CSE2029: Data Communication & Computer Networks

Lecture-3: Introduction to networking cont'd…

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Outline

- Throughput in Computer Networks
- Protocol Layers and Their Service Models
  - Application Layer
  - Transport Layer
  - Network Layer
  - Link Layer
  - Physical Layer
- Encapsulation and De-encapsulation

Throughput in Computer Networks

- The **instantaneous throughput** at any instant of time is the rate (in bits/sec) at which a receiving system (Host) is receiving the data (file).

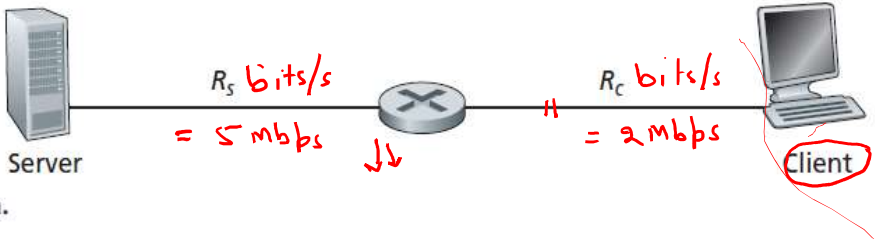
- If the file consists of F bits and the transfer takes T seconds for receiving system (Host) to receive all F bits, then the **average throughput** of the file transfer is F/T bits/sec.

- For some applications, such as Internet telephony, it is desirable to have a low delay and an instantaneous throughput consistently above some threshold (*for example, over 24 kbps for some Internet telephony applications and over 256 kbps for some real-time video applications*).

Throughput in Computer Networks

Bottleneck link: It is the slowest link on the way from source to the destination host.

Bottleneck Condition: A network bottleneck, is a condition that limits the data flow of your network. A network bandwidth bottleneck occurs when there are not enough resources to ensure prompt and reliable network data delivery.



a.

Q.1: Throughput?

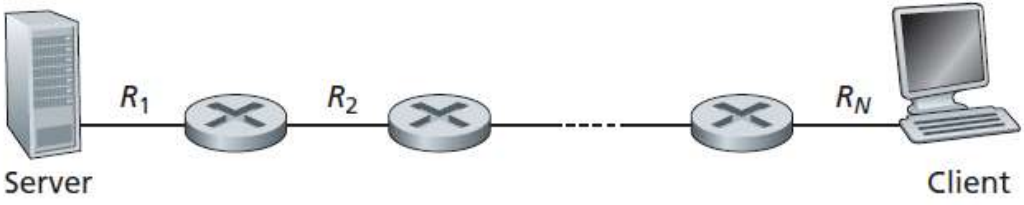
$= \min[R_s, R_c]$ bits/s

$= 2$ mbps

Q.2: Time taken to transfer a file (F bits) from server to client?

$= \frac{F}{\min[R_s, R_c]}$ seconds.

