CLOUD COMPUTING CONCEPTS

with Indranil Gupta (Indy)

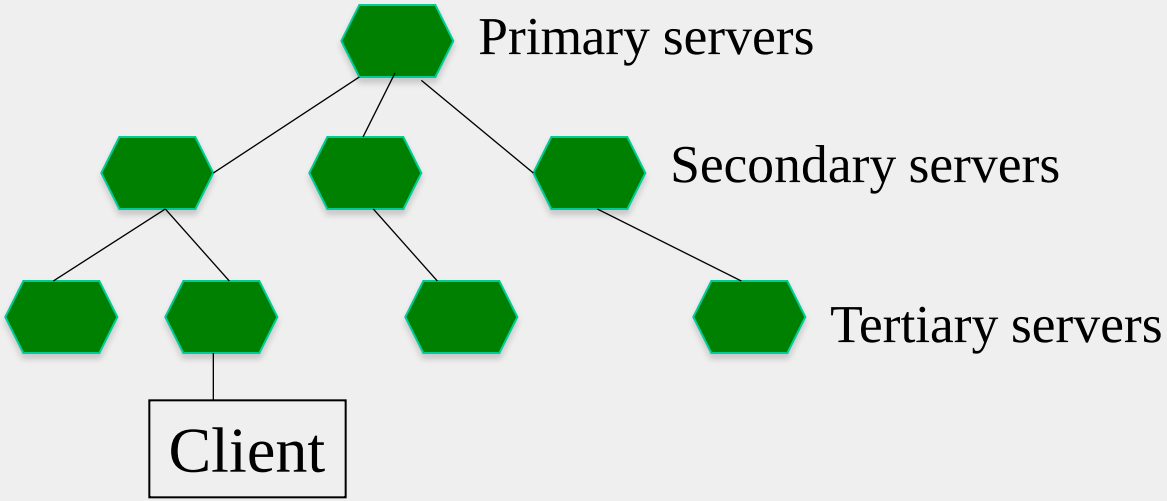
TIME AND ORDERING

Lecture C

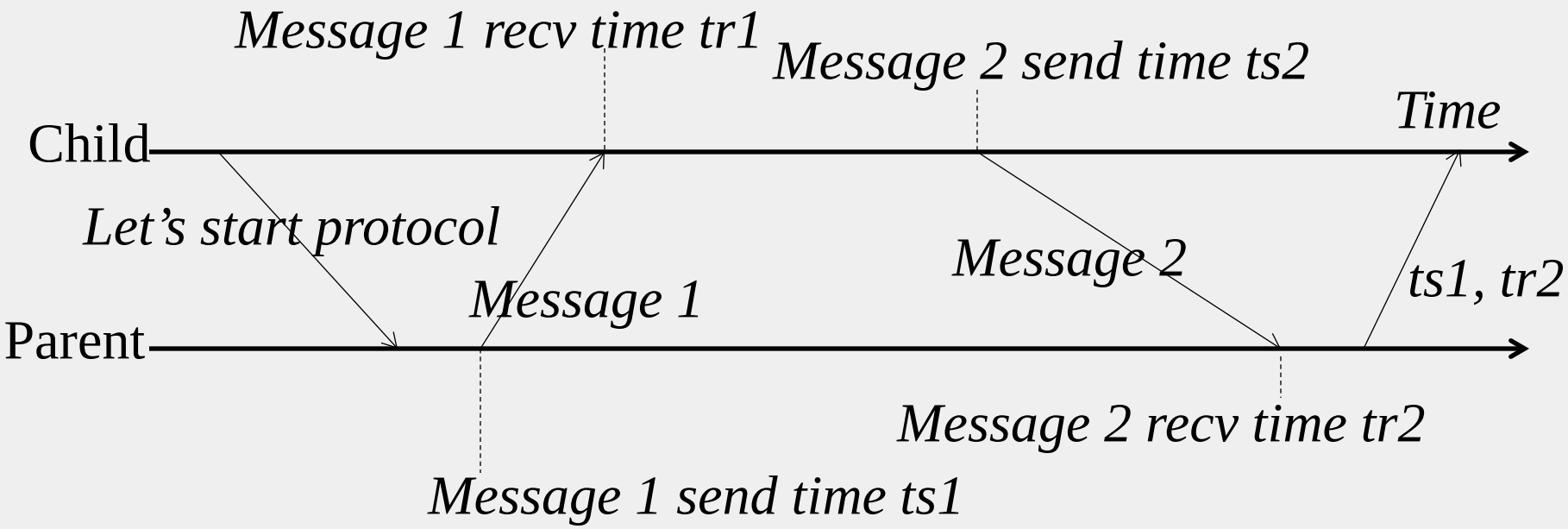
NTP

NTP = Network Time Protocol

- NTP servers organized in a tree
- Each client = a leaf of tree
- Each node synchronizes with its tree parent



NTP Protocol



What the Child Does

- Child calculates *offset* between its clock and parent's clock
- Uses *ts1*, *tr1*, *ts2*, *tr2*
- Offset is calculated as

  $o = (tr1 - tr2 + ts2 - ts1)/2$

Why o = (tr1 - tr2 + ts2 - ts1)/2?

- **Offset *o* = *(tr1 – tr2 + ts2 – ts1)/2***
- **Let’s calculate the error**
- **Suppose real offset is *oreal***
  - Child is ahead of parent by *oreal*
  - Parent is ahead of child by *-oreal*
- **Suppose one-way latency of Message 1 is *L1* (*L2* for Message 2)**
- **No one knows *L1* or *L2*!**
- **Then**

  tr1 = ts1 + L1 + oreal

  tr2 = ts2 + L2 – oreal

Why o = (tr1 - tr2 + ts2 - ts1)/2?

- **Then**

  $tr1 = ts1 + L1 + oreal$

  $tr2 = ts2 + L2 - oreal$

- **Subtracting second equation from the first**

  $oreal = (tr1 - tr2 + ts2 - ts1)/2 + (L2 - L1)/2$
  $\Rightarrow oreal = o + (L2 - L1)/2$

  $\Rightarrow |oreal - o| < |(L2 - L1)/2| < |(L2 + L1)/2|$

  – Thus, the error is bounded by the round-trip-time

And yet…

- **We still have a non-zero error!**
- **We just can’t seem to get rid of error**
  - Can’t, as long as message latencies are non-zero
- **Can we avoid synchronizing clocks altogether and still be able to order events?**