WHAT IS THE INTERNET?

Which of the following descriptions below correspond to a *"nuts-and-bolts"* view of the Internet? Select one or more of the answers below that are correct. [Hint: more than one of answers below are correct].

- [x] A collection of billions of computing devices, and packet switches interconnected by links.
- [ ] A platform for building network applications.
- [x] A collection of hardware and software components executing protocols that define the format and the order of messages exchanged between two or more communicating entities, as well as the actions taken on the transmission and/or receipt of a message or other event.
- [ ] A place I go for information, entertainment, and to communicate with people.
- [x] A "network of networks".

WHAT IS THE INTERNET (2)?

Which of the following descriptions below correspond to a *"services"* view of the Internet? Select one or more of the answers below below that are correct below that are correct. [Hint: more than one of answers below are correct].

- [ ] A "network of networks".
- [x] A platform for building network applications.
- [x] A place I go for information, entertainment, and to communicate with people.
- [ ] A collection of hardware and software components executing protocols that define the format and the order of messages exchanged between two or more communicating entities, as well as the actions taken on the transmission and/or receipt of a message or other event.
- [ ] A collection of billions of computing devices, and packet switches interconnected by links.

WHAT IS A PROTOCOL?

Which of the following human scenarios involve a protocol (recall: "Protocols define the format, order of messages sent and received among network entities, and actions taken on message transmission, receipt")? Select one or more answers below that are correct. Hint: more than one of answers below are correct.

- [ ] A person reading a book.
- [x] One person asking, and getting, the time to/from another person.
- [ ] A person sleeping.
- [x] Two people introducing themselves to each other.
- [x] A student raising her/his hand to ask a really insightful question, followed by the teaching acknowledging the student, listening carefully to the question, and responding with a clear, insightful answer. And then thanking the student for the question, since teachers *love* to get questions.

ROUTING VERSUS FORWARDING.

Choose one the following two definitions that makes the correct distinction between routing versus forwarding.

- (●) Forwarding is the local action of moving arriving packets from router's input link to appropriate router output link, while routing is the global action of determining the source-destination paths taken by packets.
- ( ) Routing is the local action of moving arriving packets from router's input link to appropriate router output link, while forwarding is the global action of determining the source-destination paths taken by packets.

WHAT IS A NETWORK OF NETWORKS?

When we say that the Internet is a “network of networks,” we mean? Check all that apply (hint: check two or more).

- [ ] The Internet is the *fastest* network ever built.
- [x] The Internet is made up of access networks at the edge, tier-1 networks at the core, and interconnected regional and content provider networks as well.
- [ ] The Internet is the *largest* network ever built.
- [x] The Internet is made up of a lot of different networks that are interconnected to each other.

QUESTION LIST:

Time needed to perform an integrity check, lookup packet information in a local table and move the packet from an input link to an output link in a router.

D

Time spent waiting in packet buffers for link transmission.

A

Time spent transmitting packets bits into the link.

B

Time need for bits to physically propagate through the transmission medium from end one of a link to the other.

C

ANSWER LIST:

A. Queueing delay

B. Transmission delay

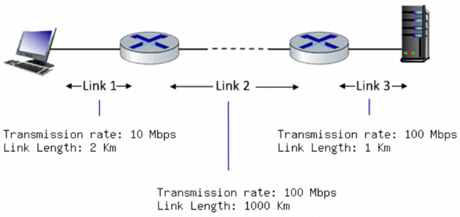
C. Propagation delay

D. Processing delay

COMPUTING PACKET TRANSMISSION DELAY (3).

Consider the network shown in the figure below, with three links, each with the specified transmission rate and link length. Assume the length of a packet is 8000 bits.

What is the transmission delay at link 2? [Note: you can find more problems like this one here.]

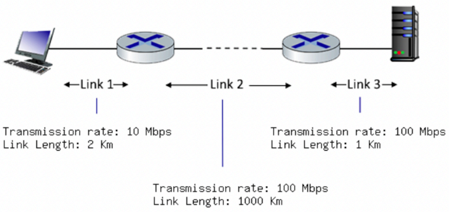


- .00096 secs
- 8 x 10^(-5) secs
- 12,500 secs
- 100 secs
- 12.5 secs

COMPUTING PROPAGATION DELAY.

Consider the network shown in the figure below, with three links, each with the specified transmission rate and link length. Assume the length of a packet is 8000 bits. The speed of light propagation delay on each link is 3x10^8 m/sec

What is the propagation delay at (along) link 2?

