ComputerNetworks

Homework 1

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1. What is the difference between Ethernet and the Internet? What are the differences between the main use cases?

Solution:

Internet

The internet is a global interconnected network comprising thousands of networks. It wasn't always this expansive, though. When the internet's predecessor, ARPANET, was created in the 1960s, only computers on the same network could communicate with each other through packet switching

Internet use cases

Use cases for the internet include the following:

- sending and receiving emails and instant messages;
- transferring files between devices;
- browsing the web; and
- providing infrastructure support for loT

What is Ethernet

Ethernet is a technology that connects devices together in a LAN. A physical Ethernet cable connects the devices and facilitates communication between them. Data travels between the wires, and protocols enable the devices to talk to each other.

Ethernet use cases

Use cases for Ethernet include the following:

- connecting devices together in a LAN;
- providing internet access for devices;
- ensuring reliable, fast and secure connectivity; and
- Power over Ethernet(PoE) support for loT devices.

Ethernet	Internet
Ethernet is a system where the computers are connected within a primary physical space.	Internet is a system of interconnected computer networks which use the TCP/IP protocol to link devices worldwide.
An example of Ethernet is LAN (Local Area Network).	An example of the Internet is WAN (Wide Area Network).
Ethernet is more secure because outside devices have no access to the network.	Internet is less secure as anyone can access the network and gain information.
Uses broadcast network to implement communications.	Internet uses point to point network to implement communications.
It allows only one communication at a time.	It allows multiple communications taking place concurrently along its different paths.

2. What is the difference between a WAN and a LAN (local area network)?

Solution:

A. LANs are simple networks that are used to connect computers and devices within a small area like an office, a building, or a campus. A Wide Area Network (WAN) is a much larger network than a LAN or a MAN.

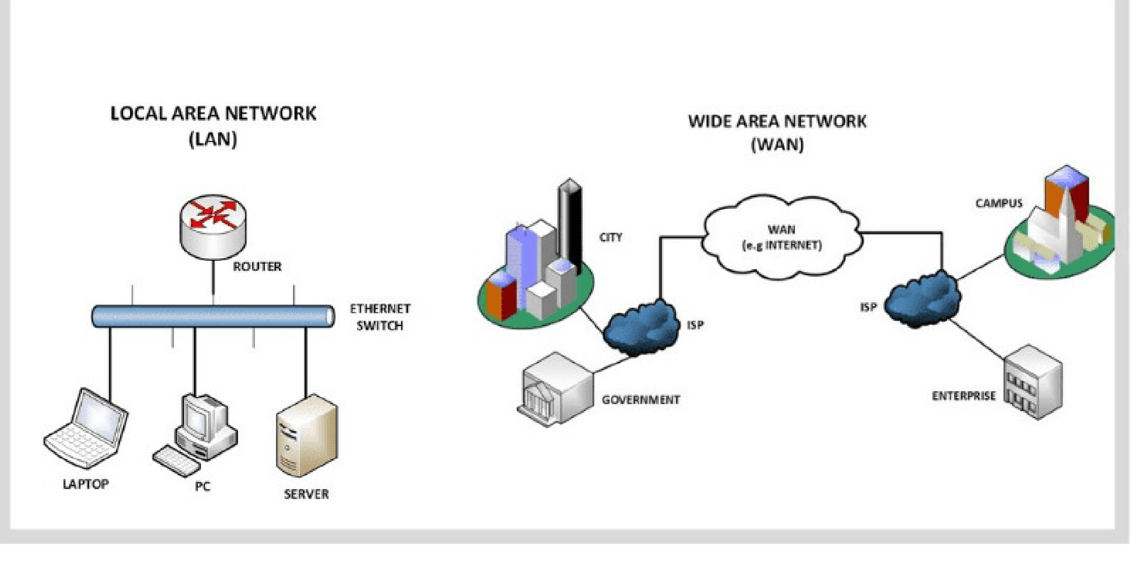
A LAN, abbreviated from Local Area Network, is a network that covers a small geographical area such as homes, offices, and groups of buildings.

