The OSI reference model

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Before OSI

Communications using proprietary protocols ties users to particular vendor products

Communications between networks difficult requiring expensive gateways

Communications were expensive but computers were more expensive

- No common framework
- Vendor-specific solutions
- Communications between different networks required complex gateways

7-Layer Stack

Applications Programs

L7 Applications Layer
L6 Presentation Layer
L5 Session Layer
L4 Transport Layer
L3 Network Layer
L2 Link Layer
L1 Physical Layer

Cabling

The OSI reference model introduced the notion of a "***protocol layer***".

Layers group related ***functions***.

Each layer provides a ***service*** to the layers above.

The service (moving data) is providing using layer below

After OSI

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The OSI reference model introduced the notion of a "***protocol layer***".

Layers group related ***functions***.

Each layer provides a ***service*** to the layers above.

The service (moving data) is providing using the layer below

L1-3

3 Network Layer
- Network routing
- Network Addressing
- Fragmentation & Reassembly

2 (Data) Link Layer
- Data framing
- Link (LAN) Addressing
- Management
- Error control

1 Physical Layer
- Mechanical interface
- Signaling and interface control
- Electrical interface

Network Communication functions

L4-7

7 Application Layer
- Application services
- Reliability
- Library functions

6 Presentation Layer
- Data-oriented communication tasks
- Transfer syntax
- Data transformation

5 Session Layer
- Application-oriented communication
- Dialogue and synchronisation control

Application functions

Middleware

4 Transport Layer
- End-to-end communication
- Connection management, segmentation
- Resequencing (ordering out-of-sequence Packets)
- Error control (retransmission of missing Packets)
- Flow control (setting the correct rate for the receiver)
- Congestion Control (setting the correct rate for the network layer)

BENEFITS OF OSI

Reduced complexity

Breaks network communications into smaller, simpler parts.

Standardizing interfaces

This allows multiple vendor development and support.

Facilitates modular engineering

Allows different types of hardware and software to talk to each other (interoperability).

Accelerating Evolution

Update of individual components without affecting other components

After OSI

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A small number of "standard" protocols → Better protocols More suppliers

Internet Protocol (IP)

Well-understood interfaces → May interchange products

Communications between networks simplified using wide range of routers → Shared cost of internets

ES & IS

Two types of systems

- Intermediate Systems
  - Network service moves IP packets around
- End Systems
  - Implement middleware (software libraries)
  - Transport Layer that controls end-to-end communication