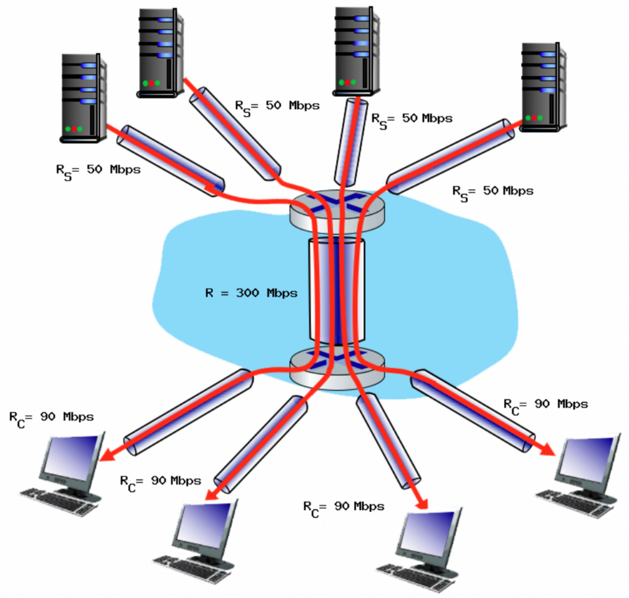


- 3 x 10^8 secs
- 3 secs
- .0033 secs
- .33 secs

Consider the scenario shown below, with four different servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 300 Mbps. The four links from the servers to the shared link have a transmission capacity of R_S = 50 Mbps. Each of the four links from the shared middle link to a client has a transmission capacity of R_C = 90 Mbps.

Assuming that the servers are all sending at their maximum rate possible, what are the link utilizations for the server links (with transmission capacity R_S)? Enter your answer in a decimal form of 1.00 (if the utilization is 1) or 0.xx (if the utilization is less than 1, rounded to the closest xx).

Your answer: The utilization of the server links is: [A]



1.00

0.67

Shared link

Client link – 0.56

QUESTION LIST:

Protocols that are part of a distributed network application.

B

Transfer of data between one process and another process (typically on different hosts).

C

Delivery of datagrams from a source host to a destination host (typically).

E

Transfer of data between neighboring network devices.

A

Transfer of a bit into and out of a transmission media.

D

ANSWER LIST:

A. Link layer

B. Application Layer

C. Transport layer

D. Physical layer

E. Network layer

QUESTION LIST:

Application layer

B

Transport layer

E

Network layer

D

Link layer

C

Physical layer

A

ANSWER LIST:

A. Bit

B. Message

C. Frame

D. Datagram

E. Segment

WHAT IS "ENCAPSULATION"?

Which of the definitions below describe what is meant by the term "encapsulation"?

- ○ Receiving a “packet” from the layer below, extracting the payload field, and after some internal actions possibly delivering that payload to an upper layer protocol.
- ○ Computing the sum of all of the bytes within a packet and placing that value in the packet header field.
- ◉ Taking data from the layer above, adding header fields appropriate for this layer, and then placing the data in the payload field of the “packet” for that layer.
- ○ Determining the name of the destination host, translating that name to an IP address and then placing that value in a packet header field.
- ○ Starting a transport layer timer for a transmitted segment, and then if an ACK segment isn’t received before the timeout, placing that segment in a retransmission queue.

“HTTP IS STATELESS.”

What do we mean when we say “HTTP is stateless”? In answering this question, assume that cookies are not used. Check all answers that apply.

- [ ] The HTTP protocol is not licensed in any country.
- [ ] We say this when an HTTP server is not operational.
- [ ] An HTTP *client* does not remember anything about what happened during earlier steps in interacting with any HTTP server.
- [ ] An HTTP client does not remember the identities of the servers with which it has interacted.
- [x] An HTTP *server* does not remember anything about what happened during earlier steps in interacting with this HTTP client.

THE HTTP GET.

What is the purpose of the HTTP GET message?

- The HTTP GET request message is sent by a web server to a web client to get the identity of the web client.
- The HTTP GET request message is used by a web client to request a web server to send the requested object from the server to the client.
- The HTTP GET request message is used by a web client to post an object on a web server.
- The HTTP GET request message is sent by a web server to a web client to get the next request from the web client.

CONDITIONAL HTTP GET.

What is the purpose of the conditional HTTP GET request message?

- To allow a server to only send the requested object to the client if the client is authorized to received that object.
- To allow a server to only send the requested object to the client if the client has never requested that object before.
- To allow a server to only send the requested object to the client if this object has changed since the server last sent this object to the client.
- To allow a server to only send the requested object to the client if the server is not overloaded.

