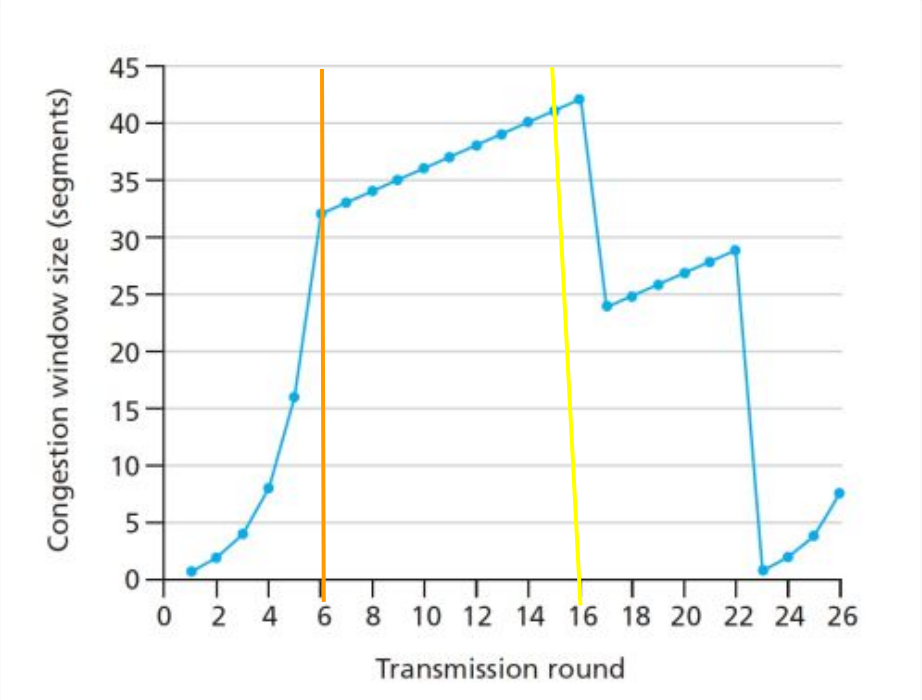
TCP Congestion window

Identifiser et intervall der TCP slow start fungerer.



TCP Congestion window

Identifiser et intervall der TCP slow start fungerer. Hvordan er segmenttap identifisert etter den 16. overføringsrunden(**Trippel duplikat ACK)**



Routing Algorithms

OSPF(Open Shortest Path First**)** - Uses Dijkstra's algorithm to find the shortest path

OSPF(Open Shortest Path First**) -** exchanges information about neighbour routers with all routers in the network.

BGP (Border Gateway Protocol) - is dominated by routing policies instead of focusing on finding the path with lowest cost in the network.

BGP(Border Gateway Protocol**) -** announces a subnet to all autonomous systems on the Internet.

RIP (Routing Information Protocol**)** - exchanges information about changed routing tables with neighbour routers.

AS Routing

Routing Protocols

Dijkstra's korteste vei algoritme er mye brukt med **Link-State(LS)** ruting protokoller.

- Ruteren har fullstendig informasjon om alle link kostnader innenfor sitt autonome system.
- Ruteren har fullstendig topologi over alle andre rutere innenfor sitt autonome system
- Ruteren har fullstendig topologi over alle andre rutere i hele Internettet

Bellman-Ford ligningen er mye brukt med **Distance-Vector(DV)** rutin protokoller.

- Ruteren kan kjøre RIP
- Ruteren kjenner kun avstand til fysisk tilkoblede naboer.
- Ruteren er avhengig av at direkte tilknyttede naboer annonserer sine vektortabeller for å kunne oppdatere sin egen rutingtabell
- Ruteren kjenner bare fysisk tilkoblede naboer.

TCP/IP Switch Layers

Which layers in the TCP/IP model are involved when an Ethernet switch forwards packets?

- Link layer
- Physical Layer

TCP/IP Router Layers

Which layers in the data plane are involved when a router forwards packets from an input port and to an output port in the router?

- Network layer
- Link Layer
- Physical layer

Wireless Concepts

In **infrastructure mode** each wireless host is connected to the internet via an access point.

