Clock synchronization

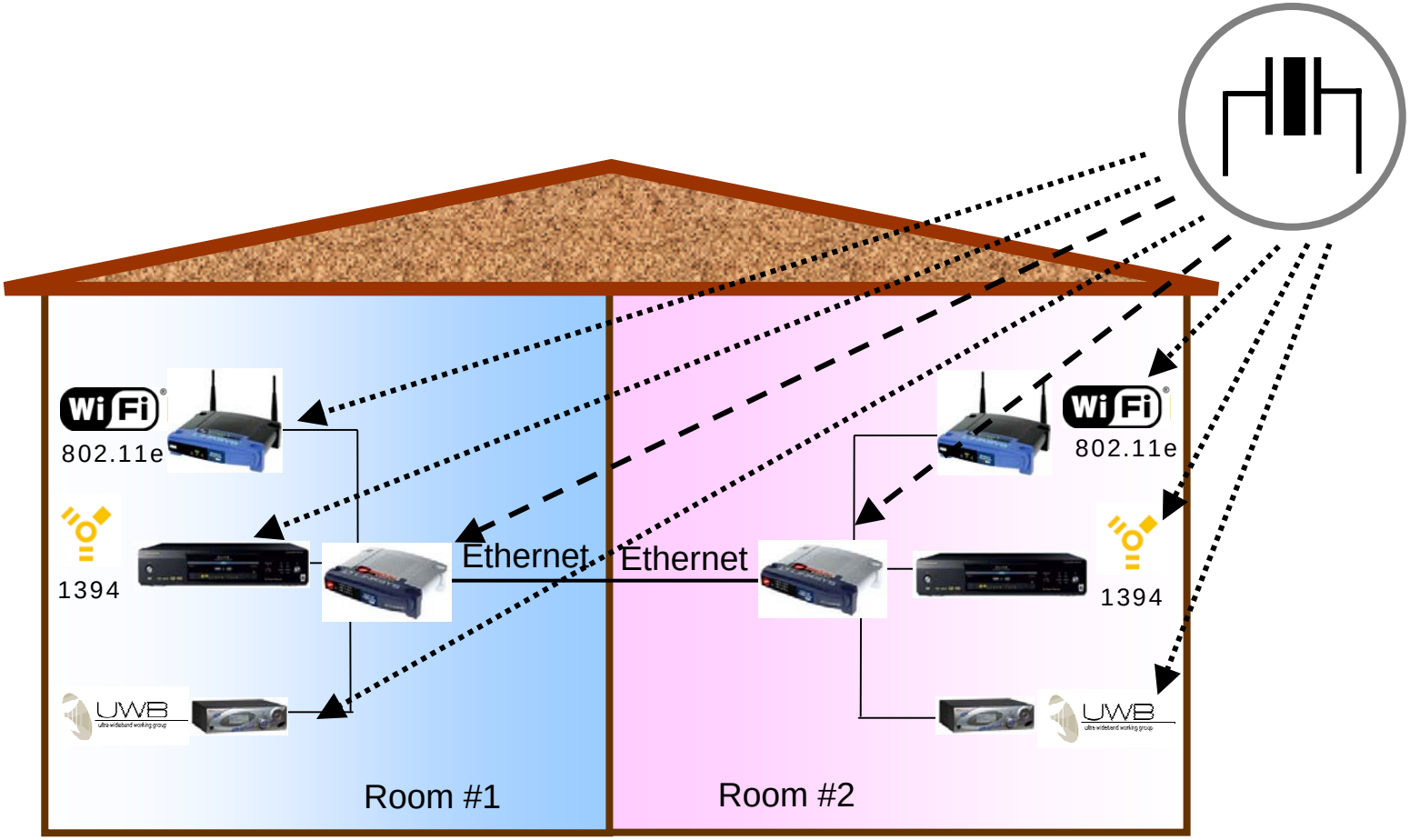
(a Residential Ethernet SG presentation)