Again, suppose a client is sending an HTTP GET request message to a web server, gaia.cs.umass.edu. Suppose the client-to-server HTTP GET message is the following (same as in previous problem):

```
GET /kurose_ross_sandbox/interactive/quotation2.htm HTTP/1.1
Host: gaia.cs.umass.edu
Accept: text/plain, text/html, text/xml, image/jpeg, image/gif, audio/mpeg, audio/mp4, video/wmv, video/mp4,
Accept-Language: en-us, en-gb;q=0.1, en;q=0.7, fr, fr-ch, da, de, fi
If-Modified-Since: Wed, 09 Sep 2020 16:06:01 -0700
User Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/535.11 (KHTML, like Gecko) Chrome/17.0.963.56 Safari/535.11
```

Does the client have a cached copy of the object being requested?

[Note: you can find additional questions similar to this here.]

- There's not enough information in the header to answer this question.
- No, because a client would not request an object if it had that object in its cache.
- Yes, because this is a conditional GET, as evidenced by the If-Modified-Since field.
- Yes, because HTTP 1.1 is being used.

Suppose now the server sends the following HTTP response message the client:

HTTP/1.0 200 OK
Date: Wed, 09 Sep 2020 23:46:21 +0000
Server: Apache/2.2.3 (CentOS)
Last-Modified: Wed, 09 Sep 2020 23:51:41 +0000
ETag:17dc6-a5c-bf716880.
Content-Length: 418
Connection: Close
Content-type: image/html

Will the web server close the TCP connection after sending this message?

[Note: you can find more questions like this one here.]

- ○ There's not enough information in the response message to answer this question.
- ○ No, the server will leave the connection open as a persistent HTTP connection.
- ○ Yes, because the HTTP response indicated that only one object was requested in the HTTP GET request.
- ◉ Yes, the server will close this connection because version 1.0 of HTTP is being used, and TCP connections do not stay open persistently.

WHY WEB CACHING?

Which of the following are advantages of using a web cache? Sselect one or more answers.

- [x] Caching generally provides for a faster page load time at the client, if the web cache is in the client's institutional network, because the page loaded from the nearby cache rather than from the distant server.
- [ ] Caching allows an origin server to more carefully track which clients are requesting and receiving which web objects.
- [x] Caching uses less bandwidth coming into an institutional network where the client is located, if the cache is also located in that institutional network.
- [ ] Overall, caching requires fewer devices/hosts to satisfy a web request, thus saving on server/cache costs.

WHAT'S IN AN HTTP REPLY?

Which of the following pieces of information will appear in a server's application-level HTTP reply message? (Check all that apply.)

- [ ] A sequence number
- [ ] The server's IP address
- [ ] A checksum
- [ ] The name of the Web server (e.g., gaia.cs.umass.edu)
- [x] A response phrase associated with a response code
- [x] A response code

IF-MODIFIED-SINCE.

What is the purpose of the *If-Modified-Since* field in a HTTP GET request message

---

- ○ To inform the HTTP cache that it (the cache) should retrieve the full object from the server, and then cache it until the specified time.
- ○ To indicate to the server that the server should replace this named object with the new version of the object attached to the GET, if the object has not been modified since the specified time
- ○ To indicate to the server that the client wishes to receive this object, and the time until which it will cache the returned object in the browser's cache.
- ◉ To indicate to the server that the client has cached this object from a previous GET, and the time it was cached.
- ○ To allow the server to indicate to the client that it (the client) should cache this object.

WHAT HAPPENS AFTER AN HTTP REPLY?

Suppose an HTTP server sends the following HTTP response message a client:

HTTP/1.0 200 OK
Date: Wed, 09 Sep 2020 23:46:21 +0000
Server: Apache/2.2.3 (CentOS)
Last-Modified: Wed, 09 Sep 2020 23:51:41 +0000
ETag:17dc6-a5c-bf716880.
Content-Length: 418
Connection: Close
Content-type: image/html

Will the web server close the TCP connection after sending this message?

- ○ No, this is a persistent connection, and so the server will keep the TCP connection open.
- ○ There's not enough information to answer this question.
- ◉ Yes, because this is HTTP 1.0

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GET /kurose_ross_sandbox/interactive/quotation2.htm HTTP/1.1
Host: gaia.cs.umass.edu
Accept: text/plain, text/html, text/xml, image/jpeg, image/gif, audio/mpeg, audio/mp4, video/wmv, video/mp4,
Accept-Language: en-us, en-gb;q=0.1, en;q=0.7, fr, fr-ch, da, de, fi
If-Modified-Since: Wed, 09 Sep 2020 16:06:01 -0700
User Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/535.11 (KHTML, like Gecko) Chrome/17.0.963.56 Safari/535.11

Does the client have a cached copy of the object being requested?

