Distributed Systems

06. Exam 1 Review

Paul Krzyzanowski

Rutgers University

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Question 1

What problem can arise with a system that exhibits fail-restart behavior?

Stale state: the system has an outdated view of the world when it starts up.

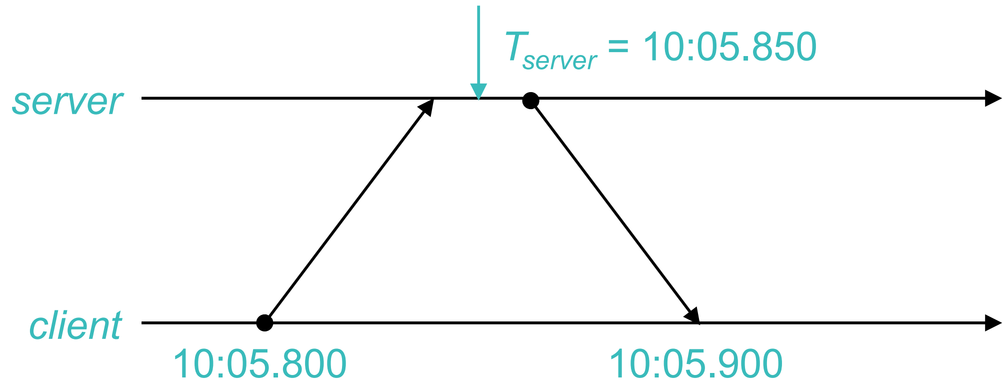
Not: data gets lost or missed messages
– that is true for fail-stop behavior as well

Question 2

At 10:05.800, a client sends the server a request for the time. The server response arrives at 10:05.900 containing a time stamp of 10:05.850. Using Cristian's algorithm, to what value does the client set its clock?

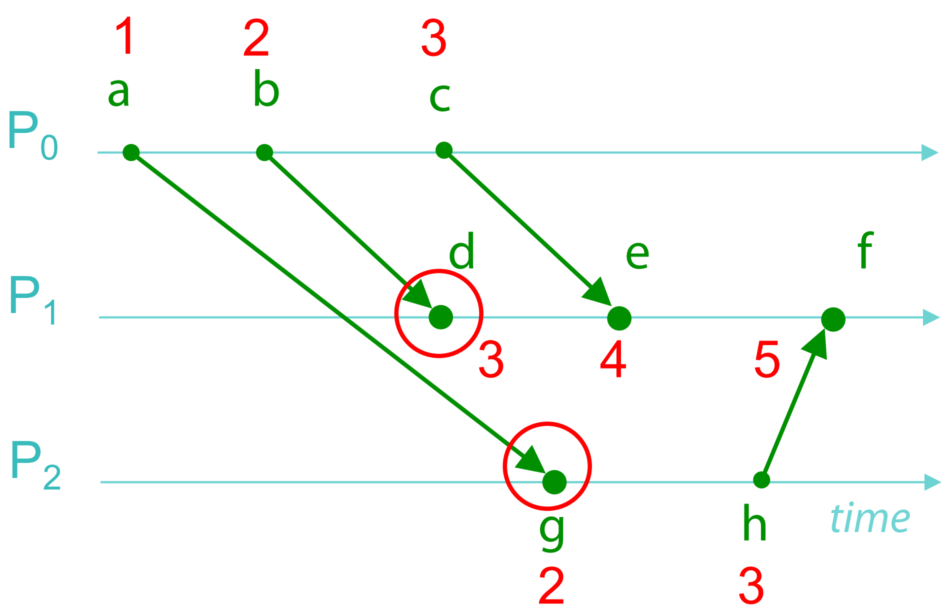
$$\begin{aligned} \text{offset} &= (T_{received} - T_{sent}) \div 2 \\ &= (10{:}05.900 - 10{:}05.800) \div 2 \\ &= 0.1 \div 2 = 0.05 \end{aligned}$$

New time = T_{server} + offset = 10:05.850 + 0.05 = **10:05.9**



Question 3

In the diagram of events shown, what is the Lamport timestamp of event f ?
Assume that all Lamport counters are initialized to 0 and incremented before events.