Whereas a WAN, abbreviated from is a network that covers larger geographical areas that can span the globe.

An example of a widely used WAN is the Internet, which is a collection of tens of thousands of networks that connects tens of billions of devices.

Local Area Networks predominantly use Ethernet technology, which is a group of networking technologies that dictates how data is transmitted over the physical media, with the most common media being CAT# cabling.

Local Area Networks can use both Layer 1 and Layer 2 devices; Layer 1 devices include HUB's and repeaters and the Layer 2 devices that can be used are switches and bridge devices. While LAN's use Layer 1 and Layer 2 devices, WAN's operate using Layer 3 devices such as multi-layer switches and routers.



LANs operate over a much smaller geographical area than WANs

3. What is the difference between FDM and TDM?

Solution:

TDM is a technique of transmitting and receiving separate signals across a shared signal path using synchronized switches at either end of the transmission line, with each signal appearing on the line for a fraction of a second in an alternating pattern.

FDM is a telecommunications method that divides the overall bandwidth available in a communication channel into a number of non-overlapping frequency bands, each of which carries a distinct signal.

TDM :

1. TDM stands for Time Division Multiplexing
2. TDM works well with both analog as well as digital signals.
3. TDM has low conflict
4. Wiring or Chip of TDM is simpler.
5. TDM is efficient
6. Time is shared in TDM.
7. Synchronization pulse is mandatory in TDM

FDM :

1. FDM stands for Frequency Division Multiplexing.
2. FDM works only with analog signal.
3. FDM has high conflict
4. Wiring or Chip of FDM is complex.
5. FDM is quite inefficient.
6. Frequency is shared in FDM.
7. Synchronization pulse is not mandatory.

4. The transmission distance between the two ends of the transceiver is 1000 km, and the signal propagation speed on the media is 2×10^8 m/s. **Try calculating the send delay and propagation delay in the following two cases** (There is no need to consider about nodal processing and queueing time) :

(1) The data length is 10^7 bits, and the data transmission rate is 100kb/s.
(2) The data length is 10^3 bits, and the data transmission rate is 1Gb/s.

What conclusions can be drawn from the above calculations (For example: What is the main component in the total delay if the data length is short and the send rate is high)?

Solution:

(1)

The data length is 10^7 bits, and the data transmission rate is 100kb/s.

D_{trans}: transmission delay:

L: packet length (bits)
R: link bandwidth (bps)

$d_{trans} = L/R$

$= 10^7 \text{ bits } / 100\text{kb/s}$

We know, 1kb =1000 bits

$= 10000000/100000$ bits   seconds

$= 100$ seconds

(2)

The data length is 10^3 bits, and the data transmission rate is 1Gb/s.

$d_{trans} = L/R$

$= 10^3 \text{ bits } / 1\text{Gb/s}$

We know, 1Gb $=10^9$ bits

$= 10^3 / 10^9$ bits   seconds

$= 1000 / 10^9$ bits   seconds

$= 0.000001$ seconds

$= 10^{-6}$ seconds

$= 1\ \mu s$

Reference : https://youtu.be/GxC7llQRovo

d_{prop}: propagation delay:

(1)

The data length is 10^7 bits, and the data transmission rate is 100kb/s.

d: length of physical link
s: propagation speed ($\sim 2\text{x}10^8$ m/sec)

$d_{prop} = d/s$

$= 1000 \text{ km} / 2x10^8 \text{ m/sec}$

$= 1000*10^3 \text{ m} / 2x10^8 \text{ m} \quad \text{seconds}$

$= 500*10^{-5}$ seconds

(2)

The data length is 10^3 bits, and the data transmission rate is 1Gb/s.

