Network Layers

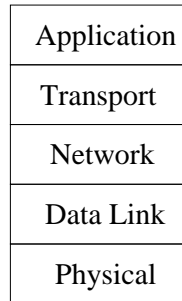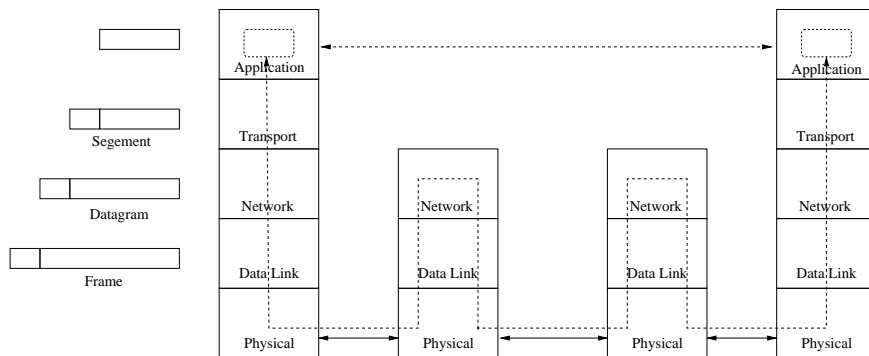| |
|---|
| Application |
| Transport |
| Network |
| Data Link |
| Physical |

Goal

- Understand how application processes set up a connection and exchange messages.
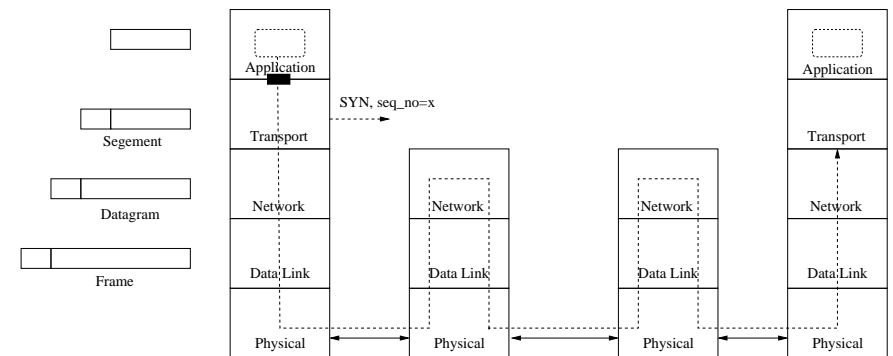
- Understand how addresses are determined

Data Exchange Between Application Processes

TCP Connection-Setup Between Application Processes

SYN, seq_no=x

TCP Connection-Setup Between Application Processes: Client

(1) **Application Layer:** Application process on client creates a socket, and specifies host IP address and the destination port number for the application process on the host.

(2) **Transport Layer:** Chooses source port number and initial sequence number, and creates connection-request segment to be sent to the TCP on the server.

(3) **Network Layer:** Creates datagram and consults routing table to find find IP-address of next interface.

(4) **Data Link Layer:** Looks-up LAN address of next interface and creates frame.

Control Information Exchange between Layers: Client

(1) Transport layer gets from application layer IP address of host and port number of process on the host.

(2) Network layer gets from transport layer IP address of host.

(3) Data link layer gets from network layer IP address of next interface.
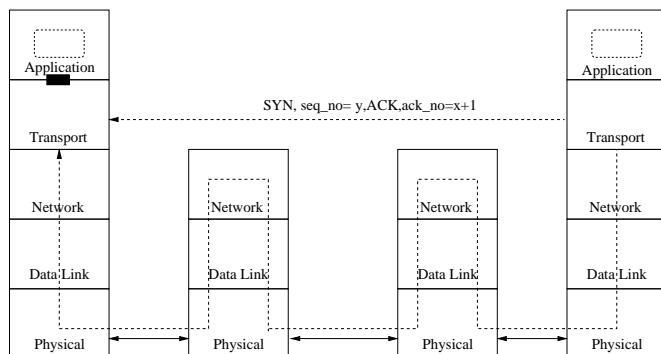
TCP Connection-Setup Between Application Processes
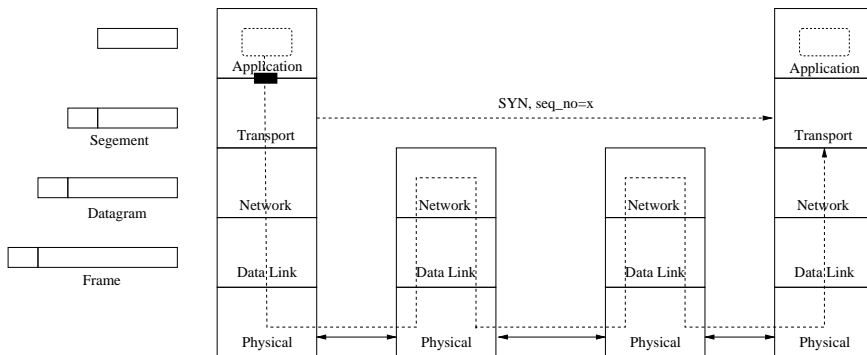
TCP Connection-Setup Between Application Processes: Server