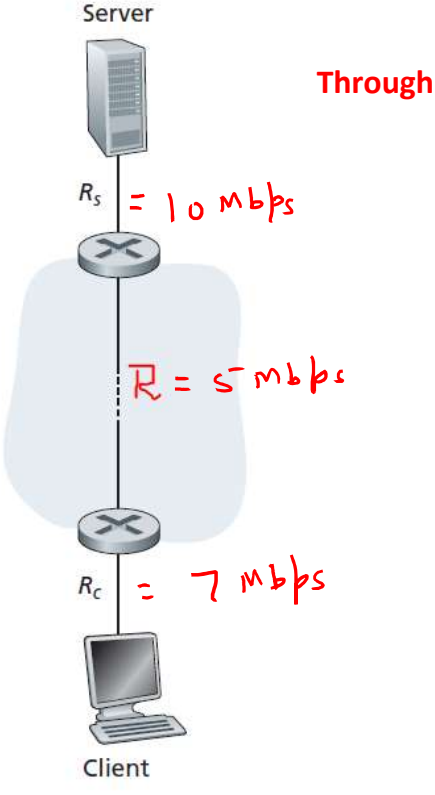
Throughput in Computer Networks



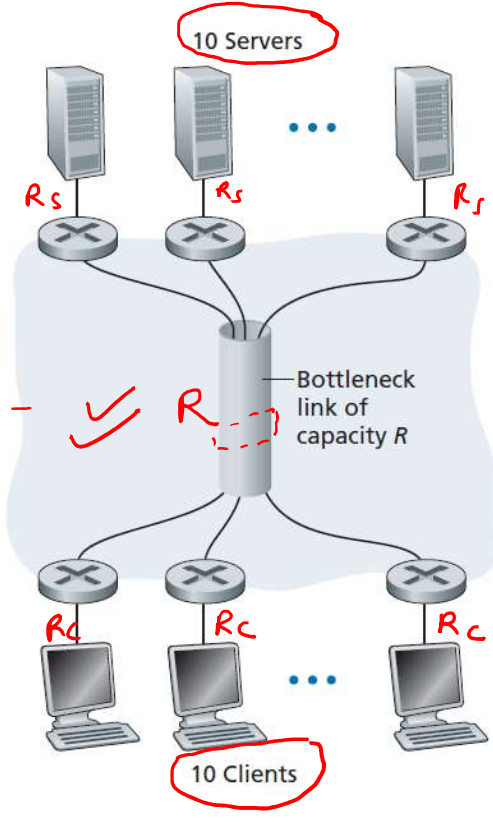
Q.1: Throughput? $= \text{Min}[R_1, R_2 \ldots, R_N]$ bits/s.

Q.2: Time taken to transfer a file (F bits) from server to client? $= \dfrac{F}{\text{Min}[R_1, R_2 \ldots R_N]}$ Seconds

Throughput in Computer Networks



Throughput? = 5 mbps

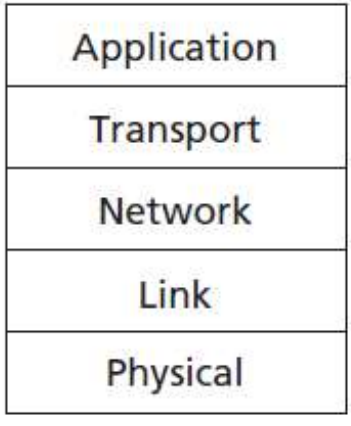


Throughput? = $\frac{R}{10}$ = 0.5 mbps

Protocol Layers and Their Service Models

Application Layer:

- The application layer is where network applications and their application-layer protocols reside.
- The Internet's application layer includes many protocols, such as the HTTP, SMTP, FTP and DNS etc.
- The packet of information at the application layer as a **message**.

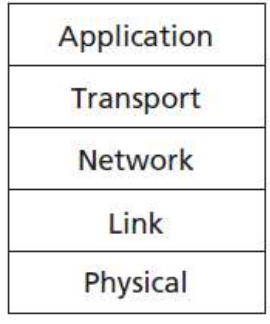


Five-layer Internet protocol stack

Protocol Layers and Their Service Models

Transport Layer:

- The Internet's transport layer transports application-layer messages between application endpoints.
- There are two transport protocols, TCP and UDP, either of which can transport application-layer messages.
- TCP provides a connection-oriented service to its applications. This service includes guaranteed delivery of application-layer messages to the destination and flow control (that is, sender/receiver speed matching). TCP also breaks long messages into shorter segments and provides a congestion-control mechanism, so that a source throttles (control) its transmission rate when the network is congested.
- The UDP protocol provides a connectionless service to its applications. This is a no-frills service that provides no reliability, no flow control, and no congestion control.
- The packet of information at the transport layer as a **segment**.

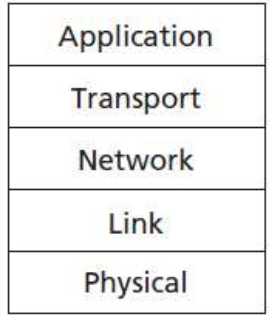


Five-layer Internet protocol stack

Protocol Layers and Their Service Models

Network Layer:

- The packet of information at the network layer as a **datagram**.
- The network layer is responsible for moving the datagrams from one host to another.
- The transport-layer protocol (TCP or UDP) in a source-host passes the transport-layer segment (with a destination address) to the network layer. The network layer then provides the service of delivering the segment to the transport layer in the destination host.
- Network layer includes the **IP protocol** which defines the fields in the datagram as well as how the end systems and routers act on these fields.
- Network layer also contains routing protocols that determine the routes that datagrams take between sources and destinations.

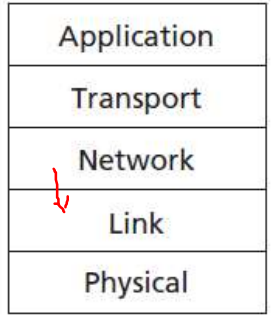


Five-layer Internet protocol stack

Protocol Layers and Their Service Models

Link Layer:

- The network layer routes a datagram through a series of routers between the source and destination. To move a packet from one node (host or router) to the next node in the route, the network layer relies on the services of the link layer.
- The services provided by the link layer depend on the specific link-layer protocol that is employed over the link.
- Examples of link-layer protocols include Ethernet, WiFi, and the cable access network's DOCSIS protocol.
- As the packets typically need to traverse several links to travel from source to destination, a packet may be handled by different link-layer protocols at different links along its route.
- A packet of information at the link layer as a **frame**.

