416 practice questions (PQs)

1. **Goal**: give you some material to study for the final exam and to help you to more actively engage with the material we cover in class.

2. **Format**: questions that are in scope of what we covered in the lecture. Each question slide is followed by an answer slide.

PQ 1

- I'm using three file systems: AFS, NFS, CODA. I go camping and disconnect from the network. Files in which file system remain accessible to me? [Choose one answer]

  A. AFS

  B. NFS

  C. CODA

  D. AFS and NFS

  E. NFS and CODA

  F. AFS and CODA

  G. AFS, NFS, CODA

PQ 1

- I'm using three file systems: AFS, NFS, CODA. I go camping and disconnect from the network. Files in which file system remain accessible to me? [Choose one answer]

A. AFS

B. NFS

C. CODA [Only CODA has support for disconnected operation]

D. AFS and NFS

E. NFS and CODA

F. AFS and CODA

G. AFS, NFS, CODA

PQ 2

- You want to extend assignment 2 with a set of secrets, each of which can only be used once. How do you change your existing implementation to accomplish this? [Answer in a couple of paragraphs]

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Take a sequence of secrets on the command line, parse these into a list. Whenever a client sends the fserver a client-hash, check if the client-hash matches some secret from the list by iterating through the list and performing the check:
$md5(nonce+secret_i)$ =?= client-hash

If this is true for some i, delete $secret_i$ from the list.

PQ 3

- Alice and Bob have laptops, each of which uses NTP to set the local time. Alice and Bob use a chat app. to communicate. This app. timestamps each message at the sender using the local clock and includes this clock value in the message. It shows a history of messages on the screen in an order based on these timestamps. Based on this description, can the scenario below occur? Why or why not? [Answer in a couple of sentences]

Alice: hi

Bob: hello

Alice: how is 416?

Bob: I like it

Actual exchange

Bob: hello

Bob: I like it

Alice: hi

Alice: how is 416?

Alice's history

Bob: hello

Bob: I like it

Alice: hi

Alice: how is 416?

Bob's history

PQ 3

- Alice and Bob have laptops, each of which uses NTP to set the local time. Alice and Bob use a chat app. to communicate. This app. timestamps each message at the sender using the local clock and includes this clock value in the message. It shows a <u>history</u> of messages on the screen in an order based on these timestamps. Based on this description, can the scenario below occur? Why or why not? [Answer in a couple of sentences]

Yes, this is possible. We can generate this scenario by having Bob's laptop set its time to 3:00PM before the conversation with Alice, and Alice's computer set it's time to 3:01PM before the conversation with Bob.

Actual exchange
Alice: hi
Bob: hello
Alice: how is 416?
Bob: I like it

Alice's history
Bob: hello
Bob: I like it
Alice: hi
Alice: how is 416?

Bob's history
Bob: hello
Bob: I like it
Alice: hi
Alice: how is 416?

PQ 4

- Which file system can support more clients, given a server that runs on identical hardware? [Choose one answer]

  A. NFS

  B. AFS

PQ 4

- Which file system can support more clients, given a server that runs on identical hardware? [Choose one answer]

  A. NFS

  B. AFS [AFS pushes client load from the server by caching entire files on the client side. It is strictly more scalable (in terms of number of clients) than NFS.]

PQ 5

- Given two events **a** and **b**, where a’s vector timestamp is [2,3,4] and b’s vector timestamp is [4,3,2], which of the following statements are true? [Choose one answer]

  A. a happened before b

  B. b happened before a

  C. a and b happened concurrently

  D. Not enough information

PQ 5

- Given two events **a** and **b**, where a's vector timestamp is [2,3,4] and b's vector timestamp is [4,3,2], which of the following statements are true? [Choose one answer]

  A. a happened before b

  B. b happened before a

  C. **a and b happened concurrently** [The two vector timestamps cannot be ordered, therefore the corresponding events occurred concurrently]

  D. Not enough information

PQ 6

- Given two events **a** and **b**, where a's Lamport clock timestamp is 2 and b's Lamport clock timestamp is 3, which of the following statements are true? [Choose one answer]