David V James	JGG
Alexei Beliaev	Gibson
George Claseman	Micrel

Categories of work

- Service discovery (out of scope)
  - Identify/control “talkers” and their available “plugs”
- Subscription (802.1 centric)
  - Establish conversation between talker and listener(s)
  - Reject unless: *linkBandwidth* < *linkCapacity*
- Clock synchronization
  - Synchronous reception, forwarding, and presentation
- Pacing
  - Talkers must not be well behaved
  - Bridges should “sustain” such behaviors
- Formats
  - Frame formats and content (stream IDs, time stamps)
  - Time aware service interfaces

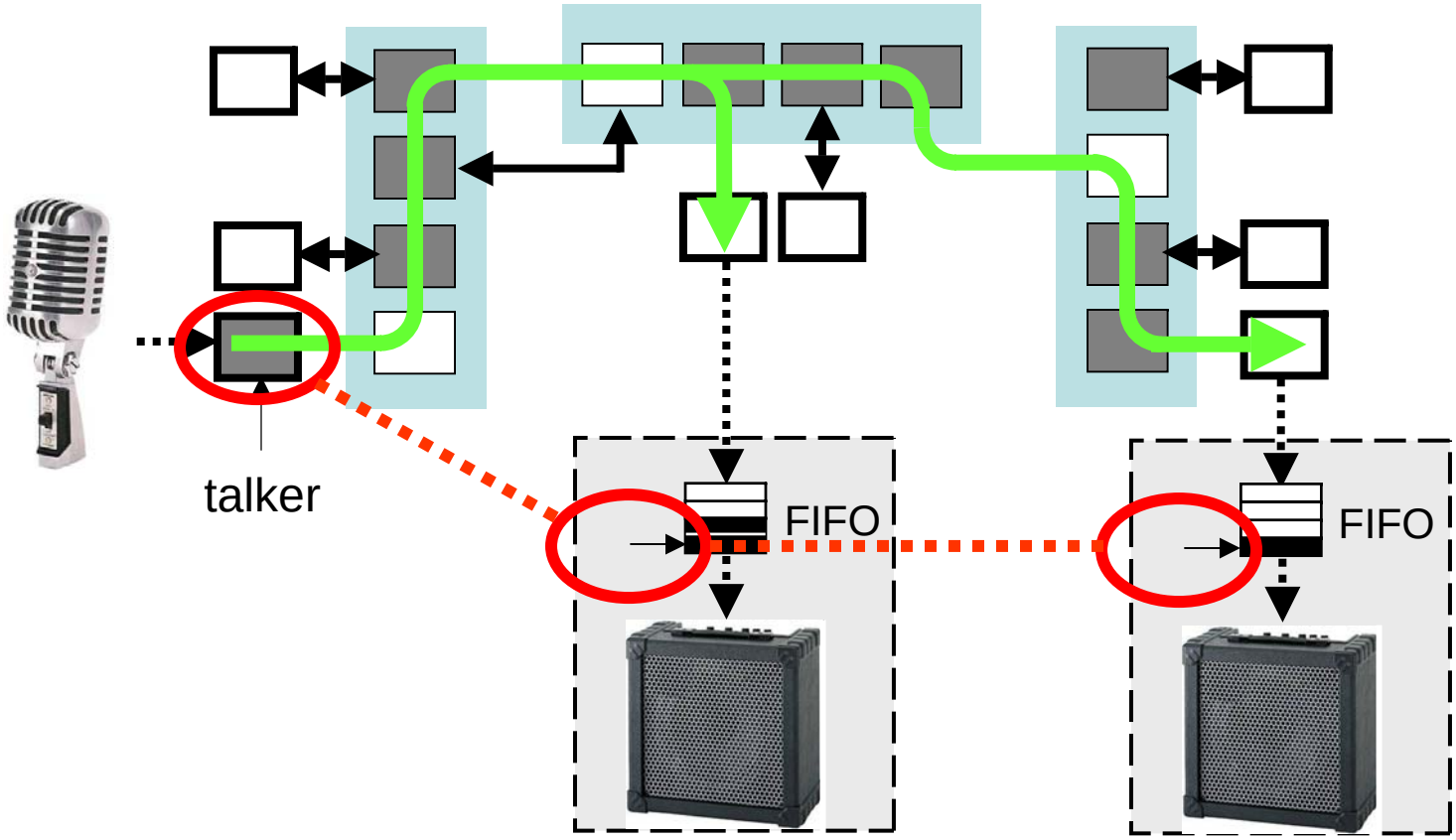
House reference clock



Overview

- What?
  - The clock slaves time-of-day tracks the grand master
  - No requirement for slaves to be clock-synchronous
- How?
  - Periodic exchanges of small messages
- Why?
  - Bridges: synchronized 125us cycles
  - Applications: accurate presentation times