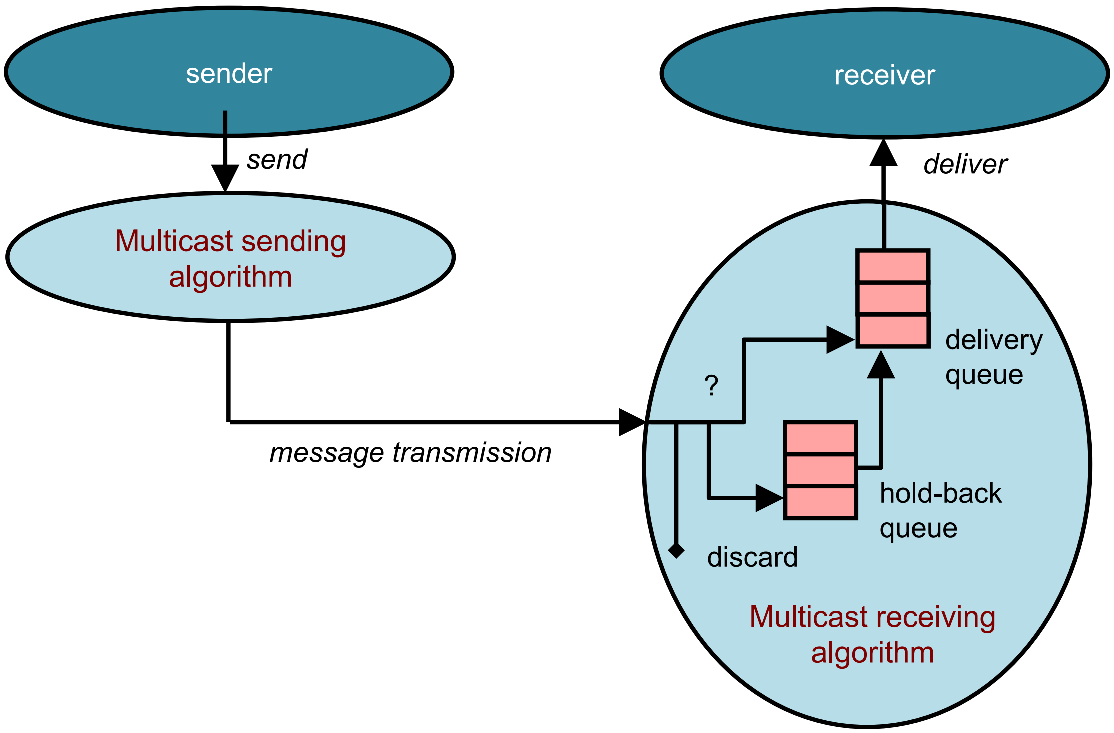
f = 5

Question 4

Explain the distinction between receiving and delivering a message.

Receiving = message arrives the computer

Delivering = message is presented to the application



Question 5

Moore's law states that the:

(a) Number of computers on the Internet doubles approximately every two years.

(b) Amount of data on the Internet doubles approximately every two years.

(c) Number of transistors in an integrated circuit doubles approximately every two years.

(d) Speed of a network doubles approximately every two years.

Question 6

Metcalfe's law addresses the:

(a) Bandwidth of a communication network.
(b) Number of redundant paths in a communication network.
(c) Latency of a communication network.
(d) Value of a communication network.

The value of a telecommunications network is proportional to the square of the number of connected users of the system.

Question 7

A network *partition* refers to:

(a) A protected segment of the network for administrative tasks.

(b) Each local area network within the Internet.

(c) A type of fault where the network fragments into two or more disconnected sub-networks.

(d) A file system that is shared among multiple systems on a network.

Question 8

A *Byzantine fault* is:
(a) A fault that triggers other failures, also known as a cascading failure.
(b) Any complex fault that is difficult to identify.
(c) The case when a system does not behave as expected.
(d) The situation when messages take longer to arrive than expected.

Instead of ceasing to work as with fail-stop, a Byzantine fault produces incorrect results.

(a) and (b) may be side-effects of a byzantine fault.

Question 9

Which is *NOT* a key design principle of the Internet?
(a) Support the interconnection of different physical networks.
(b) Provide reliable communication.
(c) Use routers to move data between networks.
(d) Not have centralized control of the network.

IP does not guarantee reliable, in-order delivery.

If reliability is needed, it must be provided at the edge in software.