$d_{prop} = d/s$

$= 1000 \text{ km} / 2x10^8 \text{ m/sec}$

$= 1000*10^3 \text{ m} / 2x10^8 \text{ m} \quad \text{seconds}$

$= 500*10^{-5}$ seconds

$= 500*10^{-2}$ milisec(msec)

$= 500\mu s$(microsecond)

Conclusion:

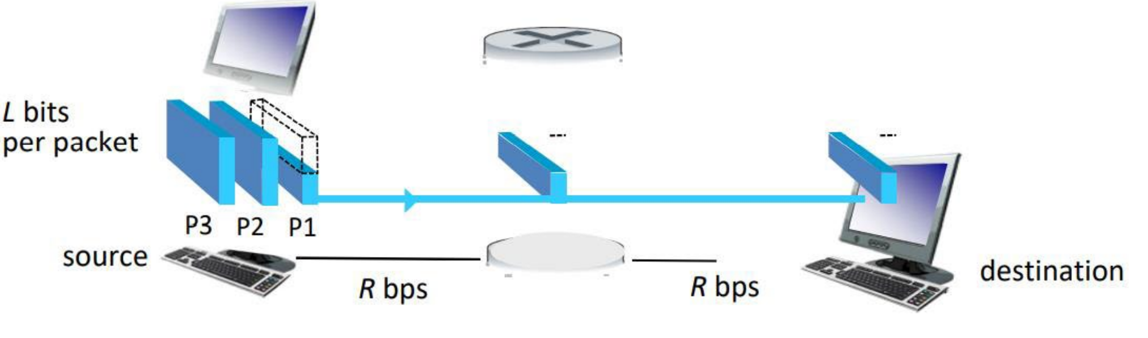
In packet switched networks, there are four types of commonly identified delays – **processing, queuing, transmission and propagation delays**.

This delay is proportional to the packet's length in bits, It is given by the following formula: seconds. Most packet switched networks use store-and-forward transmission at the input of the link.

The delay can be due to various factors like **number of active packets, transmission capacity** etc.. The delay can be calculated by dividing the "total number of bits(packet length)" to the transmission rate(number of bits per second).

If the data length is short and the send rate is high then packet loss could happen.

5. Scenario 3: Store and forward technique with 4 packets. **What is the end-end delay?**



Solution:

Store and forward: Entire packet must arrive at router before it can be transmitted on next link .

End-end delay = 2L/R (assume zero prop-delay)

A more general case with N links for 1pkt

By store and forwarding technique

End – end delay = N × L / R (sec)

End-end delay per packet: 2L/R seconds

Note: Source is **A**, Destination is **B** and circular object is middle is router.

L/R seconds: Router has received 1st packet and started sending to B

2L/R seconds: 1st packet receive at (B) and 2nd packet receive at router

3L/R seconds: 2nd packet receive at (B) and 3rd packet receive at router

4L/R seconds: 3rd packet receive at (B) and 4th packet receive at router

5L/R seconds: 4th packet receive at (B)

Reference: https://youtu.be/k8rJFgeuZRw

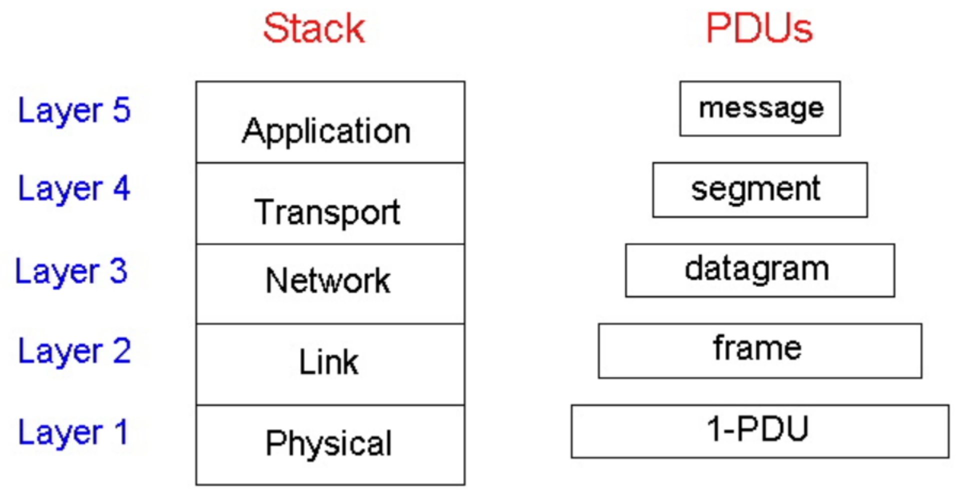
6. Please **draw the protocol stacks of Internet**, and **describes the principle of each part**. Then use graphical descriptions to describe **the process of adding control information** as a message pass through the layered model.