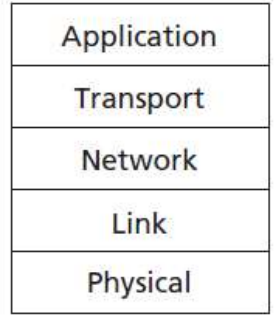


Five-layer Internet protocol stack

Protocol Layers and Their Service Models

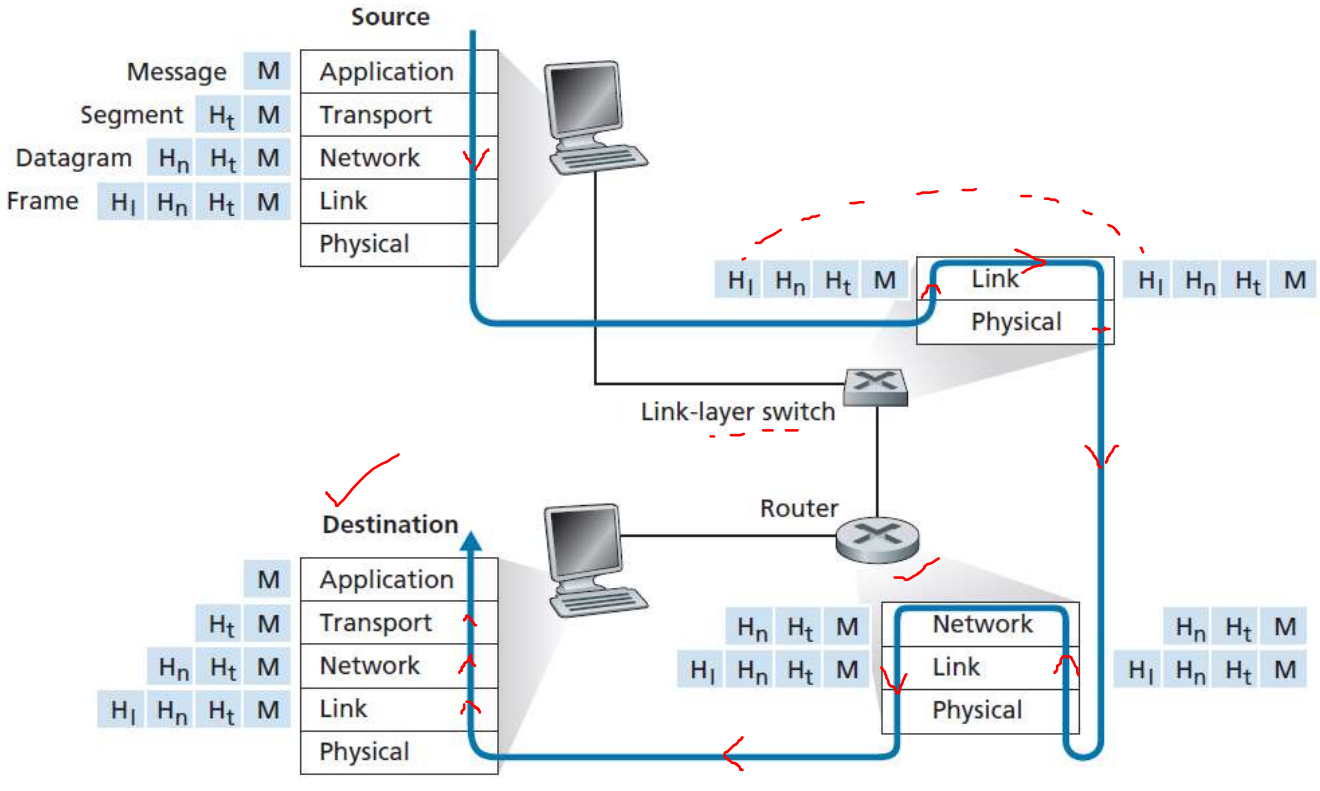
Physical Layer:

- While the job of the link layer is to move entire frames from one network element to an adjacent network element, the job of the physical layer is to move the **individual bits** within the frame from one node to the next.
- The protocols in this layer are again link dependent and further depend on the actual transmission medium of the link. For example, Ethernet has many physical-layer protocols: one for twisted-pair copper wire, another for coaxial cable, another for fiber, and so on. In each case, a bit is moved across the link in a different way.



Five-layer Internet protocol stack

Encapsulation



Encapsulation and De-encapsulation

- As the packet travels through the internet's protocol stack, the protocols at each layer either add or remove fields from the basic header. When a protocol on the sending host adds data to the packet header, the process is called data encapsulation.

- De-encapsulation is the exact reverse process of encapsulation. The additional information (header) added on the sender's side during encapsulation, gets removed when the packet travels on the receiver's side from the Physical layer to the Application layer.

Thank you.