Precise time synchronization

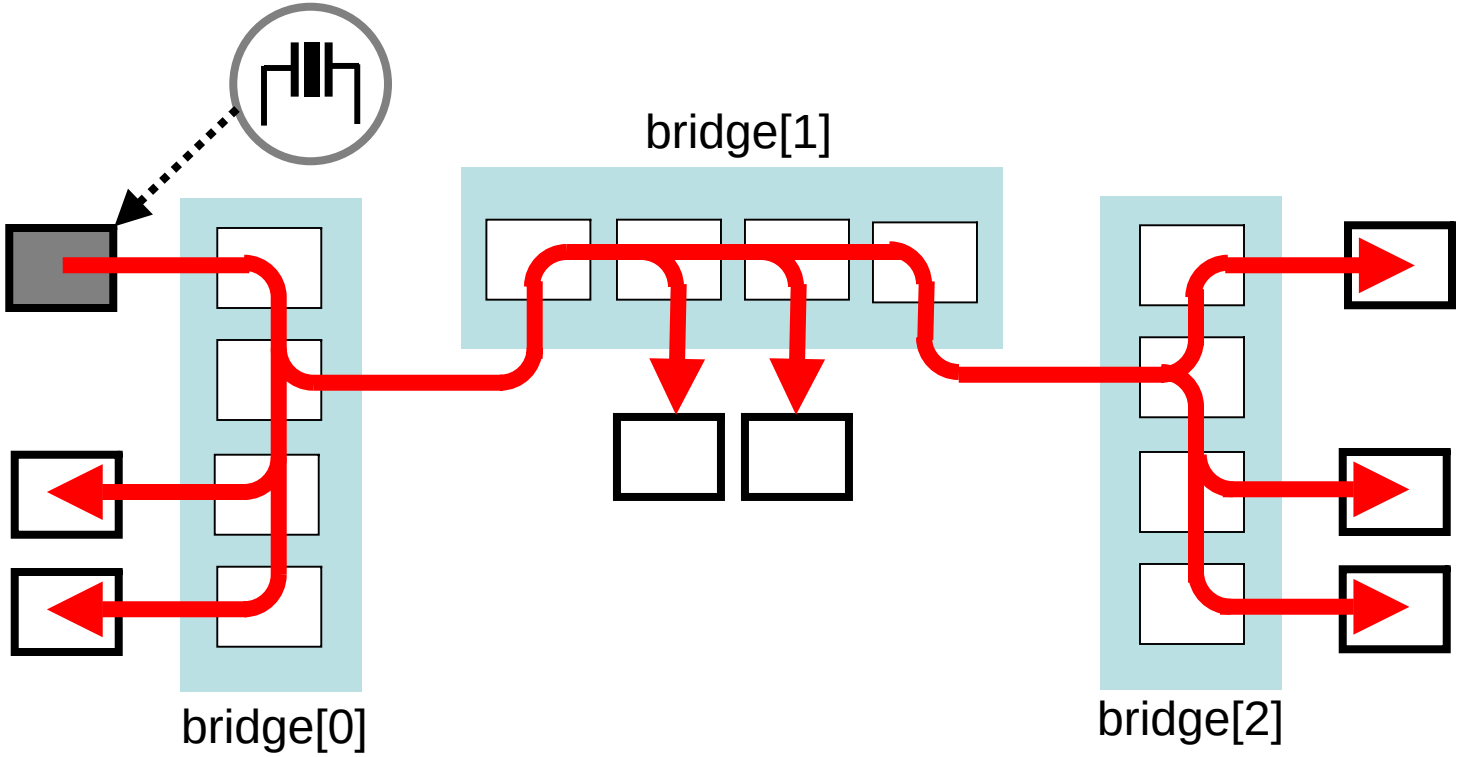


Leveraged protocols

- Spanning tree protocol (STP)
  - Defines the grand-master precedence format
  - But, we use a distinct value and distribution protocol (The STP root and grand master could be distinct!)
- NTP (RFC-1305) and SNTP (RFC-2030)
  - Definition of the 64-bit time-of-day value
- IEEE 1588-2002
  - Techniques for delayed-sampling synchronization