  A. a happened before b

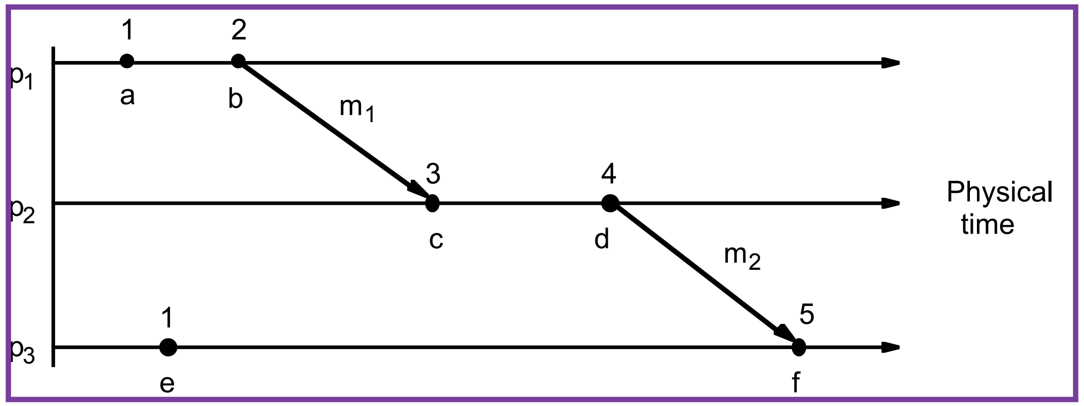
  B. b happened before a

  C. a and b happened concurrently

  D. Not enough information

PQ 6

- Given two events **a** and **b**, where a's Lamport clock timestamp is 2 and b's Lamport clock timestamp is 3, which of the following statements are true? [Choose one answer]



A. a happened before b

B. b happened before a

C. a and b happened concurrently

D. Not enough information [For Lamport clock values 2 < 3 does not imply that 'a happened before b'. Using the clock values alone we cannot tell which case we are in (see example diagram for counter-examples)]

PQ 7

- When building a distributed system our first goal is to synchronize the clocks of the nodes in the system [Choose one answer]

  A. True

  B. False

PQ 7

- When building any distributed system the first step is to synchronize the clocks of the nodes in the system [Choose one answer]

  A. True

  B. False [Synchronizing clocks is complex and many useful distributed systems do not require clock synchrony.]

PQ 8

- In an asynchronous environment it is impossible to provide distributed mutual exclusion with fairness guarantees [Choose one answer]

  A. True

  B. False

PQ 8

- In an asynchronous environment it is impossible to provide distributed mutual exclusion with fairness guarantees [Choose one answer]

A. True

B. False [We covered two algorithms that do this: dist. mutual exclusion with fairness in a ring topology and the Ricart Agrawala algorithm]

PQ 9

- Ricart and Agrawala distributed mutual exclusion algorithm uses logical clocks [Choose one answer]

  A. True

  B. False

PQ 9

- Ricart and Agrawala distributed mutual exclusion algorithm uses logical clocks [Choose one answer]

  A. **True** [It uses lamport clock timestamps to decide whether or not a node should respond to a request]

  B. False

PQ 10

You are tasked with designing a new distributed mutual exclusion protocol based on voting. You come up with the following solution:

- A node requests permission (votes) from other nodes before proceeding to execute its critical section.
- The node does not proceed unless it receives a majority of replies from other nodes.

What are some problems with this solution?

PQ 10

You are tasked with designing a new distributed mutual exclusion protocol based on voting. You come up with the following solution:

- A node requests permission (votes) from other nodes before proceeding to execute its critical section.
- The node does not proceed unless it receives a majority of replies from other nodes.

What are some problems with this solution?

1. Possibility of deadlock. Group of 6 nodes: node X receives 2 votes and node Y receives 2 votes. Neither can proceed.
2. Unfair. Node X issues requests before node Y, but node Y could collect majority of votes faster than X.
3. Cannot make progress when nodes fail (no “liveness” guarantee on failures). Group of 6 nodes: 3 nodes fail, then node X issues requests and receives 2 votes. But, it needs at least 3 votes to start executing critical section.