In **ad-hoc mode** wireless hosts themselves provide routing, address assignment and DNS

Wireless stations discover and identify the access point using **beacon frames**.

Attenuation of the wireless signal when travelling through matter is called **path loss**

When two or more sources within a basic service set transmit at the same time on the same frequency then **interference** may occur.

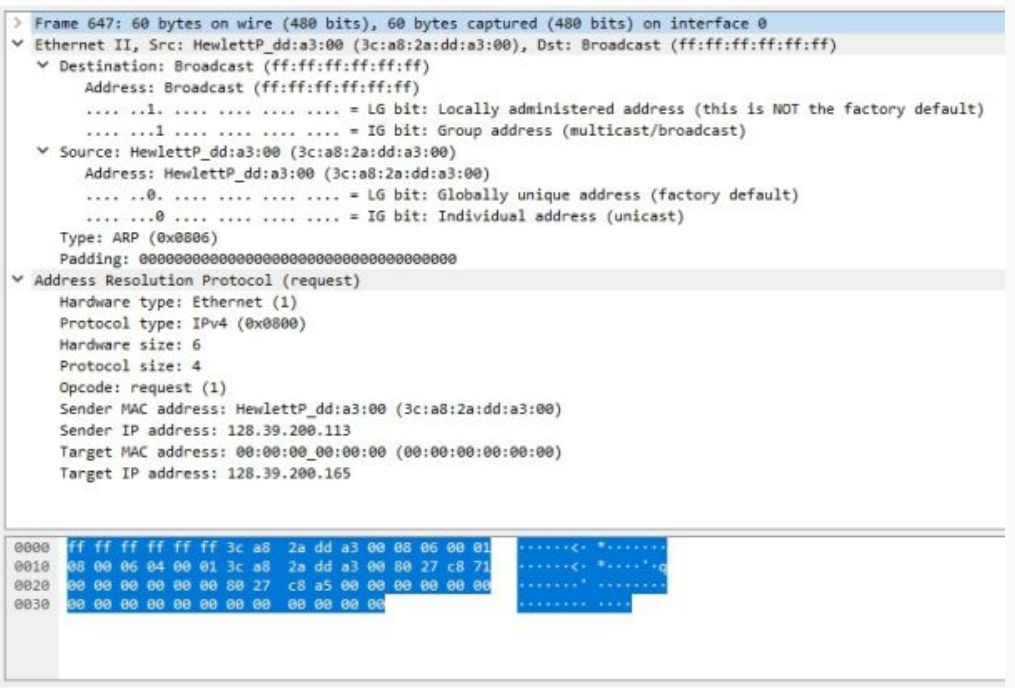
Blurring of the received signal due to several reflections of the electromagnetic wave from objects and ground is called **multipath propagation**

Wireshark HTTP

Hvilken linklagsprotokoll brukes her?

ARP

- Verter og rutere bruker ARP til å knytte en IP-adresse til en MAC-adresse og vedlikeholde en ARP-tabell i sitt minne.
- Vert med IP-adresse 128.39.200.113 har MAC-adresse 3c:a8:2a:dd:a3:00.
- ARP er en protokoll som ligger et sted mellom nettverkslaget og linklaget i Internett protokollstakk



Routers and SDN

I de senere årene, har Software-Defined Networking (SDN) fått økende interesse. Nedenfor er noen sanne uttalelser
angående tradisjonelle rutere og SDN

- Med tradisjonelle rutere håndteres både videresending og ruting funksjonen (kontroll, kommunikasjon, beregning av videresendingstabeller) per-ruter

- Tradisjonelle rutere utfører destinasjonsbasert videresending ved å matche destinasjonens IP-adresse mot deres respektive videresendingstabell

- SDN pakkesvitsjer kan utføre videresending ved å matche flere felter i linklagets, nettverkslagets og transportlagets headere mot deres respektive flyt tabell

Ethernet LAN

Ethernet er den mest brukte teknologien for kablede Local Area Network (LAN)

