* Distributed System (DS) - Assignment Number - 3.

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★ Compare Cristan's algorithm and Berkeley's algorithm.

→ Cristan's Algorithm :-

Cristan's algorithm is a clock synchonization algorithm is used to synchronize time with a time server by client processes. This algorithm works well with low-latency network where Round Trip Times is short as compared to accuracy while redundancy-prone distributed systems/ applications do not go hand in hand with this algorithm. Here Round Trip Time refers to the time duration between the start of a Request and the end of the corresponding Response.

Algorithm :-

1) The process on the client machine sends the request for fetching clock time (time at the server) to the Clock Server at time T_0.
2) The Clock Server listens to the request made by the client process and returns the response in form of clock server time.
3) The client process fetches the response from the Clock Server at the time T_1 and calculate the synchronized client clock time using the formula.. $T_{client} = T_{server} + (T_1 - T_0)/2$.

Berkeley's Algorithm :-

Berkeley's Algorithm is a clock synchronization technique used in distributed systems. The algorithm assumes that each machine node in the network either doesn't have an accurate time source or doesn't possess an UTC server.

Algorithm :-

1) An individual node is chosen as the master node from a pool nodes in the network. This node is the main node in the network which acts as a master and rest of the nodes act as slaves. Master node is chosen using a election process / leader election algorithm.
2) Master node periodically pings slaves nodes and fetches clock time at them using Cristian's algorithm.
3) Master node calculates average time difference between all the clock times received and the clock time given by master's system clock itself. This average time difference is added to current time at master's system clock and broadcasted over the network.

★ Compare Centralized, Distributed and Token ring mutual exclusion algorithms.

→	Parameters	Centralized Algorithm	Distributed Algorithm	Token ring Algorithm
①	Election	One process is, elected as coordinator	Total ordering of all events in the System.	Uses token for entering critical section.
②	Messages per entry / exit.	Requires three messages to enter and exit a critical region.	Requires $2(n-1)$ messages.	Variable number of messages required.

	Parameters	Centralized Algorithm	Distributed Algorithm	Token Ring Algorithm
③	Delay in messages time	Delay for messages is 2 messages.	Delay for messages is 2(n-1).	The time varies from 0 to n-1 tokens.
④	Mutual Exclusion	Guarantee mutual exclusion.	Mutual exclusion guaranteed without dead lock.	Mutual exclusion is guarnteed.
⑤	Starvation	No starvation	No starvation	No starvation
⑥	Complexity	Easy to implement	Complicated process	Implementation is easy.
⑦	Used for	Used for general allocation	Used for small group processes that do not change group membership.	Used process in ring configuration.
⑧	Problem	Entire system can go down Due to single point of failure, Bottleneck.	N points of failure	Detecting the lost token and regeneration is difficult.
⑨	Expense	Less expensive	More expensive	Less expensive
⑩	Robustness	More robust	Less robust	More robust.