CLOUD COMPUTING CONCEPTS

with Indranil Gupta (Indy)

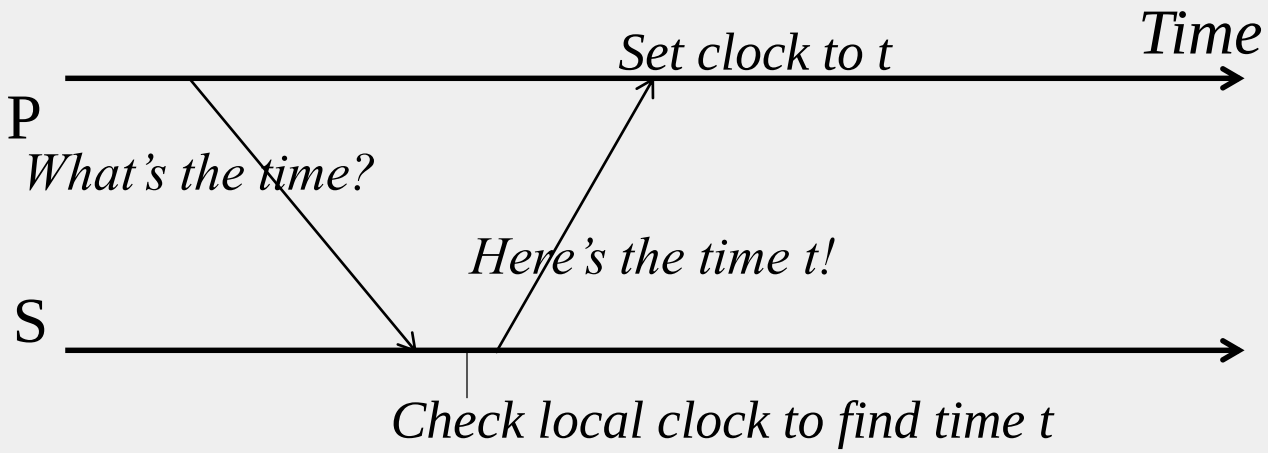
TIME AND ORDERING

Lecture B

CRISTIAN'S ALGORITHM

Basics

- **External time synchronization**
- **All processes P synchronize with a time server S**

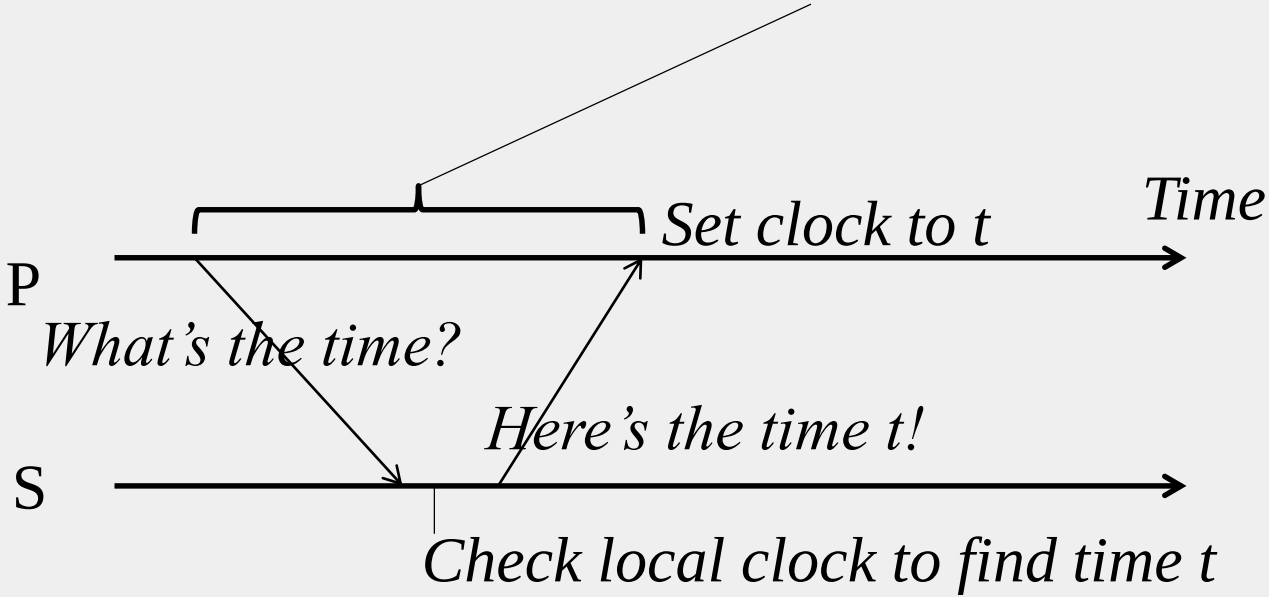


What's Wrong

- By the time response message is received at P, time has moved on
- P's time set to *t* is inaccurate!
- Inaccuracy a function of message latencies
- Since latencies unbounded in an asynchronous system, the inaccuracy cannot be bounded