Solution:

Protocol stacks of Internet

- **Application:** supporting network applications. Such as: FTP, SMTP, HTTP
- **Transport:** process-process data transfer. Such as: TCP, UDP
- **Network:** routing of datagrams from source to destination. Such as: IP, routing protocols
- **Link:** data transfer between neighboring network elements. Such as: Ethernet, 802.111 (Wi-Fi), PPP
- **Physical:** bits "on the wire"

The protocol stack and protocol data units



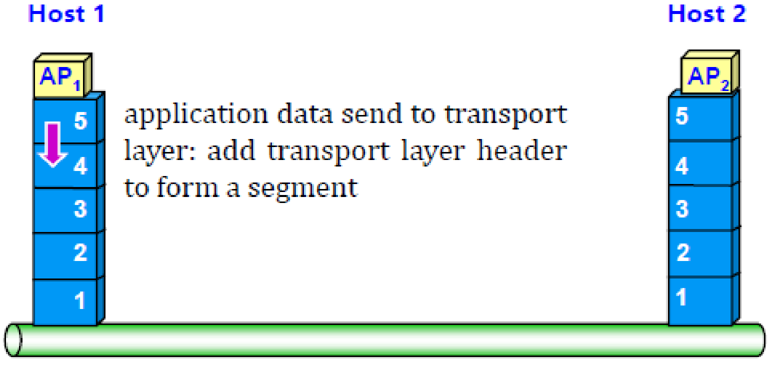


Fig : Step1

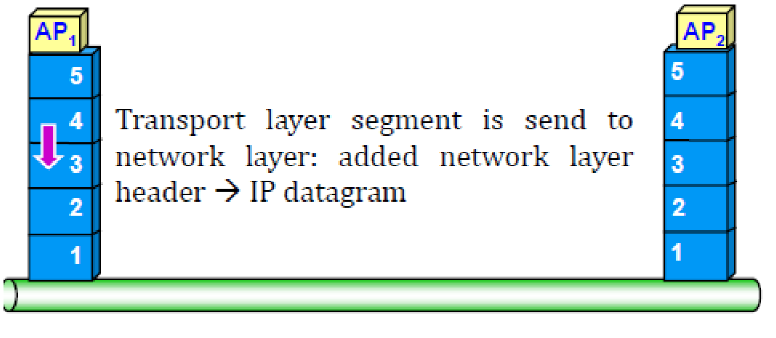


Fig : Step2

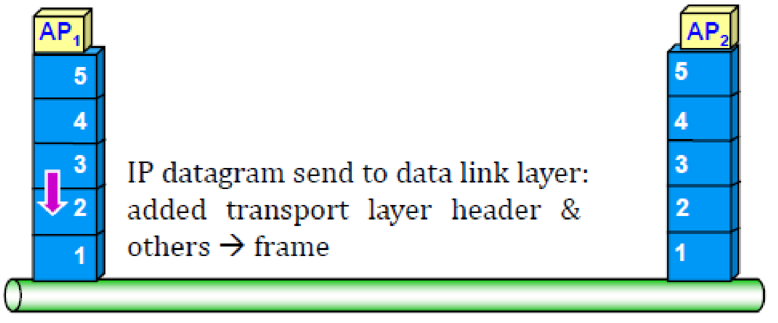


Fig : Step3

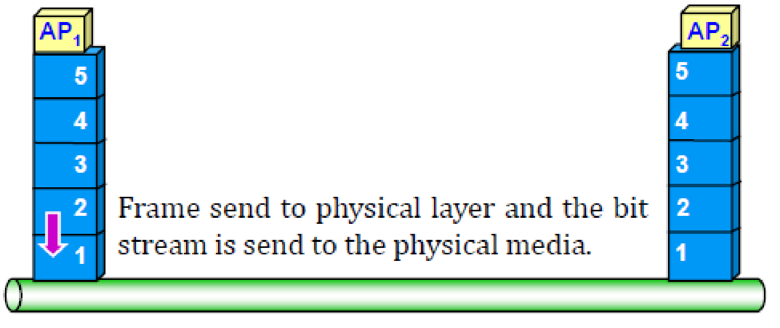
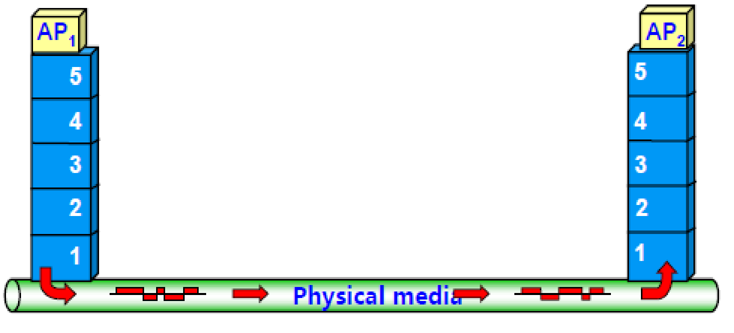


Fig : Step4



- Electrical signals (or optical signals) propagate in physical media
- From the physical layer of the sender to the physical layer of the receiver