(1) **Transport Layer:** Receives connection-request segment and allocates buffer space to connection.

TCP Connection-Setup Between Application Processes

Application

Transport

Network

Data Link

Physical

SYN, seq_no= y,ACK,ack_no=x+1

Application

Transport

Network

Data Link

Physical

Network

Data Link

Physical

Network

Data Link

Physical

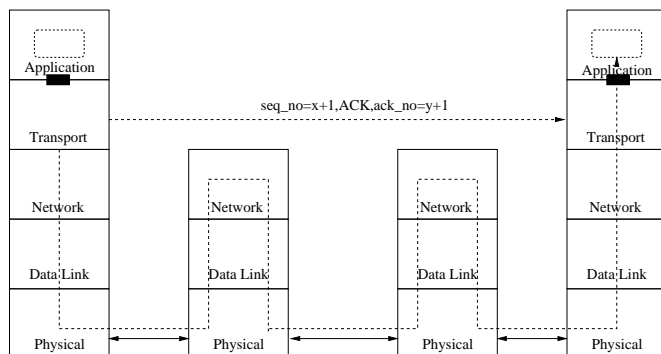**TCP Connection-Setup Between Application Processes (cont.)**

Server:

(1) **Transport Layer:** Chooses sequence number and sends connection-granted segment.

Client:

(1) **Transport Layer:** Allocates buffer space.

TCP Connection-Setup Between Application Processes

Application

Transport

Network

Data Link

Physical

seq_no=x+1,ACK,ack_no=y+1

Application

Transport

Network

Data Link

Physical

Network

Data Link

Physical

Network

Data Link

Physical

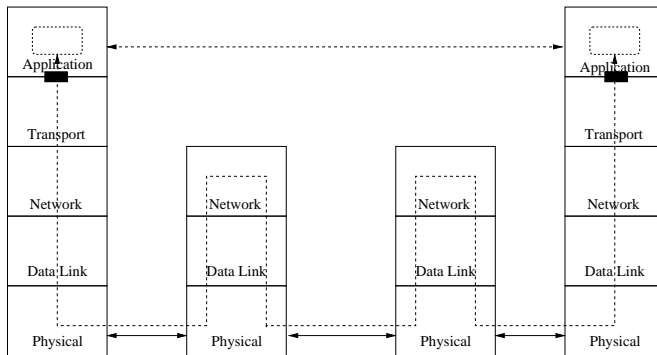**TCP Connection-Setup Between Application Processes (cont.)**

Client:

(1) **Transport Layer:** Sends connection-granted segment.

Server:

(1) **Transport Layer:** Passes connection-request to application layer.

(2) **Application Layer:** Creates socket.

Data Exchange Between Application Processes

Address Translation

- Applications (processes) know hostnames (cs.toronto.edu) - but need to know IP address to request a (TCP) connection.

- Data link layer receives a destination IP address from network layer - but needs to use LAN address.

Address Translation

- Applications layer uses DNS (domain name system) to translate hostnames to IP addresses

- Data link layer uses ARP (address resolution protocol) to translate IP addresses into LAN addresses.

- Note: DNS needs to provide address translation for whole Internet. ARP only needs to provide address translation for LAN.

DNS - Domain Name System

DNS is a

- distributed database implemented in a hierarchy of name servers.

- application layer protocol that allows hosts and name servers to communicate in order to provide the translation service.

DNS - Domain Name System

Local name server

- Each ISP (Internet Service Provider) - such as an university, a company, or a residential ISP - has a local name server. The IP address of the local name server is typically configured by hand (Control Panel - Network -TCP/IP - DNS).

Root name server

- When a local name server can not satisfy a query from a host, it queries itself a root name server (there are a dozen or so root name servers in the Internet).

