Computer Networks

Tutorial 1:

Forwarding Tables and Transmission Time

Scope of This Tutorial

- Forwarding tables
- Throughput vs. link rate
- Comparison of switching types

Forwarding Tables

A forwarding table – aka. a forwarding information base (FIB), or MAC table

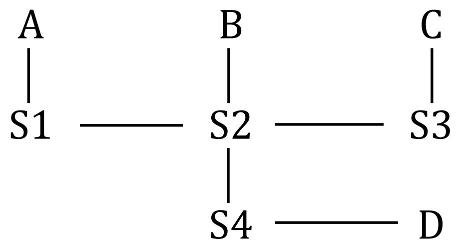
- dynamic table that maps MAC addresses to ports (i.e. output interfaces)
- implemented in hardware in content-addressable memory

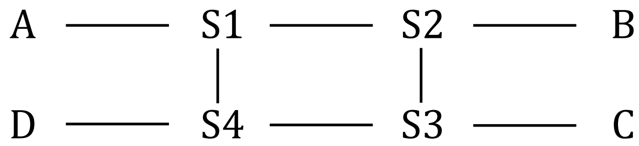
There maybe more output queues bound to one output – if the switch supports traffic classification

- Forwarding table maps priority values & to output queues

Exercise 1

Give forwarding tables for each of the switches S1-S4 in the following network with destinations A, B, C, D. For the next-hop column, give the neighbour on the appropriate link rather than the interface number.





Example solution:

S1: (A, A) (B, S2) (C, S2) (D, S2)
S2: (A, S1) (B, B) (C, S3) (D, S4)
S3: (A, S2) (B, S2) (C, C) (D, S2)
S4: (A, S2) (B, S2) (C, S2) (D, D)

Destination	Next Hop
A	S2
B	S2
C	S2
D	D

Solution:

S1:
S2:
S3:
S4:

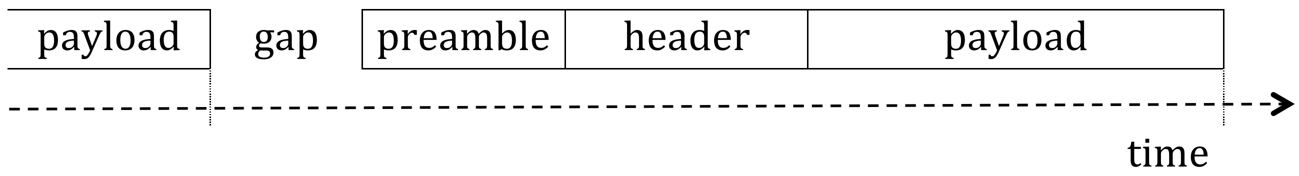
Throughput vs. link rate

Throughput	– the overall effective transmission rate
Link Rate	– the rate at which bits are transmitted

Exercise 2

The bit rate of a link between 2 devices is 1 Mb/s.
Max. size of the frame (header + payload) is 1024 bits.
The header size is 64 bits.
Preamble (clock synchronization pattern) length is 16 bits.
The silence time between 2 consecutive frames is chosen randomly from the range between 16 and 128 μs.

Calculate the throughput of the link.



Average gap time is:

Full frame transmission time is:

Preamble transmission time is:

Average time to transmit the every payload:

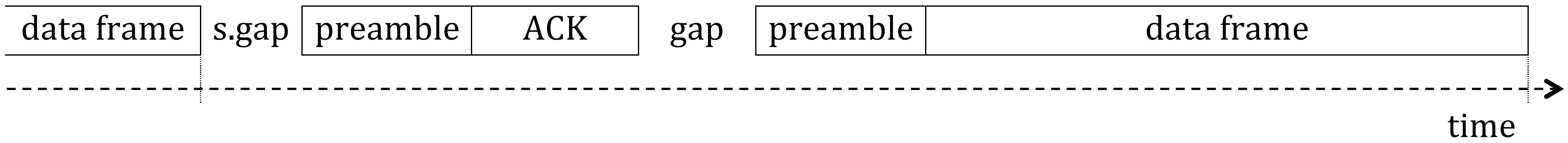
Throughput = payload size / average time to transmit =

Exercise 3

All assumptions as in the previous exercise.
The difference is that between two consecutive data frames the recipient acknowledges received data

- ACK frame length is 32 bits
- Preamble length is 16 bits.
- Short ACK gap is 8 µs.

Calculate the throughput of the link.



Average time to transmit the every payload without ACK:

Average time to transmit the every payload:

Throughput = payload size / average time to transmit =

Comparison of Switching Types

Circuit switching

- *Connect.Request* and *Connect.Confirmation* messages do reservation of a communication channel
- the channel has fixed bandwidth
- only the connection has access to the channel & can use it with full speed

Message switching

- entire message is stored and next forwarded by every switch

Packet switching

- the message is split into small packets
- the packets are stored and next forwarded by every switch in a pipeline

Exercise 4

There are 9 switches between 2 hosts A and B.
There are 10 links of the same bandwidth, i.e. 100 Mb/s.
Host A sends a message to host B. The message size is 1kB.
Assume that the only delays are:

- transmission with the full link speed
- buffering by switches, i.e. data are retransmitted immediately after successful reception (aka. store-and-forward technique)

Calculate transmission time (from the first bit sent to the last bit received).

Consider 3 network types:

A. Message switching network
B. Packet switching network. Assume that maximum packet size is 128 bytes.
C. Circuit switching network. Assume that :
   - the size of *Connect.Request* and *Connect.Confirmation* messages is 64 bytes,
   - each switch needs 10 μs to process *Connect.Req* and 1 μs to process *Connect.Conf,*
   - average data delay per switch during a connection is 1,5 bit (no clock synchronization between input and output).

Solution to exercise 4

Solution to 4A

1 kB message 1024 x 8 bits ≃ 8 192 bits

Transmission time of the message with 100 Mb/s is: 8 192 bits / 100 Mb/s = 81,92 μs

Buffering time is = transmission time in the previous link

Transmission time over 10 links: 819,2 μs

Solution to 4B

Number of packets:

Transmission time of a packet with 100 Mb/s is:

Arrival time of the 1st packet to the 10th link (9 hops):

Transmission time of all packets over the last link:

Transmission time of the message:

Solution to 4C

Transmission time of the message with 100 Mb/s is:

Its average delay over 9 switches is:

Connection.Ack transmission over 10 links:

Connection.Ack delay over 9 switches:

Connection.Req transmission over 10 links:

Connection.Req delay over 9 switches:

Overall transmission time of the message:

Exercise 5

Do the same calculations as for the 4th exercise. The only different argument is:

- message size of 100 bytes.

Consider 3 network types as previously:

A. Message switching network
B. Packet switching network
C. Circuit switching network

Exercise 6

Do the same calculations as for the 4th exercise. The only different argument is:

- message size of 10 kB.

Consider 3 network types as previously:

D. Message switching network
E. Packet switching network
F. Circuit switching network

Exercise 7

Give conclusions from the obtained results.

- In which conditions a message switching network is as efficient as a packet switching one?
- In which conditions a message switching network is less efficient than a packet switching one?
- In which conditions a circuit switching network is less efficient than a packet switching one?
- In which conditions a circuit switching network is more efficient than a packet switching one?