- ○ No, because the client would not request an object if it were cached.
- ◉ Yes, because this is a conditional GET.
- ○ There's not enough information to answer this question.

THE CLIENT-SERVER PARADIGM.

Which of the characteristics below are associated with a client-server approach to structuring network applications (as opposed to a P2P approach)?

- [x] HTTP uses this application structure.
- [x] There is a server with a well known server IP address.
- [x] There is a server that is always on.
- [ ] There is *not* a server that is always on.
- [ ] A process requests service from those it contacts and will provide service to processes that contact it.

THE PEER-TO-PEER (P2P) PARADIGM.

Which of the characteristics below are associated with a P2P approach to structuring network applications (as opposed to a client-server approach)?

- [ ] HTTP uses this application structure.
- [x] A process requests service from those it contacts and will provide service to processes that contact it.
- [ ] There is a server with a well known server IP address.
- [x] There is *not* a server that is always on.
- [ ] There is a server that is always on.

TCP SERVICE.

When an application uses a TCP socket, what transport services are provided to the application by TCP? Check all that apply.

- [x] *Congestion control.* The service will control senders so that the senders do not collectively send more data than links in the network can handle.
- [ ] *Throughput guarantee.* The socket can be configured to provide a minimum throughput guarantee between sender and receiver.
- [x] *Flow Control*. The provided service will ensure that the sender does not send so fast as to overflow receiver buffers.
- [x] *Loss-free data transfer.* The service will reliably transfer all data to the receiver, recovering from packets dropped in the network due to router buffer overflow.
- [ ] *Real-time delivery.* The service will guarantee that data will be delivered to the receiver within a specified time bound.
- [ ] ~~*Best effort service*~~. ~~The service will make a best effort to deliver data to the destination but makes no guarantees that any particular segment of data will actually get there~~.

LOCATION OF TRANSPORT-LAYER FUNCTIONALITY.

Where is transport-layer functionality primarily implemented?

- ○ Transport layer functions are implemented primarily at each end of a physical link connecting one host/router/switch to another one host/router/switch.
- ○ Transport layer functions are implemented primarily at the routers and switches in the network.
- ◉ Transport layer functions are implemented primarily at the hosts at the “edge” of the network.

TRANSPORT-LAYER FUNCTIONALITY.

True or False: The transport layer provides for host-to-host delivery service?

- ○ False
- ◉ True.

TRANSPORT LAYER SERVICES USING TCP.

Check all of the services below that are provided by the TCP protocol.

- [x] In-order data delivery
- [ ] A guarantee on the *minimum* amount of throughput that will be provided between sender and receiver.
- [ ] A message abstraction, that preserves boundaries between message data sent in different socket send calls at the sender.
- [ ] A guarantee on the maximum amount of time needed to deliver data from sender to receiver.
- [x] Reliable data delivery.
- [x] A byte stream abstraction, that does not preserve boundaries between message data sent in different socket send calls at the sender.
- [x] A congestion control service to ensure that multiple senders do not overload network links.
- [x] A flow-control service that ensures that a sender will not send at such a high rate so as to overflow receiving host buffers.

NETWORK-LAYER FUNCTIONALITY.

The transport layer sits on top of the network layer, and provides its services using the services provided to it by the network layer. Thus it’s important that we know what is meant by the network layer’s “best effort” delivery service. True or False:

> *The network layer’s best-effort delivery service means that IP makes its “best effort” to deliver segments between communicating hosts, but it makes no guarantees. In particular, it does not guarantee segment delivery, it does not guarantee orderly delivery of segments, and it does not guarantee the integrity of the data in the segments.*

- ◉ Correct! The network layer’s best effort service doesn’t really provide much service at all, does it?
- ○ Nope. The network layer’s best effort service doesn’t really provide much service at all, does it?

TRANSPORT-LAYER DEMULTIPLEXING.

What is meant by transport-layer demultiplexing?