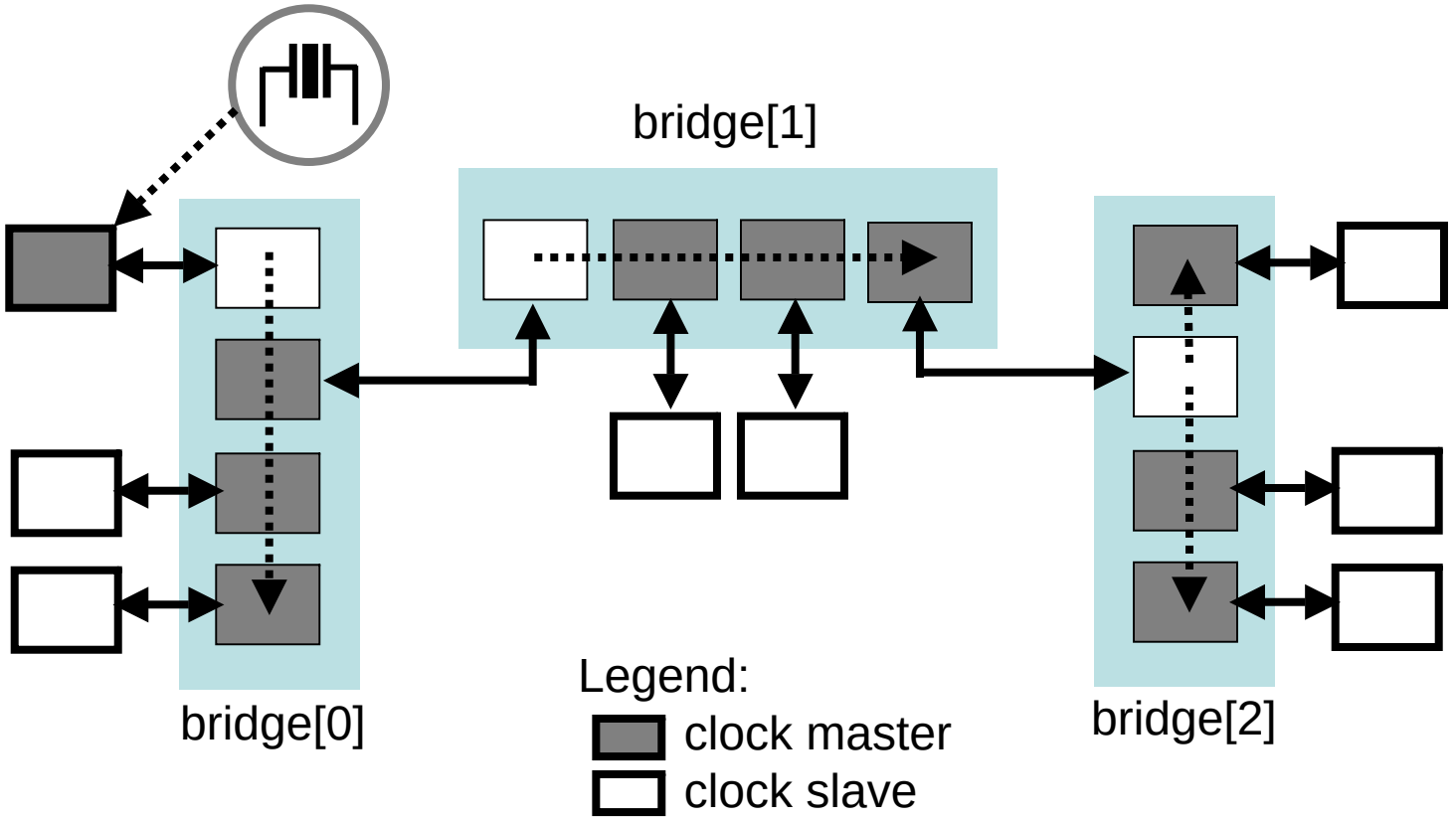
Cascaded TOD synchronization

Wall-clock distribution model