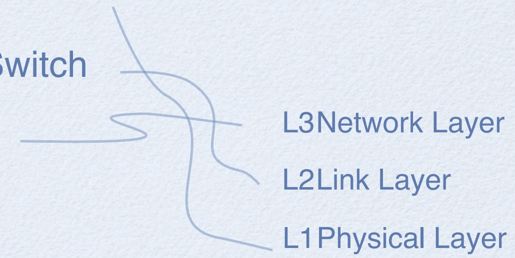
Intermediate Systems

Intermediate Systems implement only lower layers

Layer 1: Repeater/Hub

Layer2: Bridge/Switch

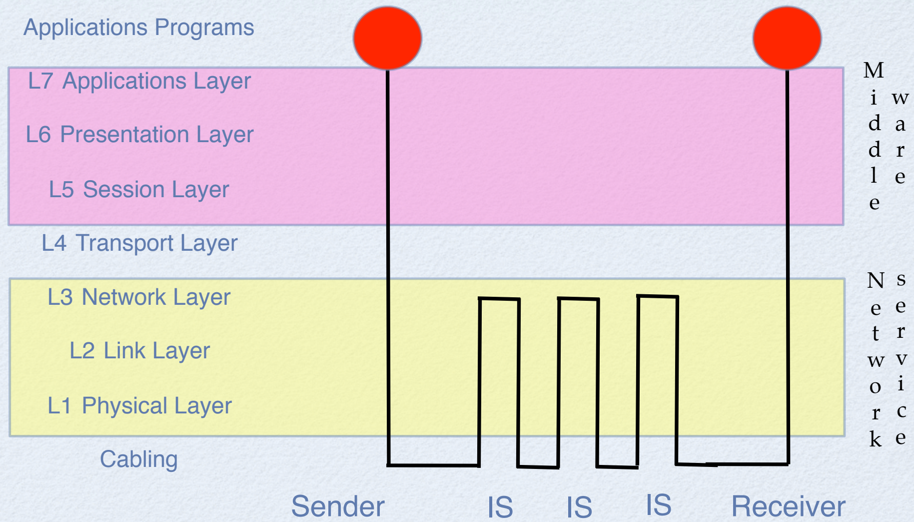
Layer 3: Router



Protocol Exchanges

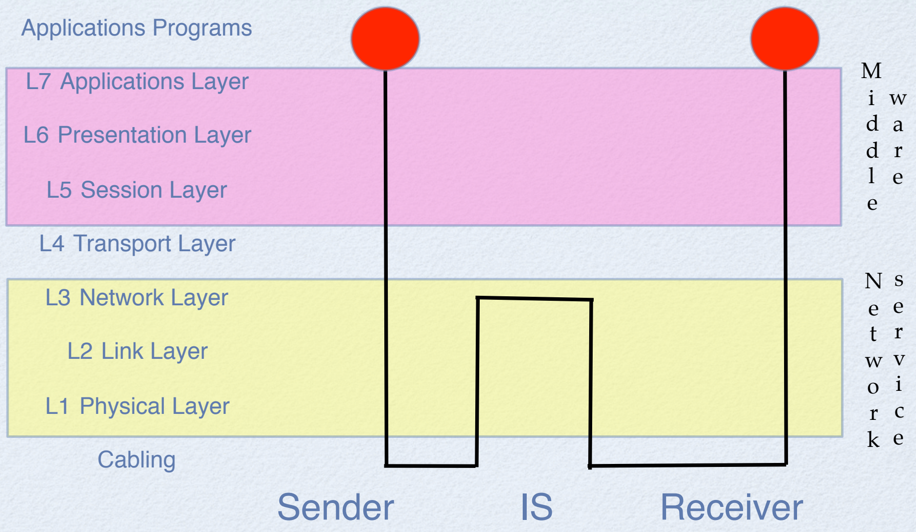
- Intermediate Systems (L1-L3)
  - Work hop by hop with their neighbour
- End Systems (L4-L7)
  - Work end-to-end with their peer

Hop-by-Hop



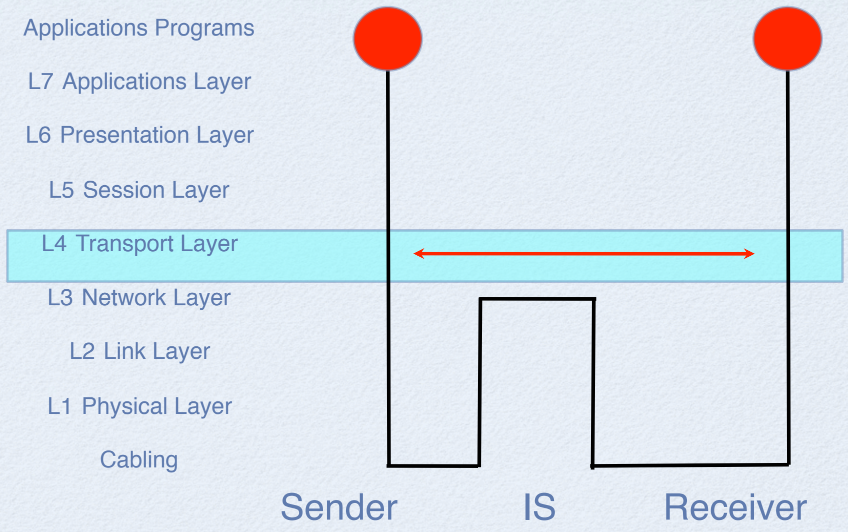
Network layer works ho-by-hop between ES