- ◉ Receiving a transport-layer segment from the network layer, extracting the payload (data) and delivering the data to the correct socket.
- ○ Taking data from multiple sockets, all associated with the same destination IP address, adding destination port numbers to each piece of data, and then concatenating these to form a transport-layer segment, and eventually passing this segment to the network layer.
- ○ Taking data from one socket (one of possibly many sockets), encapsulating a data chuck with header information – thereby creating a transport layer segment – and eventually passing this segment to the network layer.
- ○ Receiving a transport-layer segment from the network layer, extracting the payload, determining the destination IP address for the data, and then passing the segment and the IP address back down to the network layer.

TRANSPORT-LAYER MULTIPLEXING.

What is meant by transport-layer multiplexing?

- ○ Receiving a transport-layer segment from the network layer, extracting the payload, determining the destination IP address for the data, and then passing the segment and the IP address back down to the network layer.
- ○ Receiving a transport-layer segment from the network layer, extracting the payload (data) and delivering the data to the correct socket.
- ◉ Taking data from one socket (one of possibly many sockets), encapsulating a data chuck with header information – thereby creating a transport layer segment – and eventually passing this segment to the network layer.
- ○ Taking data from multiple sockets, all associated with the same destination IP address, adding destination port numbers to each piece of data, and then concatenating these to form a transport-layer segment, and eventually passing this segment to the network layer.

TRANSPORT-LAYER MULTIPLEXING.

What is meant by transport-layer multiplexing?

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- ○ Receiving a transport-layer segment from the network layer, extracting the payload (data) and delivering the data to the correct socket.
- ◉ Taking data from one socket (one of possibly many sockets), encapsulating a data chuck with header information – thereby creating a transport layer segment – and eventually passing this segment to the network layer.
- ○ Taking data from multiple sockets, all associated with the same destination IP address, adding destination port numbers to each piece of data, and then concatenating these to form a transport-layer segment, and eventually passing this segment to the network layer.

MULTIPLEXING/DEMULTIPLEXING: TCP PORT NUMBERS.

True or False: When multiple TCP clients send TCP segments to the same destination port number at a receiving host, those segments (from different senders) will always be directed to the same socket at the receiving host.

- ◉ False
- ○ True

MULTIPLEXING UDP WITH IDENTICAL PORT NUMBERS.

True or False: It is possible for two UDP segments to be sent from the same socket with source port 5723 at a server to two different clients.

- ○ False
- ◉ True

MULTIPLEXING TCP WITH IDENTICAL PORT NUMBERS.

True or False: It is possible for two TCP segments with source port 80 to be sent by the sending host to different clients.

- ○ False
- ◉ True

QUESTION LIST:

Lets the sender know that a packet was NOT received correctly at the receiver.

B

Used by sender or receiver to detect bits flipped during a packet's transmission.

C

Allows for duplicate detection at receiver.

A

Lets the sender know that a packet was received correctly at the receiver.

E

Allows the receiver to eventually receive a packet that was corrupted or lost in an earlier transmission.

D

ANSWER LIST:

A. Sequence numbers

B. NAK

C. Checksum

D. Retransmission

E. ACK

CUMULATIVE ACK.

What is meant by a cumulative acknowledgment, ACK*(n)*?

- ◉ A cumulative ACK*(n)* acks all packets with a sequence number up to and including *n* as being received.
- ○ A cumulative ACK*(n)* allows the receiver to let the sender know that it has not yet received an ACK for packet with sequence number *n*.
- ○ A cumulative ACK*(n)* allows the receiver to let the sender know that it has not received any packets with a new sequence number since the last cumulative ACK*(n)* was sent.

STOP-AND-WAIT: CHANNEL UTILIZATION.

Suppose a packet is 10K bits long, the channel transmission rate connecting a sender and receiver is 10 Mbps, and the round-trip propagation delay is 10 ms. What is the maximum channel utilization of a stop-and-wait protocol for this channel?

- ○ .01
- ○ 10.0
- ◉ .1
- ○ .001
- ○ 1.0

CHANNEL UTILIZATION WITH PIPELINING.

Suppose a packet is 10K bits long, the channel transmission rate connecting a sender and receiver is 10 Mbps, and the round-trip propagation delay is 10 ms. What is the channel utilization of a pipelined protocol with an arbitrarily high level of pipelining for this channel?

- ○ 0.001
- ◉ 1.0
- ○ 0.01
- ○ 10.0
- ○ 0.1

PIPELINING.

Which of the following statements about pipelining are true? One or more statements may be true.

- [x] With a pipelined sender, there may be transmitted packets "in flight" – propagating through the channel – packets that the sender has sent but that the receiver has not yet received.
- [ ] With pipelining, a receiver will have to send fewer acknowledgments as the degree of pipelining increases
- [x] A pipelined sender can have transmitted multiple packets for which the sender has yet to receive an ACK from the receiver.
- [ ] With pipelining, a packet is only retransmitted if that packet, or its ACK, has been lost.