- Hvilke IEEE standarder spesifiserer kablet Ethernet?
  - 802.3

Ethernet LAN

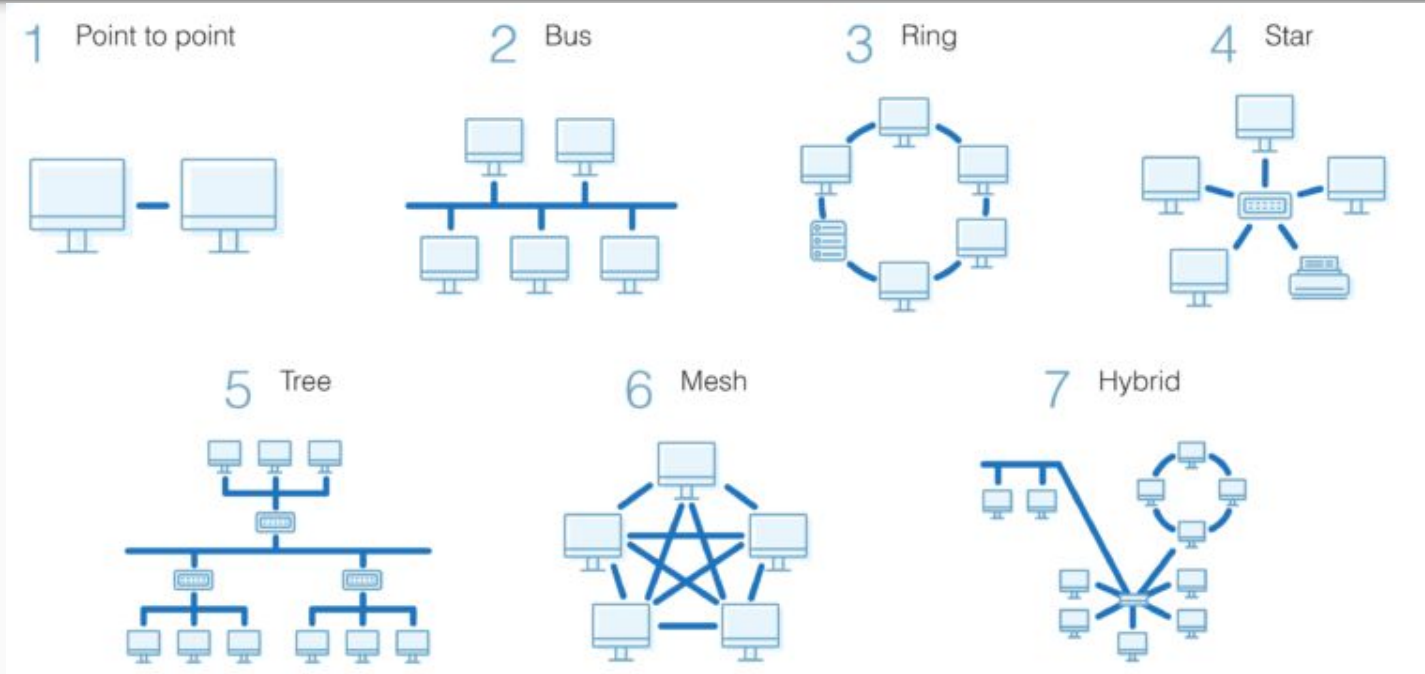
Ethernet er den mest brukte teknologien for kablede Local Area Network (LAN)

Hvilken kablet LAN topologi er den aller mest vanligste i dag?

Stjerne med punkt-til-punkt linker og svitsj i midten

Hvilken kabel type er mest vanlig i LAN i dag?

Tvunnet parkabel



Ethernet Switch

Svitsjer videresender rammer basert på destinasjonens MAC-adresse.