Question 10

Piggybacked acknowledgements:
(a) Prevent feedback implosion.
(b) Incorporate an acknowledgement within a response message.
(c) Optimize network use by sending one acknowledgement for multiple messages.
(d) Are a way for the sender to acknowledge receipt of an acknowledgement.

(a) Feedback implosion
- Send a multicast message out and get replies from all group members

(c) Sending one ack for multiple messages
- This is a cumulative acknowledgement

(d) Protocols generally do not acknowledge receipt of acks

Question 11

To convert a big endian number to a little endian format requires:
(a) Losing precision.
(b) Using fewer bytes.
(c) Risking overflow.
(d) Reversing byte positions.

- Endianness refers to the order in which bytes are arranged in multi-byte values
- Big endian = most significant byte at the lowest address
- To convert big endian to little, swap the bytes around

Question 12

An RPC server *skeleton* (stub):

(a) Receives requests from clients and calls the local function on the server.

(b) Is an automatically-generated template for writing server functions.

(c) Is used to discover remote procedures that reside on the server.

(d) Is called when the server-side function cannot be found.

(b) It's automatically generated server code but its purpose is not to be a template

(c) A name server is used for this (e.g., *portmap* on Linux)

(d) There's no "default" service that is called if the real service cannot be found

Question 13

Marshaling is the process of:

(a) Converting parameters into a network message for a remote procedure call.
(b) Sending a message that invokes a remote procedure call.
(c) The setup process that is needed before any remote procedures can be called.
(d) The process of a server receiving a message with parameters and calling the appropriate function.

Question 14

An *interface definition language* in remote procedure calls:
(a) Describes the input and return parameters of remote functions.
(b) Defines the protocol used to communicate with an RPC server.
(c) Is the language used to implement remote procedure calls.
(d) Is used to inform clients of available web services.

- An IDL is used to generate client & server stubs.

Question 15

Idempotent functions are desirable for remote services because:

(a) They are functional without the need to manage objects.
(b) We do not have to worry if multiple copies of the same request are received.
(c) They take no parameters, so data serialization is not an issue.
(d) They are architecture independent and can migrate to different servers.

Idempotent function = may be called multiple times without side-effects

Question 16

REST differs from web services such as SOAP because:
(a) There is no need to marshal data.
(b) HTTP is used as the protocol for sending & receiving content.
(c) Requests are formulated as URLs.
(d) Returned data is structured as an XML message.

(a) Marshaling is just converting parameters to an agreed-upon, pointerless format – a bunch of bytes. In REST, the parameters on a request would be marshaled as parameters in the URL

(b) HTTP is used for SOAP services too

(d) Not necessarily – can be JSON. SOAP uses XML.

Question 17

A surrogate process in Microsoft Windows is used to:
(a) Route client requests to the correct server.
(b) Act as the client stub and handle marshaling.
(c) Handle all requests for undefined services.
(d) Load COM objects at the server based on client requests.

Question 18

An advantage of *remote reference counting* over leasing is:
(a) It is more fault tolerant.
(b) Its enables shorter messages.
(c) It consumes fewer resources on the client.
(d) It allows a server to deactivate an object immediately.

(a) Remote reference counting is *less* fault tolerant.

(b) Not really. You still need to identify the object … send an *increment/decrement* directive vs. *in-use*.

(c) Not really. The server still needs to keep track of objects in use.

(d) Yes – don't have to wait for lease expiration.

Question 19

The coordinator's clock in a Berkeley algorithm reads 1:00. The clocks on the other systems read 1:01, 1:02, 1:05. After running the algorithm, to what value will the other systems be set?

(a) 1:00
(b) 1:01
(c) 1:02
(d) 1:05

The Berkeley algorithm just averages out all the times:

(1:00 + 1:01 + 1:02 + 1:05) ÷ 4

= 4:08 ÷ 4 = 1:02

Question 20

A *synchronization subnet* is:

(a) All the clients that are synchronizing from a specific NTP server

(b) A hierarchically arranged set of NTP servers

(c) A dedicated network for clock synchronization to ensure low jitter and low latency.

(d) The set of protocols used to synchronize clocks (e.g., NTP, SNTP, PTP).

NTP synchronization subnet = collection of NTP servers

Question 21

Events *x, y, z* have Lamport timestamps of 3, 3, 5, respectively. They may or may not have occurred on different processes. What can you definitively say definitively about these events?