PQ 11

- You are transmitting data packets over a link that can inject at most one bit error in each packet. What is the cheapest error detection solution that you can use to detect errors with perfect reliability?
  - md5 hash
  - Parity bit
  - Complement sums
  - CRC
  - md5 hash

PQ 11

- You are transmitting data packets over a link that can inject at most one bit error in each packet. What is the cheapest error detection solution that you can use to detect errors with perfect reliability?
  - md5 hash
  - **Parity bit [detect a single bit flip perfectly]**
  - Complement sums
  - CRC
  - md5 hash

PQ 12

- RAID uses complement sum for error detection

  A. Yes

  B. No

PQ 12

- RAID uses complement sum for error detection

A. Yes

B. No [RAID uses Parity]

PQ 13

- MTBF stands for

  A. Mean time between failure

  B. Mean time before failure

PQ 13

- MTBF stands for

  A. Mean time between failure [Remember the timeline; MTBF captures all of the time the system was running]

  B. Mean time before failure

PQ 14

- Which of these raid levels has the lowest storage utilization (most disk space wasted on redundancy)

A. RAID 0

B. RAID 1

C. RAID 4

D. RAID 5

PQ 14

- Which of these raid levels has the lowest storage utilization (most disk space wasted on redundancy)

A. RAID 0

B. RAID 1 [i.e., Drive mirroring. Wastes 1/2 of total storage capacity.]

C. RAID 4

D. RAID 5

PQ 15

- Primary-backup replication is more fault-tolerant than quorum replication.
    - True
    - False

PQ 15

- Primary-backup replication is more fault-tolerant than quorum replication.
  - True
  - False [If the primary dies, the entire system halts. Not so with a quorum-based system: as long as majority is alive, the system is available.]

PQ 16

- You are a system architect. You decide to use Paxos as a core algorithm for fault tolerance. You want to design you system to survive f failures. How many replicas do you need in your system to satisfy this requirement?

  A. f

  B. f+1

  C. 2f+1

  D. 3f+1

  E. 4f+1

PQ 16

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    A. f

    B. f+1

    C. 2f+1 [f fail => f+1 remain alive, which is enough for a quorum]

    D. 3f+1

    E. 4f+1

PQ 17

- To use the Paxos protocol you must first elect a leader.
  - True
  - False

PQ 17

- To use the Paxos protocol you must first elect a leader.
  - True
  - False [A leader-based Paxos is an optimization. You can have leaderless-Paxos. It’s just slower.]

PQ 18

- Like two phase commit, Paxos has two stages
  - True
  - False

PQ 18

- Like two phase commit, Paxos has two stages
  - True
  - False [Paxos has three stages: prepare, accept, commit]

PQ 19

- DNS is a globally distributed, strongly consistent, database
    - True
    - False

PQ 19

- DNS is a globally distributed, strongly consistent, database
  - True
  - False [DNS is **not** strongly consistent]

PQ 20

- A content distribution network provides a way for content providers to shed load from their servers
    - True
    - False

PQ 20

- A content distribution network provides a way for content providers to shed load from their servers
  - True [A CDN is fancy cache]
  - False

PQ 21

- Imagine that you wanted to build a CDN that not only cached static content, but also cached dynamically-generated results. Sketch out a high-level design for this kind of CDN. (hint: what properties must this kind of CDN provide?)

PQ 21

- Basic design:
  - Server S computing the dynamically-generated content embeds a special hash H along with the akamai link to the content
    - H is a pointer to state necessary to generate the content, this state can be maintain at S until some timeout. Assumption: given two requests, if they resolve to the same hash H, then the dynamic content response is identical.
  - Client requests and downloads index.html containing akamai links. Client resolves akamai links to the akamai servers in the usual way.
  - Akamai server A sees the hash H, and first determines if the (dynamic) content corresponding to H is in its cache.
    - If content for H is in cache, A checks if this content has expired. If not expired then return the content to client.
    - If content is not in the cache, contact S, sending along H, and receive the generated content. S will also send along an expiration TTL for the dynamically generated content in its reply. Cache this content, then reply to client.