Fig : Step5

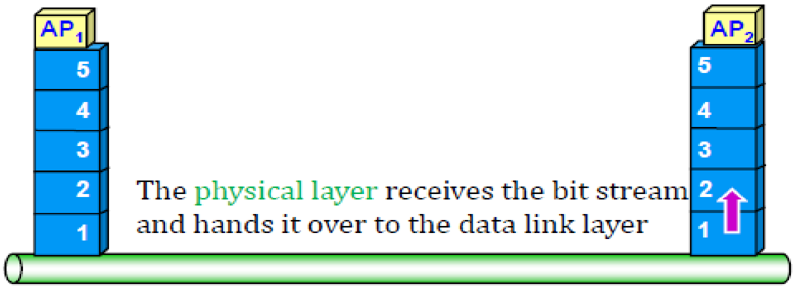


Fig : Step6

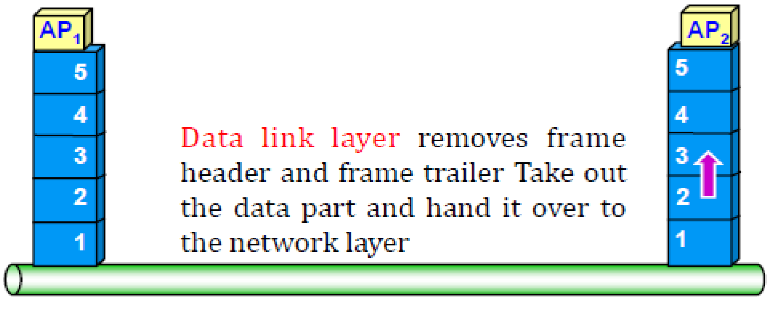


Fig : Step7

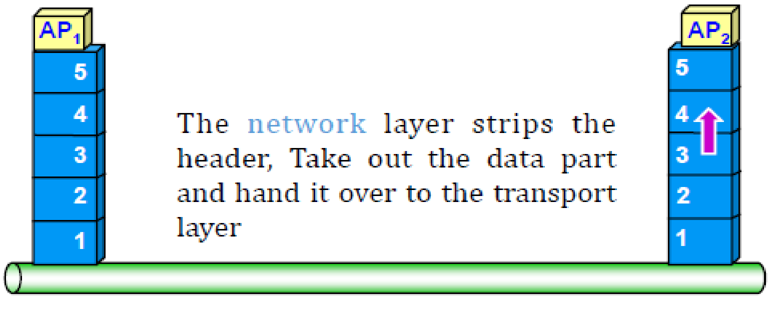


Fig : Step8

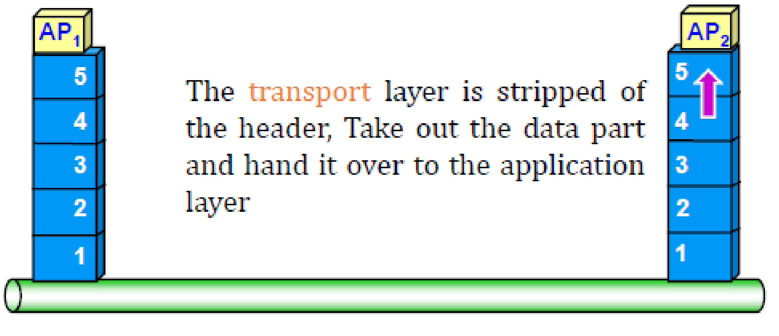