End-to-End



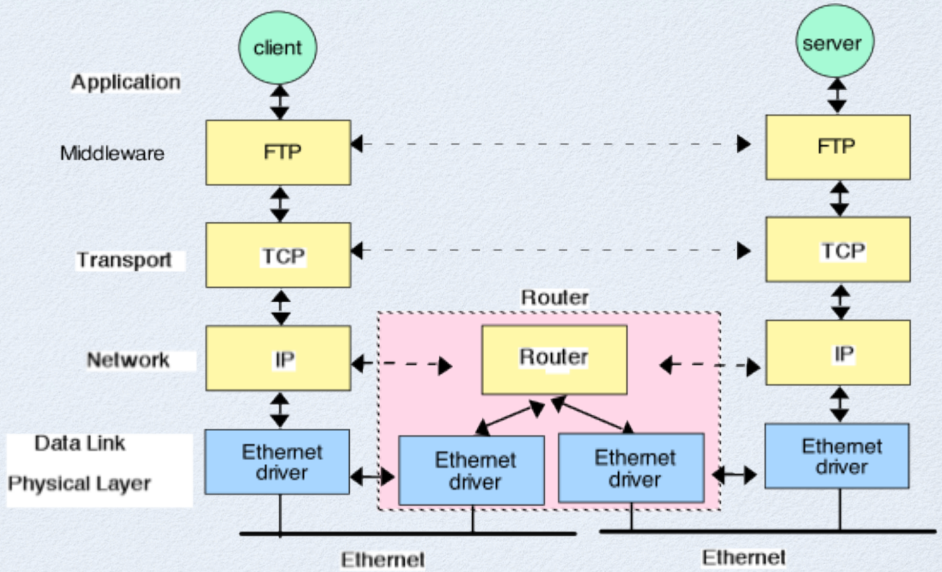
Transport layer provides an end-to-end service between ES

Peer-to-Peer

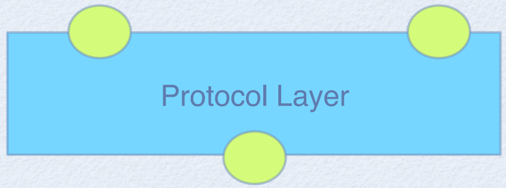


Communication appears to be "***peer-to-peer***"

FTP across a Network

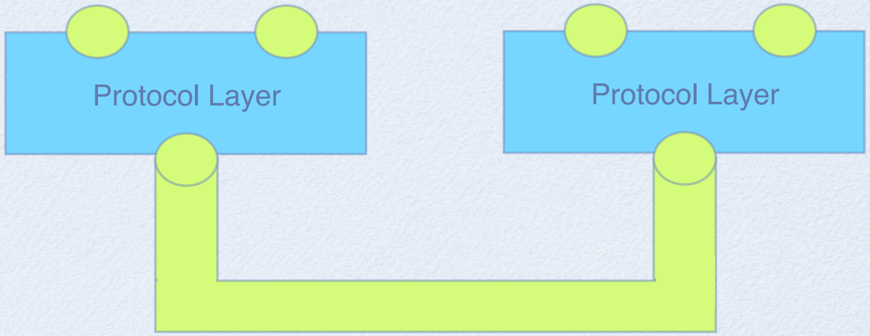


Service Access Points



Each entity (instance of a protocol) sends and receives data via the ***Service Access Points SAPs*** using ***service primitives***

The Service



The communication service
resembles a "pipe" along which PDU's flow

Subnetwork *OSI Layers 1-3*

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Layer	Rôle
3Network Layer	Network routing, call establishment and clearing, addressing, individual call management.
2(Data) Link Layer	Data framing, data transparency, error control, management, link establishment and clearing.
1Physical Layer	Mechanical interface, electrical interface, signalling and interface control.

PDU Encapsulation

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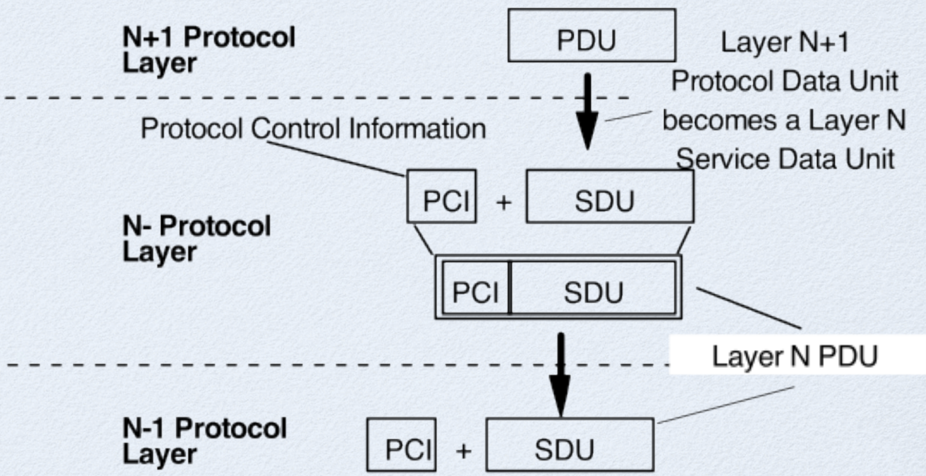