(a) *x* and *y* are concurrent.
(b) Both *x* and *y* happened before *z*.
(c) Both (a) and (b).
(d) Neither (a) nor (b).

By looking at Lamport timestamps, we cannot tell the ordering:

- If $L(a) < L(b)$, we don't know that $a \rightarrow b$

However, if two events are causal ($a \rightarrow b$) then $L(a) < L(b)$

- Two causal events will *never* have the same timestamps

Question 22

Which vector timestamp causally precedes { 4, 12, 26 } ?

(a) { 3, 14, 28 }

(b) { 4, 11, 26 }

(c) { 5, 13, 27 }

(d) { 26, 12, 4 }

(a) { 3, 14, 28 } ≸ { 4, 12, 26 }

(b) { 4, 11, 26 } < { 4, 12, 26 }

(c) { 5, 13, 27 } > { 4, 12, 26 }

(d) { 26, 12, 4 } ≸ { 4, 12, 26 }

Question 23

Which precedence vector from Process 2 can be given to the application immediately if the local vector is { 4, 12, 26 } (assume a vector of {P0, P1, P2})?

(a) { 4, 11, 27 }
(b) { 4, 10, 28 }
(c) { 5, 13, 27 }
(d) { 3, 11, 28 }

Rules

- Event counter not incremented for received messages
- Increments element that corresponds to its entry (like vector timestamps)
- Condition checks
  1. Message must be very next message from P_2
  2. Message should not be causally dependent on any other message
     Every other element must be ≤ corresponding local element:
     Check $\forall i, i \neq \text{sender}: (V_{sender}[i] \leq V_{receiver}[i])$

(b) Missing message from P_2: 26, 28

(c) Causally greater: 13 is not ≤ 12

(d) Missing message from P_2: 26, 28

Question 24

Protocol Independent Multicast is used to:

(a) Route IP multicast packets within the Internet.
(b) Support multiple forms of multicast beyond IP multicast.
(c) Provide sender-selectable levels of reliability in multicast streams.
(d) Provide sender-selectable levels of reliability and message ordering in multicast streams.

(b): PIM just handles IP multicast

(c), (d): IP multicast does not offer varying levels of reliability

Question 25

Sparse Mode PIM has the advantage over Dense Mode multicast because it:
(a) Does not funnel multicast traffic for a group through one designated router.
(b) Supports different levels of message ordering and reliability service.
(c) Does not require the use of IGMP.
(d) Does not flood the network.

Rendezvous Point = designated address

- Routers from sender direct multicast messages toward the RP
- Routers from receivers direct multicast subscriptions toward the RP

Question 26

Virtual synchrony implements this form of multicast:
(a) Atomic.
(b) Reliable.
(c) Unreliable.
(d) Consistent.

Individual messages are generally sent via reliable multicast BUT

The *view change* operation ensures that all receivers have received all messages … even if the sender dies

- *Stable* vs. *unstable* message
- *Flush* operation

Question 2

The two-army problem illustrates that, for an unreliable asynchronous network:

(a) Two parties can come to agreement by sending messages through a third party.

(b) Reliable communication requires acknowledging messages.

(c) It is not necessary to acknowledge individual messages if you use cumulative acknowledgements.

(d) An infinite series of messages is required to reach consensus.

Question 28

Although UDP guarantees reliable delivery, messages may arrive out of order.

False. UDP does not guarantee reliable delivery.

Question 29

Ethernet provides reliable delivery of packets

False.

Question 30

Because all code runs on a Java Virtual Machine, parameters do not need to be serialized with Java RMI.

False. Parameters need to be marshaled into a byte array that is sent to the remote system.

Question 31

Java uses remote reference counting for distributed garbage collection.

False. It uses leasing.

Question 32

With sync ordering, messages may sometimes arrive in a different order on different systems.

True. No specific message sequence is not guaranteed between sync operations.

Question 33

For a set of causal events, Lamport timestamps will identify their proper sequence.

True.

Question 34

Two events with identical Lamport timestamps must be concurrent.

True.

Question 35

A closed group means that no new members can join the group.

False. It means systems outside the group cannot send messages to the group.

Question 36

The Precision Time Protocol is more accurate than NTP because it can deal with asymmetric network delays.

False. PTP assumes uplink and downlink delays are symmetric.

Question 37

Two vector time stamps may be identical for concurrent events.

False. $V_1 \not\lessgtr V_2$

The end