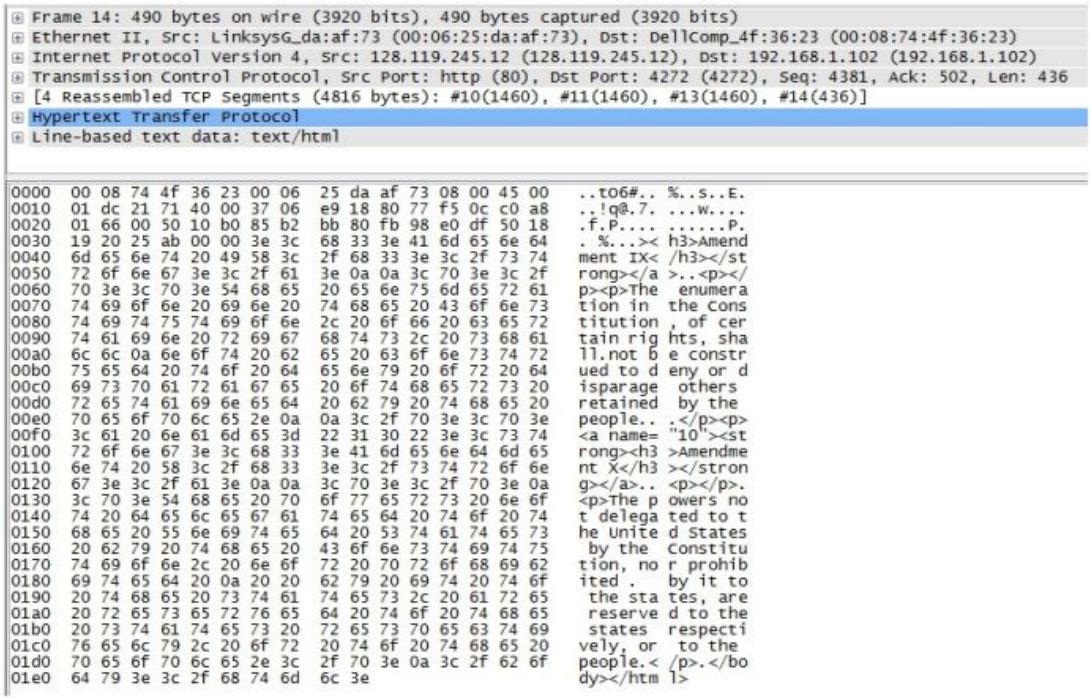
Svitsjer er enkle, raske og relativt billige

Svitsjer må vedlikeholde sine svitsjetabeller på egenhånd

Wireless Concepts

HTTP GET request

The Wireshark log shows response to a HTTP-GET request.
How many bytes data are returned to the application layer from the current TCP segment?