PACKET BUFFERING IN GO-BACK-N.

What are some reasons for discarding received-but- out-of-sequence packets at the receiver in GBN? Indicate one or more of the following statements that are correct.

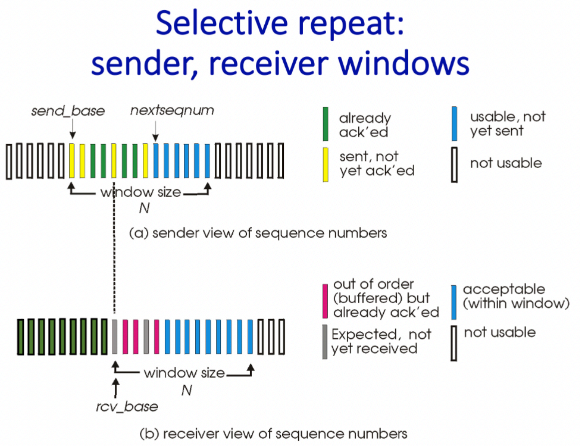
- [x] The sender will resend that packet in any case.
- [ ] If some packets are in error, then its likely that other packets are in error as well.
- [x] The implementation at the receiver is simpler.
- [ ] Discarding an out of sequence packet will really force the sender to retransmit.

PACKET BUFFERING IN GO-BACK-N (MORE).

What are some reasons for *not* discarding received-but- out-of-sequence packets at the receiver in GBN? Indicate one or more of the following statements that are correct.

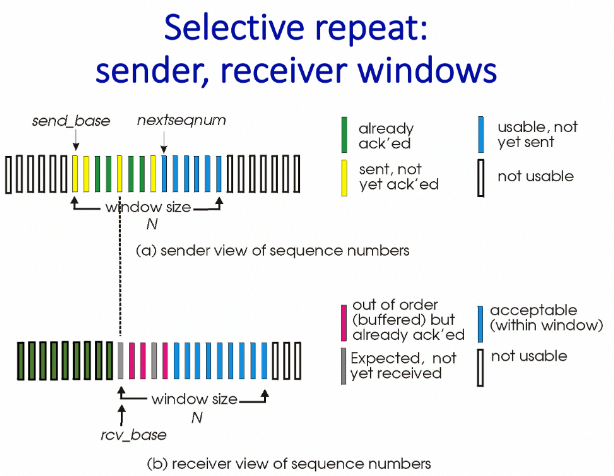
- [ ] Complex protocols are always better.
- [ ] By not discarding, the receiver can implicitly let the sender know that it (the sender) does not necessarily have to retransmit that packet.
- [x] Even though that packet will be retransmitted, its next retransmission could be corrupted, so don't discard a perfectly well-received packet, silly!

In the SR receiver window (see diagram below, taken from PPT slides and video), why haven't the red packets been delivered yet? Check the one or more reasons below that apply.



- [ ] There is a packet with a higher sequence number than any of the red packets that has yet to be received, so in-order delivery of data in the red packets to the application layer is not yet possible.
- [x] There is a packet with a lower sequence number than any of the red packets that has yet to be received, so in-order delivery of data in the red packets up to the application layer is not possible.
- [ ] Red packets have a lower delivery priority up to the application.

In SR, why does the receiver have to acknowledge packets with sequence numbers that are less than (and to the left of) those in its window, which starts at *rcv_base*.



- [x] Because the sender may not have received an ACK for that packet yet.
- [ ] Because, at the time of the data packet arrival at the receiver, the sender has definitely still not received an ACK for that packet.
- [ ] Actually, this ACK retransmission can be ignored and the protocol will still function correctly, but its performance won't be as good.

That's Correct!

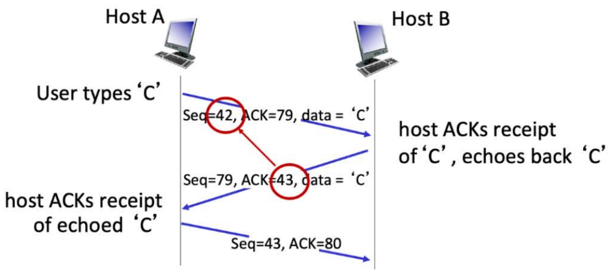
TCP RELIABILITY SEMANTICS.