Fig : Step9

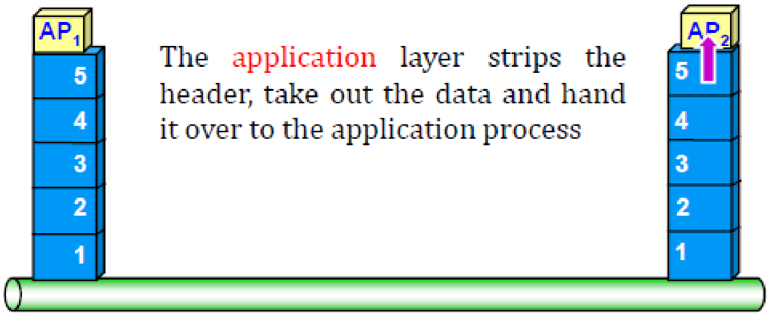


Fig : Step10

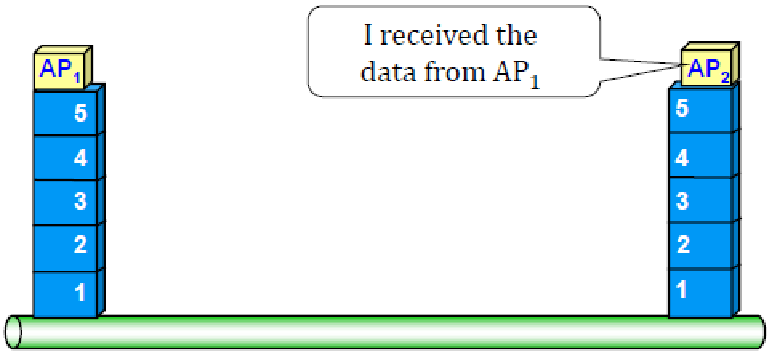
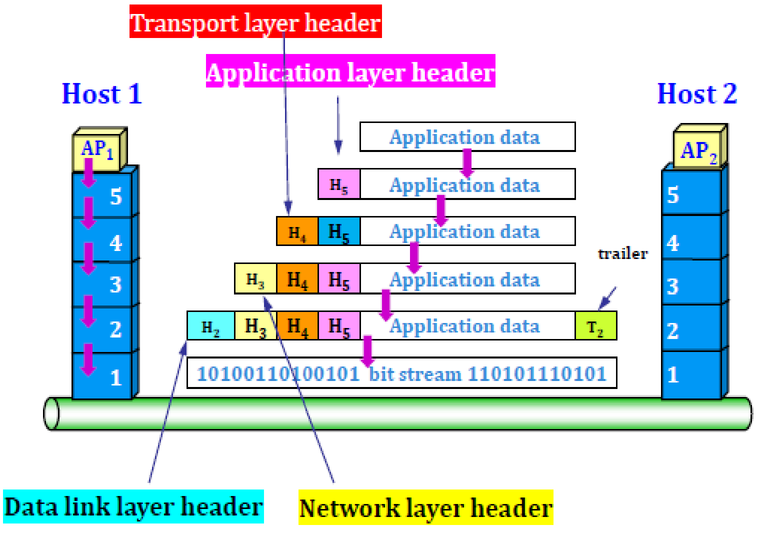
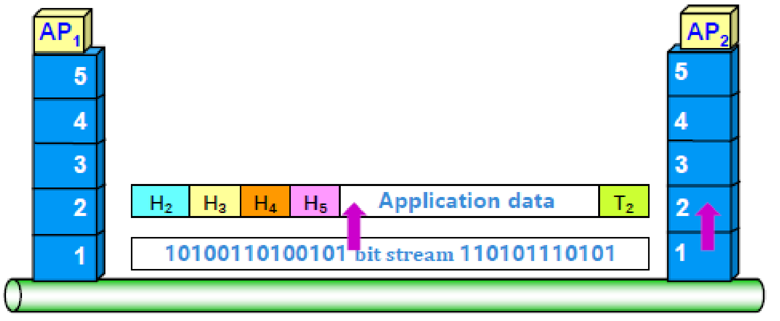