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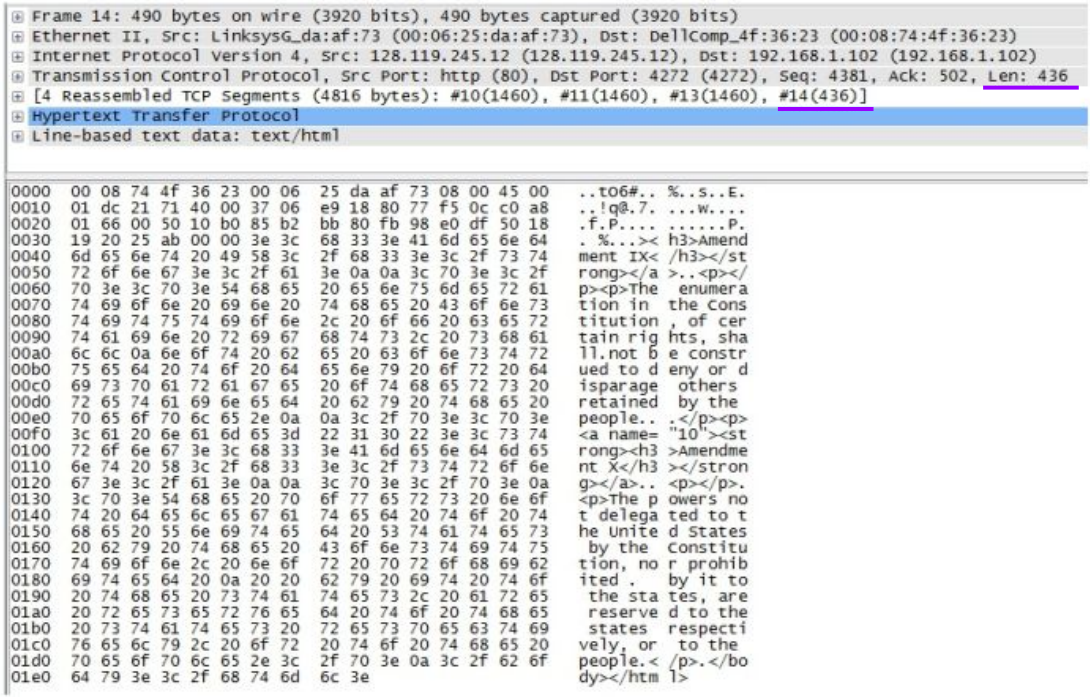
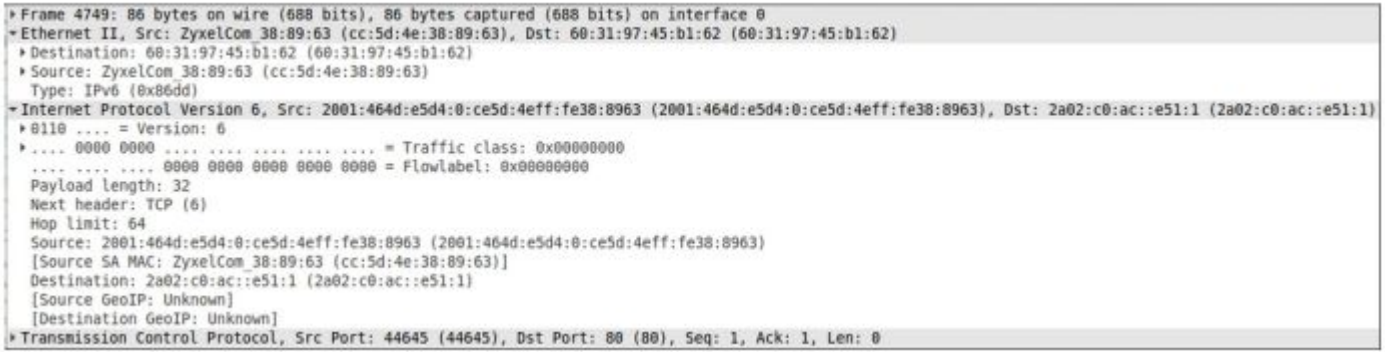


Application Layer Protocol

Wireshark IPv4 vs IPv6

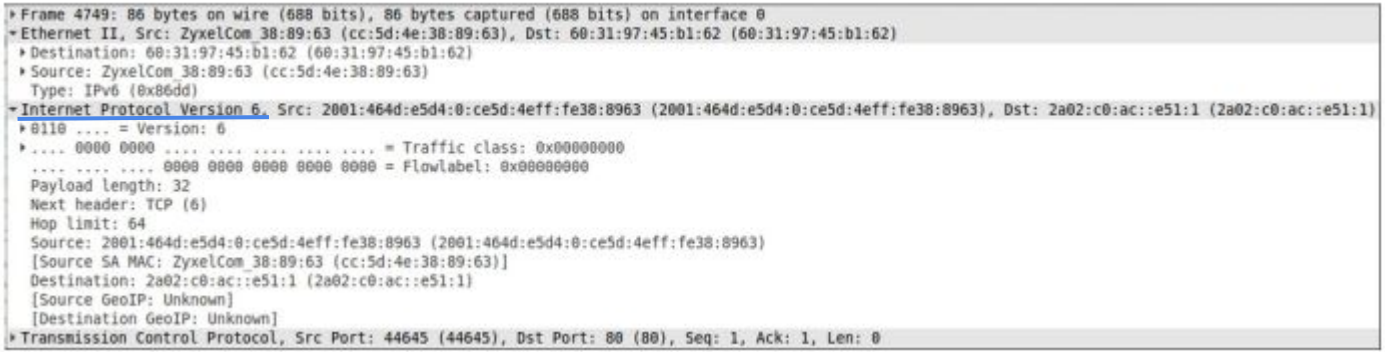
Which network scenario does the Wireshark log in the figure illustrate?



Wireshark IPv4 vs IPv6

Which network scenario does the Wireshark log in the figure illustrate?

IPv6 traffic



Link-state Algorithm