True or False: On the sending side, the TCP sender will take each application-layer chunk of data written into a TCP socket and send it in a distinct TCP segment. And then on the receiving side, TCP will deliver a segment's payload into the appropriate socket, preserving the application-defined message boundary.

- ○ True.
- ◉ False.

TCP SEQUENCE NUMBERS AND ACKS (1).

Consider the TCP Telnet scenario below (from Fig. 3.31 in text). Why is it that the receiver sends an ACK that is one larger than the sequence number in the received datagram?



simple telnet scenario

- ○ Because TCP sequence numbers always increase by 1, with every new segment, and the TCP receiver always send the sequence number of the next expected segment
- ◉ Because the send-to receiver segment carries only one byte of data, and after that segment is received, the next expected byte of data is just the next byte (i.e., has an index that is one larger) in the data stream.

TCP RTT ESTIMATION: EWMA.

Consider TCP use of an exponentially weighted moving average (EWMA) to compute the nth value of the estimated RTT:

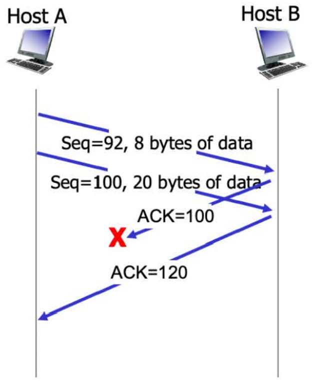
$EstimatedRTT_n = (1- a)*EstimatedRTT_{n-1} + a*SampleRTT_n$

True or False: with this EWMA algorithm the value of $EstimatedRTT_n$ has no dependence on the earlier sample, $SampleRTT_{n-1}$

- ◉ False
- ○ True

TCP TIMER MANAGEMENT.

Consider the TCP Telnet scenario below (from Fig. 3.36 in text). What timer-related action does the sender take on the receipt of ACK 120?



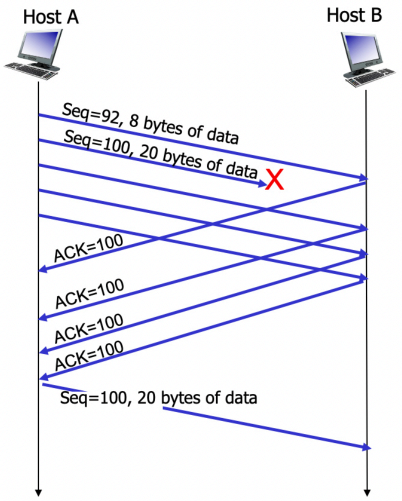
- [x] Cancels any running timers.
- [ ] Restarts a timer for the segment with sequence number 92.
- [ ] Leaves any currently-running timers running.

TCP FLOW CONTROL.

True or False: with TCP's flow control mechanism, where the receiver tells the sender how much free buffer space it has (and the sender always limits the amount of outstanding, unACKed, in-flight data to less than this amount), it is not possible for the sender to send more data than the receiver has room to buffer.

- [x] True
- [ ] False

Consider TCP's Fast Retransmit optimization (see Figure 3.37 from the text, below). Of course, the sender doesn't know for sure that the segment with sequence # 100 is actually lost (it can't see into the channel). Can a sender get three duplicate ACKs for a segment that in fact has *not* been lost? Which of the following statements are true? Suppose a channel can lose, but will not corrupt, messages.



- [x] If the channel cannot reorder messages, a triple duplicate ACK indicates to the sender that a segment loss has happened for sure. Actually (again assuming the channel cannot corrupt or reorder messages), even a *single* duplicate ACK would indicate that a segment loss has happed for sure.

- [x] If the channel can reorder messages, a triple duplicate ACK can occur even though a message is not lost; since it's possible that a message has

---

A message from client to server initiating a connection request.

A

A message from server to client ACKing receipt of a SYN message and indicating the willingness of the server to establish a TCP connection with the client.

D

A message indicating that the sending side is initiating the protocol to terminate a connection.

C

A message sent in response to a request to terminate a connection, ACKing that the side receiving this message is also willing to terminate the connection

B

A general purpose error message used during connection set up or tear down to let the other side know that an error has occurred, and that the referenced connection should be shut down.