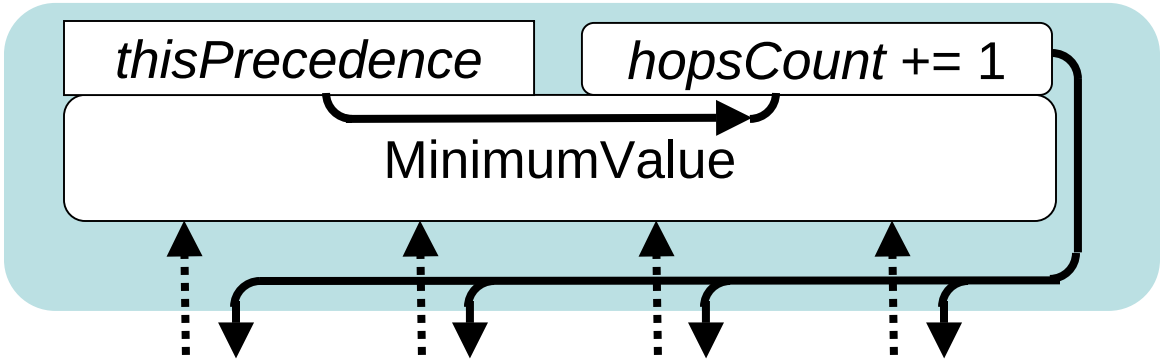
Cascaded TOD synchronization

Cascaded adjacent-synchronization hierarchy

