NTP Synchronization Algorithm

Distributed Systems - Class Presentation

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Clock Synchronization

Process of ensuring that physically distributed processors (systems) have the same notion of time.

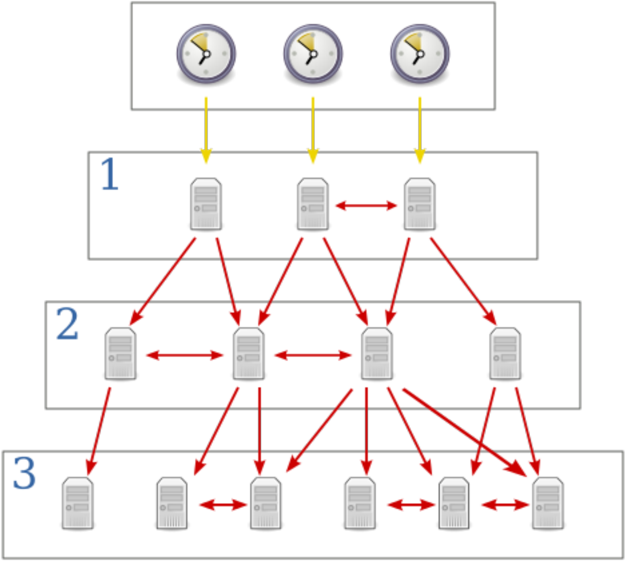
Need for clock synchronisation

- We need timestamps or intervals and orderings of time between events for processing.
- Example: Updates should be before accesses (ordering).
- Replace communication with local computation.
- Implementing timeouts in protocols or algorithms.

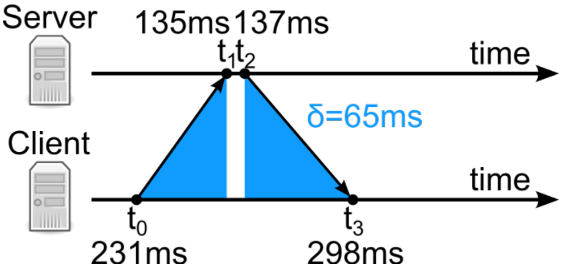
Network Time Protocol – Highlights

- NTP later structure: Multiple strata starting at 0/1 at the original time sourse. Each node syncs with it's parent node.
- Benefits of NTP: Large adjustments made quickly and then smaller adjustments keep happening over time.
- insane time (part of protocol/implementation)
- Uses UDP (user datagram protocol). Hence low latency.

Network Time Protocol – Schematic



Interaction



Protocol

Figure 3.9 Offset and delay estimation [15].

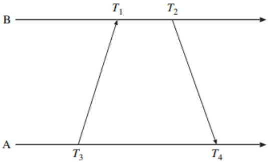
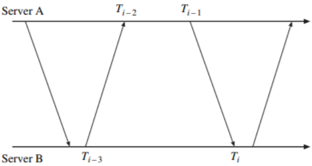


Figure 3.10 Timing diagram for the two servers [15].



Let $a = T_1 - T_3; b = T_2 - T_4$. Then,
Clock offset $\theta = (a + b)/2$
Round trip delay $\delta = a - b$

Algorithm

- A pair of servers in symmetric mode exchange pairs of timing messages.
- A store of data is then built up about the relationship between the two servers (pairs of offset and delay).
- Specifically, assume that each peer maintains pairs (O_i, D_i), where O_i is the offset θ and D_i is the transmission delay of the two messages δ
- The offset corresponding to the minimum delay is chosen. Specifically, the delay and offset are calculated as follows. Assume that message m takes time t to transfer and m' takes t' to transfer.

Algorithm ... continued

- The offset between A's clock and B's clock is O. If A and B's local clock times are $A(t)$ and $B(t)$, we have

$$A(t) = B(t) + O$$

$$T_{i-2} = T_{i-3} + t + O$$

$$T_i = T_{i-1} - O + t'$$

Assuming $t = t'$, we can estimate offset

$$O_i = (T_{i-2} - T_{i-3} + T_{i-1} - T_i)/2$$

And Round trip delay

$$D_i = (T_i - T_{i-3}) - (T_{i-1} - T_{i-2})$$

- Retain 8 latest pairs of (O_i, D_i) and choose the offset corresponding to the minimum round trip delay to estimate O.

Thank You!