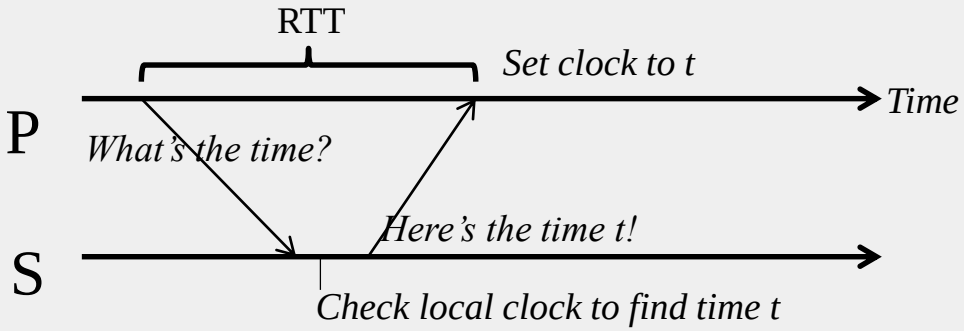
Cristian's Algorithm

- P measures the round-trip-time RTT of message exchange



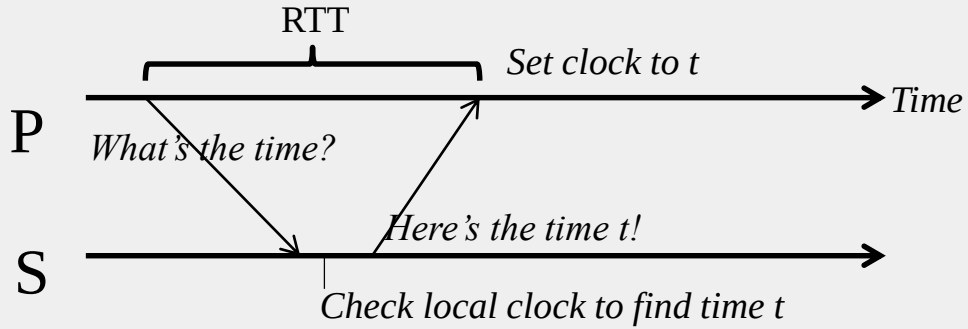
Cristian's Algorithm (2)

- **P measures the round-trip-time RTT of message exchange**
- **Suppose we know the minimum P → S latency min1**
- **And the minimum S → P latency min2**
  - min1 and min2 depend on operating system overhead to buffer messages, TCP time to queue messages, etc.



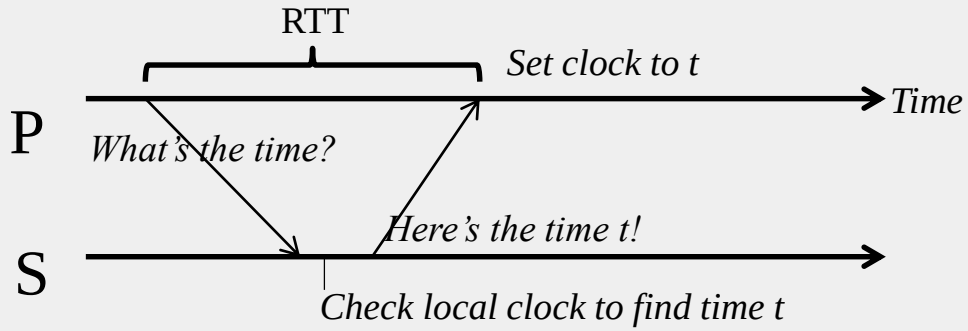
Cristian's Algorithm (3)

- P measures the round-trip-time RTT of message exchange
- Suppose we know the minimum P → S latency min1
- And the minimum S → P latency min2
  - min1 and min2 depend on Operating system overhead to buffer messages, TCP time to queue messages, etc.
- The actual time at P when it receives response is between [t+min2, t+RTT-min1]



Cristian's Algorithm (4)

- The actual time at P when it receives response is between [t+min2, t+RTT-min1]
- P sets its time to halfway through this interval
  - To: t + (RTT+min2-min1)/2
- Error is at most (RTT-min2-min1)/2
  - Bounded!



Gotchas

- **Allowed to increase clock value but should never decrease clock value**
  - May violate ordering of events within the same process
- **Allowed to increase or decrease speed of clock**
- **If error is too high, take multiple readings and average them**