Authoritative name server

- When a root name server can not satisfy a query from a local name server, it queries itself an authoritative name server for the hostname of the query. Every host is registered with an authoritative name server. Typically, the authoritative name server for a host is a name server in the host's local ISP.

DNS - Domain Name Service

Root Name Server

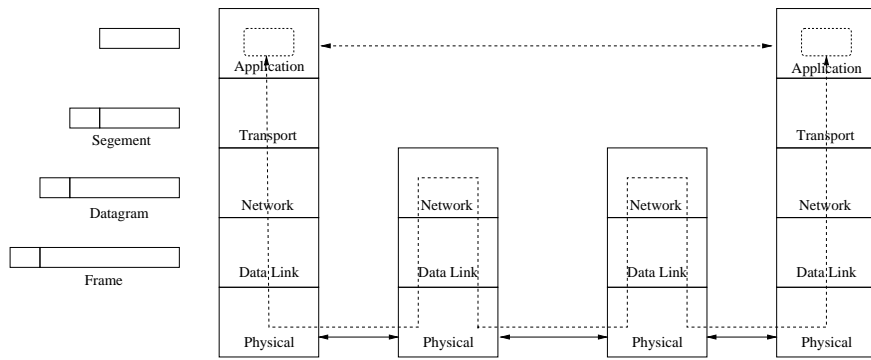Local Name Server

Authoritative Name Server

Host A

Host B
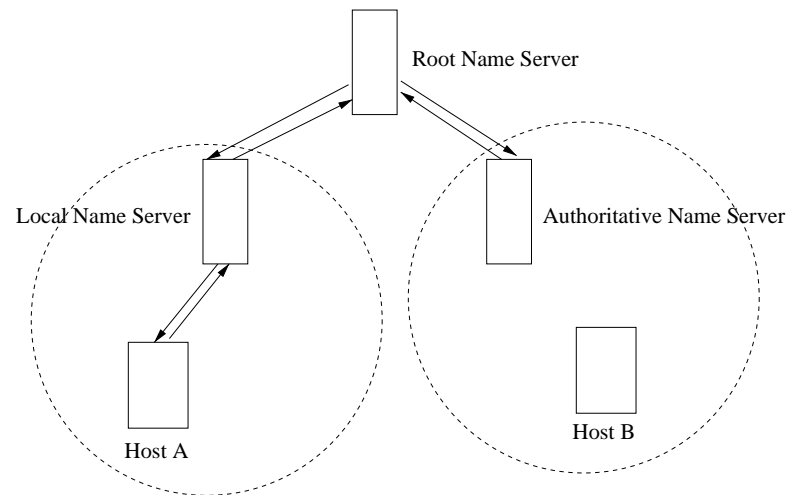
ARP - Address Resolution Protocol

- In each node, an ARP module keeps a table in its RAM called an ARP table, which contains the mapping of IP addresses to LAN addresses.

- When an ARP module can not map an IP address, then it broadcasts a request. The adapter with the requested IP addresses then replies and provides the address mapping.
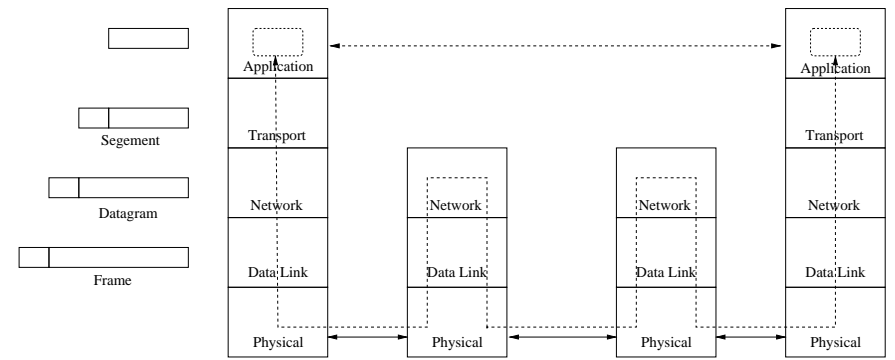
Data Exchange Between Application Processes

Segement

Datagram

Frame

Application
Transport
Network
Data Link
Physical

Network
Data Link
Physical

Network
Data Link
Physical

Application
Transport
Network
Data Link
Physical

Data Exchange Between Application Processes

Segement

Datagram

Frame

Application
Transport
Network
Data Link
Physical

Network
Data Link
Physical

Network
Data Link
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Application
Transport
Network
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