End System Software *OSI Layers 4-7*

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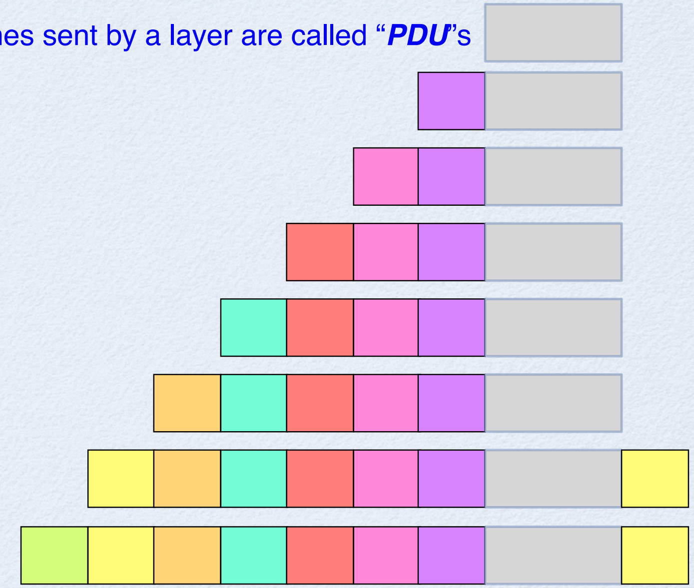
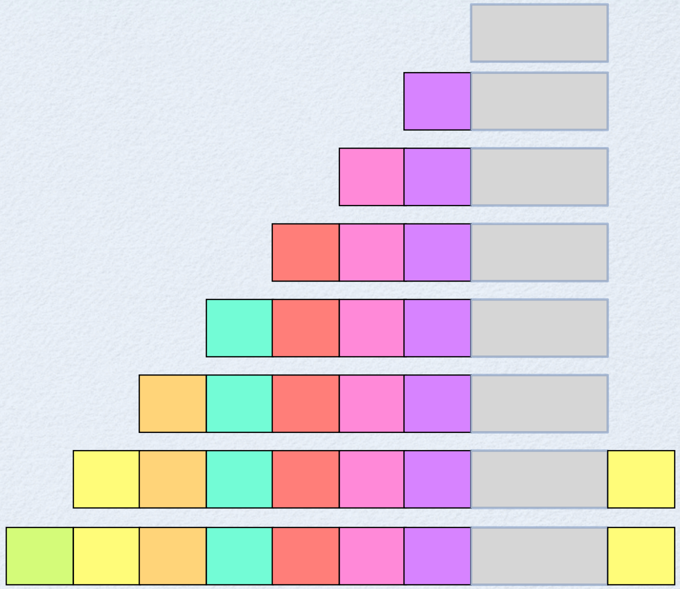
Layer	Rôle
7Application Layer	Application services: Reliability, library functions.
6Presentation Layer	Data-oriented communication tasks: Transfer syntax , data transformation.
5Session Layer	Application-oriented communication : Dialogue and synchronisation control.
4Transport Layer	End-to-end communication: Connection management, segmentation, resequencing, error control, flow control .

PDU Encapsulation

The packets / frames sent by a layer are called “***PDU***’s



PDU Decapsulation



OSI Layer Services

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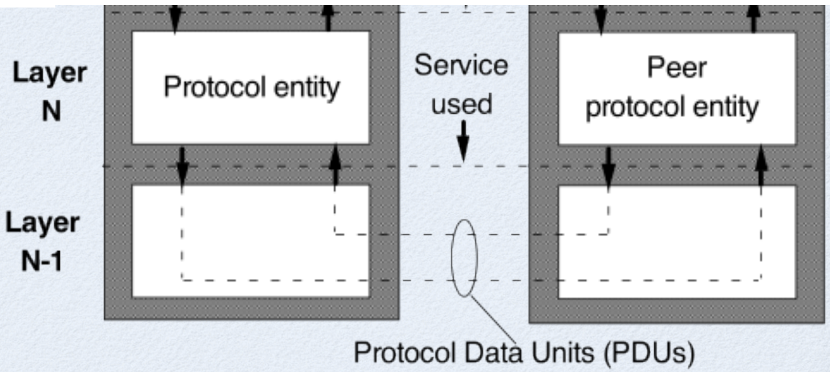
OSI introduced the notion of a “**protocol layer**” providing a “**service**”
Each ***layer*** provides a ***service*** to the ***layers*** above.
The ***service*** (moving data) is providing using the ***layer*** below