Fig : Step11

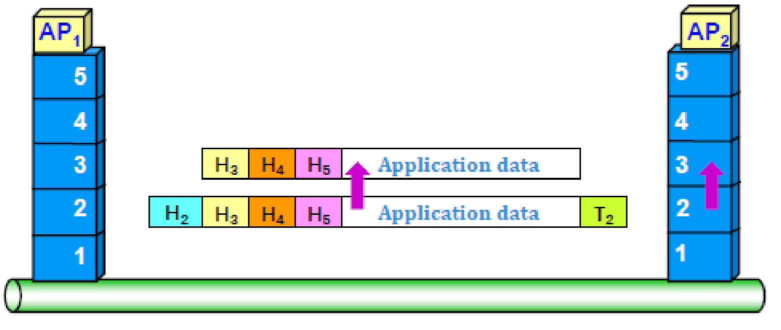
Full Description



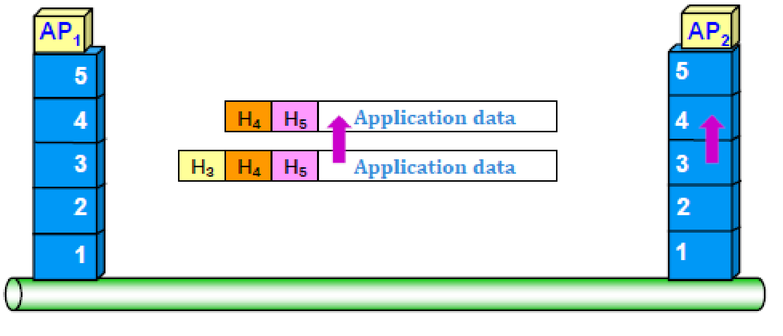


- 1. The physical layer receives the bit stream and hands it over to the data link layer

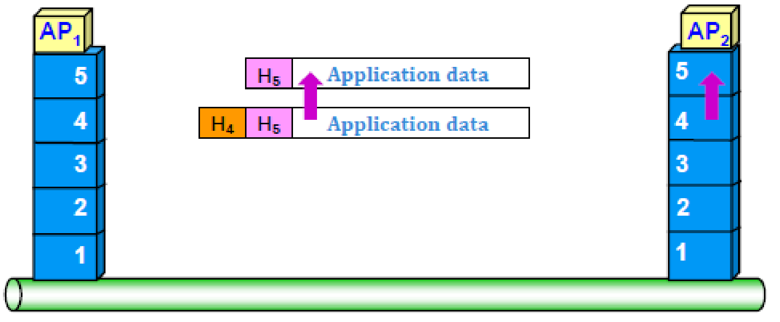
- 2， Data link layer
  - removes frame header & trailer,
  - take out the data part
  - hand it over to the network layer



- 3， The network layer
  - strips the header,
  - take out the data part
  - hand it over to the transport layer



- 4， The transport layer
  - removes the header,
  - take out the data part
  - hand it over to the application layer



- 5， The application layer
  - strips the header
  - take out the data
  - hand it over to the application process