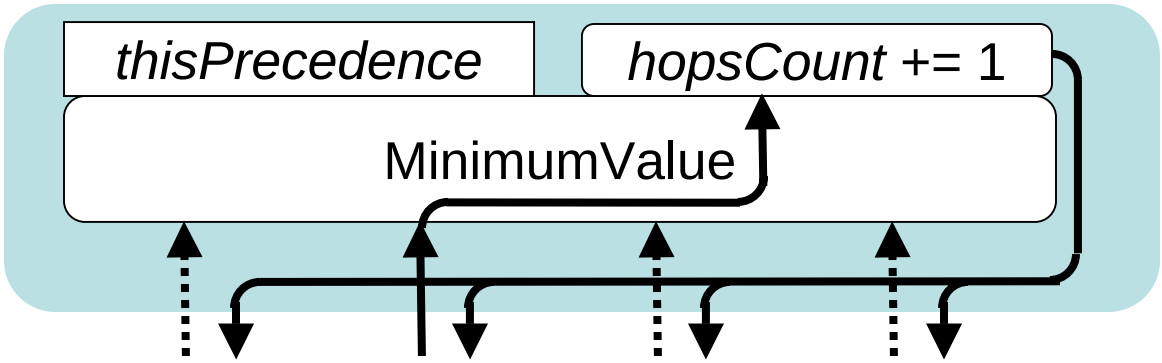


Cascaded TOD synchronization

Grand-master selection protocol

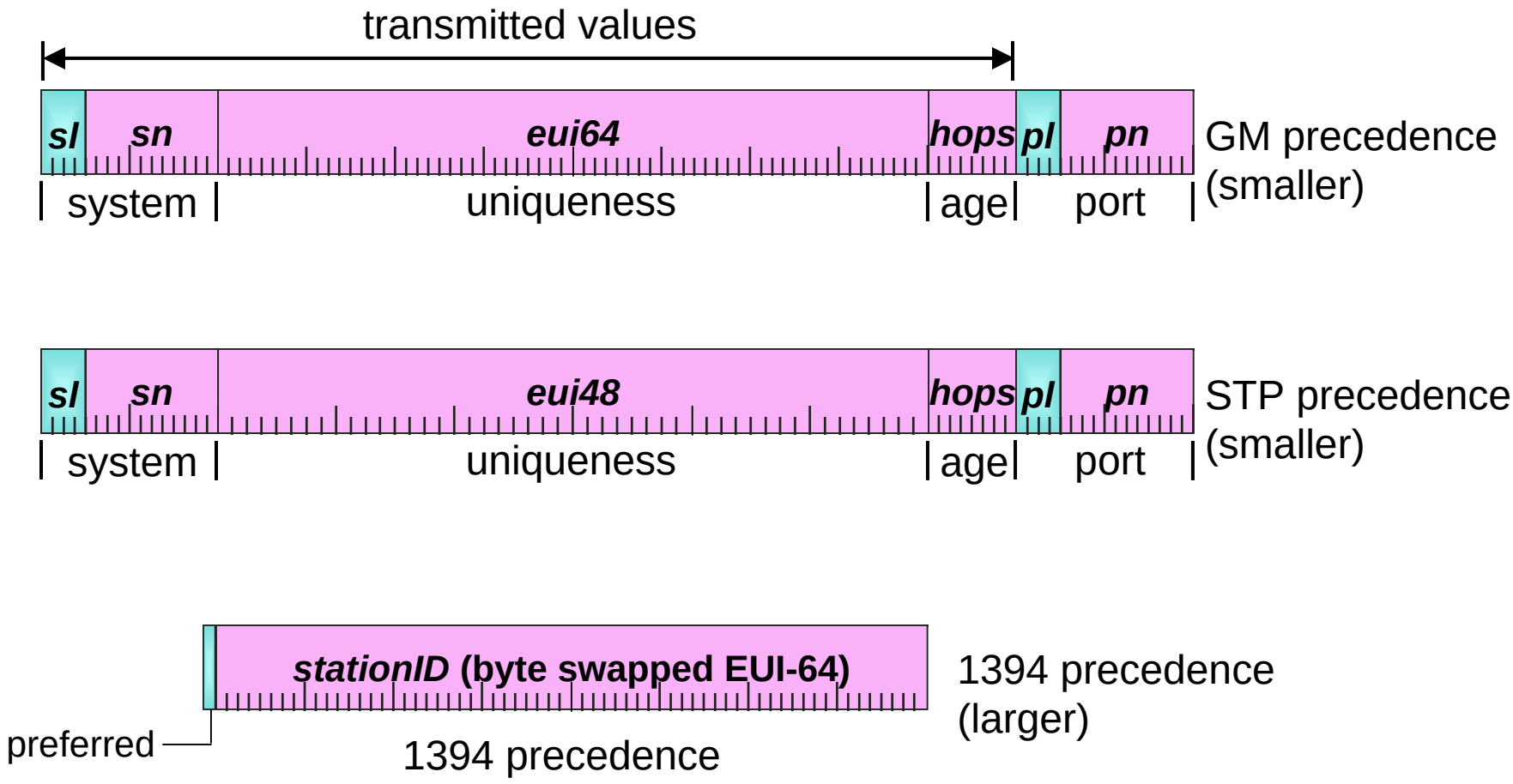