The packets / frames sent by a lower-layer “***service***”.

OSI Layer Services

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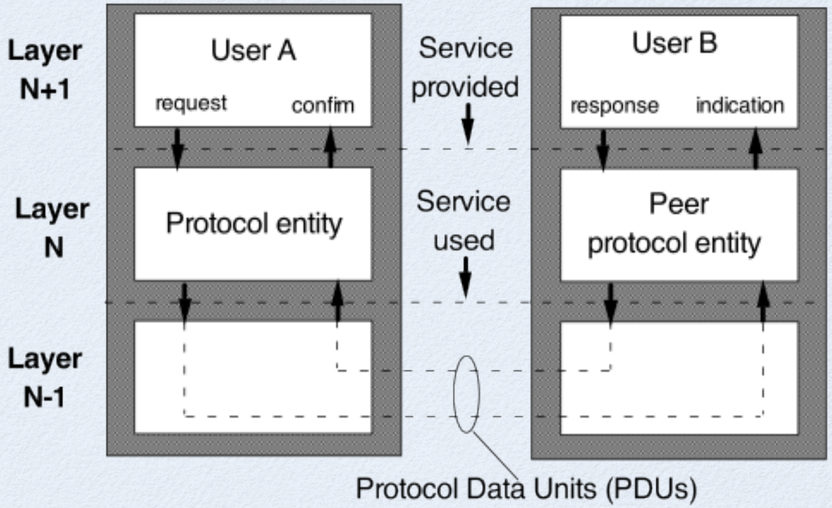

Fragmentation

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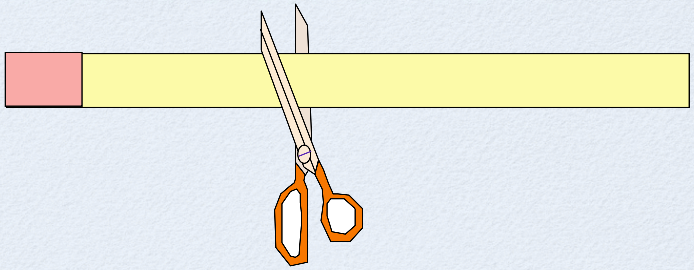


IP Specifies a maximum packet size of 64 KB

Some links support only 1500 B (Ethernet)

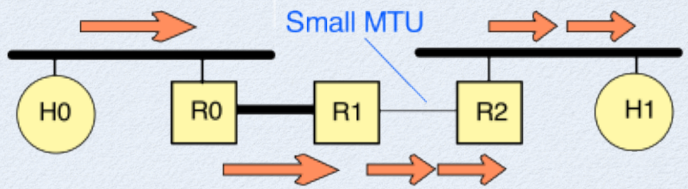
Some (e.g. Core Internet links support 16 KB) - but not all

Fragmentation needed when PDU would be too large for service of layer below

L2 Maximum Transmission Unit

Ethernet (L2) specifies a MTU of 1500 B

Packets ≤ 1500 B sent without fragmentation

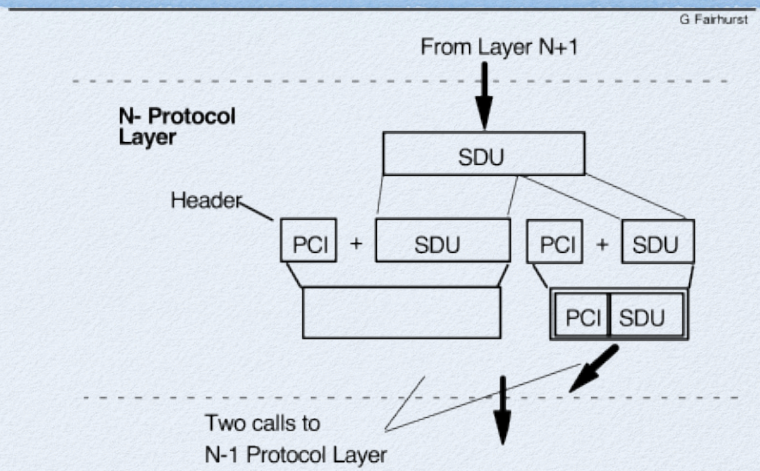


IP packets (L3 PDUs) >> Ethernet Frames (L2 SDUs)

