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Ques - 6 :- Distributed Deadlock simulation :-

Given :- (wait for graph segments)

→ S1 : P1 → P2 , P3 → P4

→ S2 : P2 → P5 , P5 → P6

→ S3 : P6 → P1

(a) Global wait for graph.

Combine all edges :-

P1 → P2

P3 → P4

P2 → P5

P5 → P6

P6 → P1

(b) Deadlock Detection :-

Look for cycle

P1 → P2 → P5 → P6 → P1

Date

→ This forms a cycle → DEADLOCK exists

Deadlock processes → {P1, P2, P5, P6}

(c) Chandy-Misra, Hass Algorithm → (Suitable Distributed Deadlock Algo) for detection

Uses probe messages to detect cycles in distributed wait for graphs without a central coordinator.

Ques 7 → given :-

→ Local access = 5 ml

→ Remote access = 25 ms

→ probability (remote) = 0.3

→ probability (local) = 0.7

(a) Expected file access time

$$E = (0.7 \times 5) + (0.3 \times 25)$$

$$E = 3.5 + 7.5$$

$$E = 11 \text{ ms.}$$

Uses " client side cache with LRU Eviction".

Reason :

- Frequently accessed remote files are cached locally → reduces remote access.
- LRU ensures only least used files are removed.
- Minimises average access time and reduces network load.

Ques 8 → given :-

→ full checkpoint = 200 ms

→ incremented checkpoint = 50 ms.

→ must recover within 1 sec RPO.

→ Total period → 10 seconds

(a) optimal min : Use 1 full checkpoint for every 10 seconds.

→ Incremental checkpoints every 1 second.

So, over 10 seconds → $10 \times 50 = 500$ ms.

(b) RPO = 1 second → must not lose more than 1 second of progress.

→ Incremental checkpoints every second satisfy RPO.

→ full checkpoint every 10 sec prevents log chains and speed recovery.

→ combination gives low overhead + fast re.

Ques 9 → (a) challenges :-

1) Highly variable workload (flash sales, sudden spikes).

2) Ensuring requests are routed to the least loaded region

3) Network latency and geographic distance

4) preventing overload of a single data centre

* Suitable Algorithm :-

- Dynamic Load Balancing using "Least loaded sensor + Global Distributed load balancer".

- Each data centre reports load to a global scheduler

- Requests routed to the region with minimum active load

- Adapts in real time during flash sale spikes.

· Use active - active Multi - Region Deployment.

Components :-

1) geo replicated databases (eg:- multimaster replication)

→ Keeps RPO ≈ 0 (almost zero data loss).

2) Global failover using anycast DNS/Traffic manager.

→ Redirects traffic to healthy region within seconds → low RTO.

3) Distributed message queues + stateless micro services.

→ Allows seamless services restart in other regions.

4) Regular checkpoints and log replication.

→ Ensures latest state recovery.

* Result :-

→ Even if one regional data centre fails, a service continues from another region with minimal downtime (Low RTO) and minimal data loss (Low RPO)