E

A. SYN message

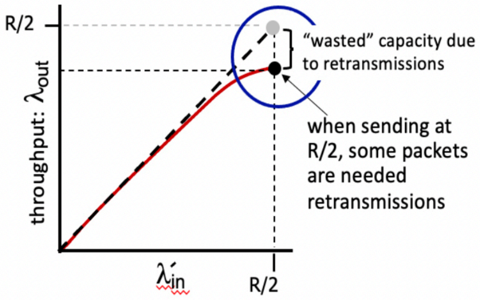
B. FINACK message

C. FIN message

D. SYNACK message

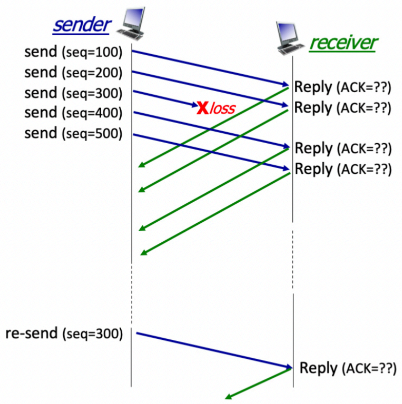
E. RESET message

Consider the figure below, which shows the application-to-application throughput achieved when two senders are competing at a shared bottleneck link. Suppose that when the overall arrival rate, lambda_{in}' (for each sender) is close to R/2, the throughput to the application layer (at each receiver), lambda_{out}, is equal to 0.8 * lambda_{in}'.



What fraction of the packets transmitted at the sender are retransmissions?

- .50
- 0
- .80
- .20



Complete the sentences below ....

QUESTION LIST:

After receiving segment 100, the receiver responds with an ACK with value:

B

After receiving segment 200, the receiver responds with an ACK with value:

A

After receiving segment 500, the receiver responds with an ACK with value:

D

After receiving the *retransmitted* segment 300, the receiver responds with an ACK with value:

C

The TCP receiver does *not* respond in the example, with an ACK with value:

E

ANSWER LIST:

A. 300

B. 200

C. 600

D. 300, a duplicate ACK

E. 400

Use the pulldown menu to match a congestion control approach to how the sender detects congestion.

QUESTION LIST:

The sender infers segment loss from the absence of an ACK from the receiver.

A

Bits are set at a congested router in a sender-to-receiver datagram, and bits are in the returned to the sender in a receiver-to sender ACK, to indicate congestion to the sender.

C

The sender measures RTTs and uses the current RTT measurement to infer the level of congestion.

B

ANSWER LIST:

A. end-end

B. delay-based

C. network-assisted

TCP'S AIMD ALGORITHM (2).

How is the sending rate typically regulated in a TCP implementation?

- By using the retransmission timeout timer and counting the number of bytes sent since the last timeout to compute the sending rate since that last timeout, and then making sure its sending rate never exceed the rate set by AIMD.
- By keeping a window of size cwnd over the sequence number space, and making sure that no more than cwnd bytes of data are outstanding (i.e, unACKnowledged). The size of cwnd is regulated by AIMD.

TCP'S SLOWSTART ALGORITHM.

Which of the following best completes this sentence: "In the absence of loss, TCP slow start increases the sending rate ... "

- "... at the same rate as AIMD."
- " ... faster than AIMD. In fact, slowstart increases the sending rate exponentially fast per RTT."
- ... slower than AIMD, that's why it's called Slowstart."

UNCONTROLLED TRANSPORT-LAYER SENDERS.

Consider the transport-layer flows interacting at a congested link. In the face of such congestion, what happens at this link to a transport-layer flow that does not cut back on its sending rate?

- That sender's datagrams will be preferentially dropped at the congested link.
- Nothing different from the other flows crossing the congested link.
- The router will send a signal to the TCP sender that would force the TCP sender to cut its rate in half.

TCP CUBIC.

Assuming that the congestion window size,cwnd, has not yet reached W_{max}, TCP CUBIC will … (check all that apply)

- [x] … increase its sending rate faster than AIMD when cwnd is far away from W_{max}, but increase slower than AIMD when cwnd is closer to W_{max}
- [x] … always have a window size, cwnd, and hence a sending rate, higher than that of AIMD (assuming a given window size, W_{max}, at which loss would occur).
- [ ] … have a sending rate that always increases faster than that of AIMD.

DELAY-BASED CONGESTION CONTROL.

For delay-based congestion control, match the sender action to the relationship of the currently measured throughput to the value of cwnd/RTT_{min}

QUESTION LIST:

The currently measured throughput is greater than cwnd/RTT_{min}

A

The currently measured throughput is equal to or a bit less than than cwnd/RTT_{min}

C

The currently measured throughput is much less that than cwnd/RTT_{min}

B

ANSWER LIST:

A. This should never happen.

B. decrease the sending rate

C. increase the sending rate