Could discard over-sized PDUs (as an error)

Could fragment big packets into smaller frames

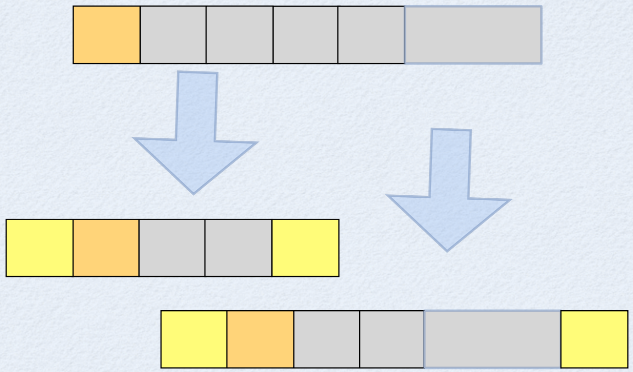
Fragmentation



SDU split into two or more fragments
Each sent separately

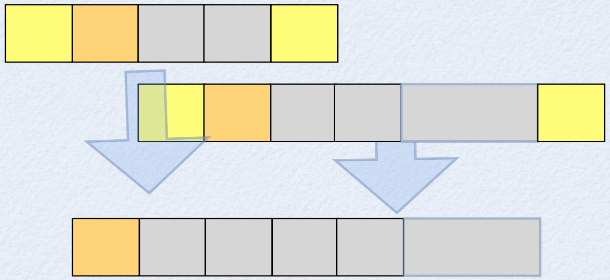
Fragmentation

Fragmentation adds PCI of the Layer to identify the fragments
Each sent as a separate PDU



Reassembly

Reassembly is the inverse function of fragmentation
Separate series of PDUs received
Requires the PCI of the Layer to identify the fragments
Reassembly occurs within same layer as fragmentation



Requires the receiver to queue/buffer fragments

Service Primitives

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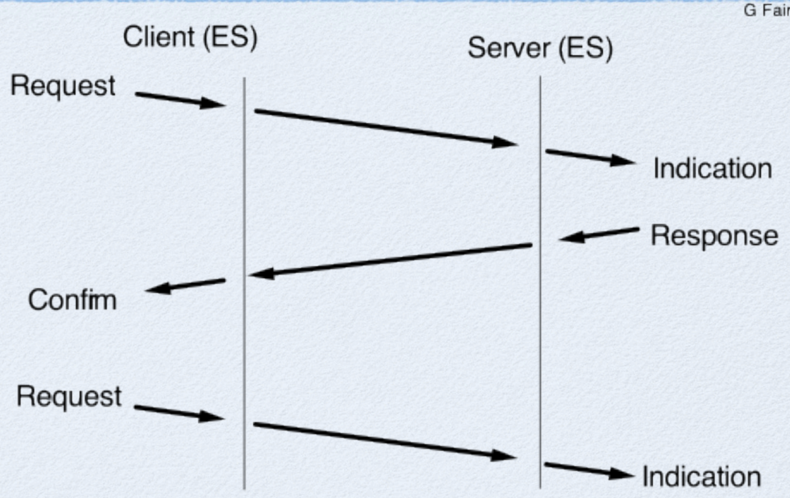

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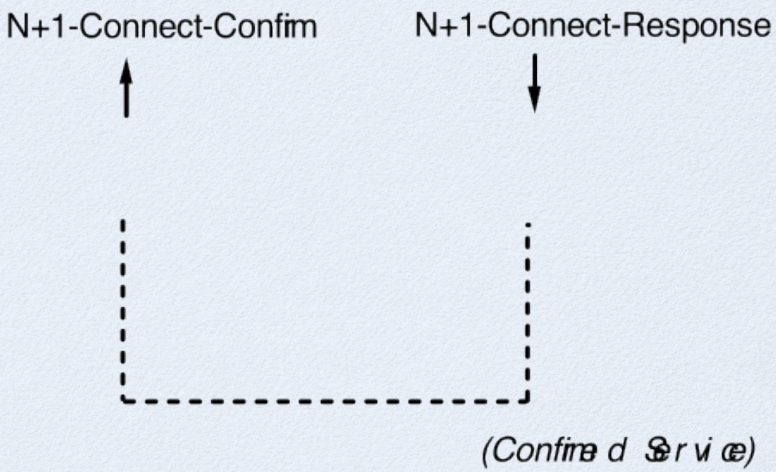
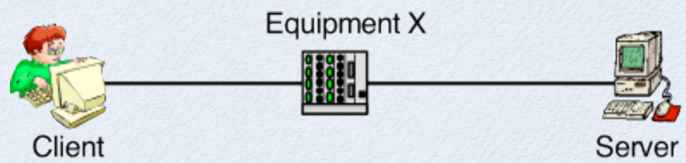


Example



1) Assume the equipment X is a 100 Mbps ***Ethernet hub.***

   (a) Using the OSI reference model, sketch the protocol stack

   (b) Sketch the Ethernet MAC frame header received by the server

2) Repeat above for equipment X being an ***Ethernet switch***.

3) Repeat above for equipment X being a ***network layer router***

HUB

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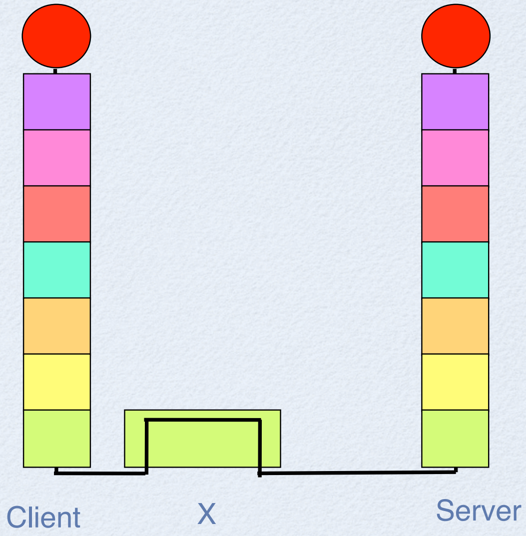
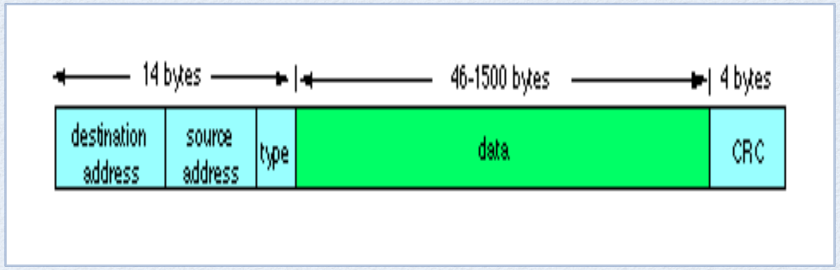


MAC FRAME HEADER



SWITCH

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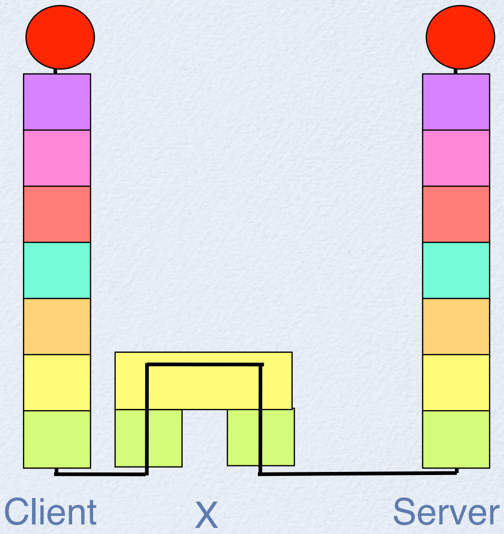
L1 Physical Layer
Cabling



ROUTER

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L3 Network Layer
L2 Link Layer
L1 Physical Layer
Cabling