Grand-master

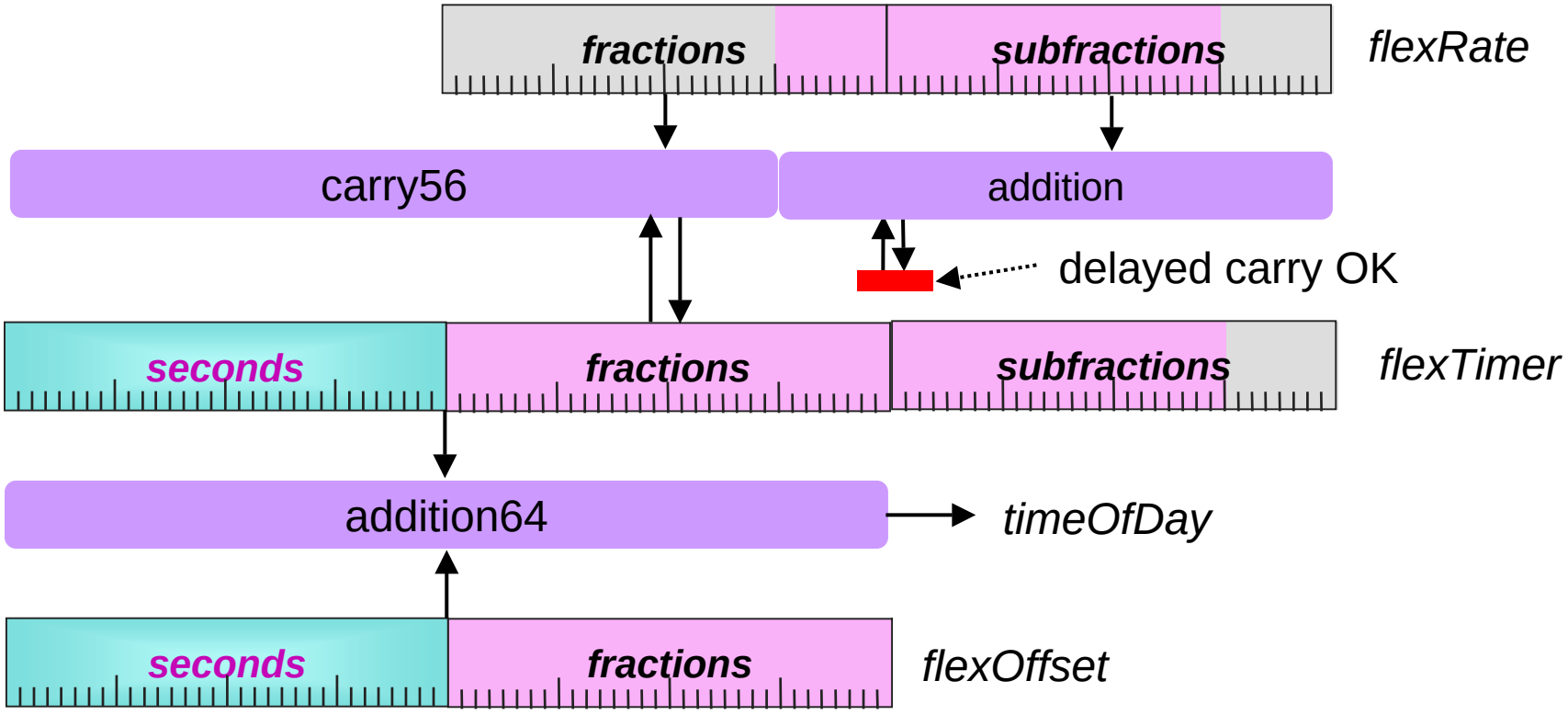


Clock-slave

Grand-master precedence

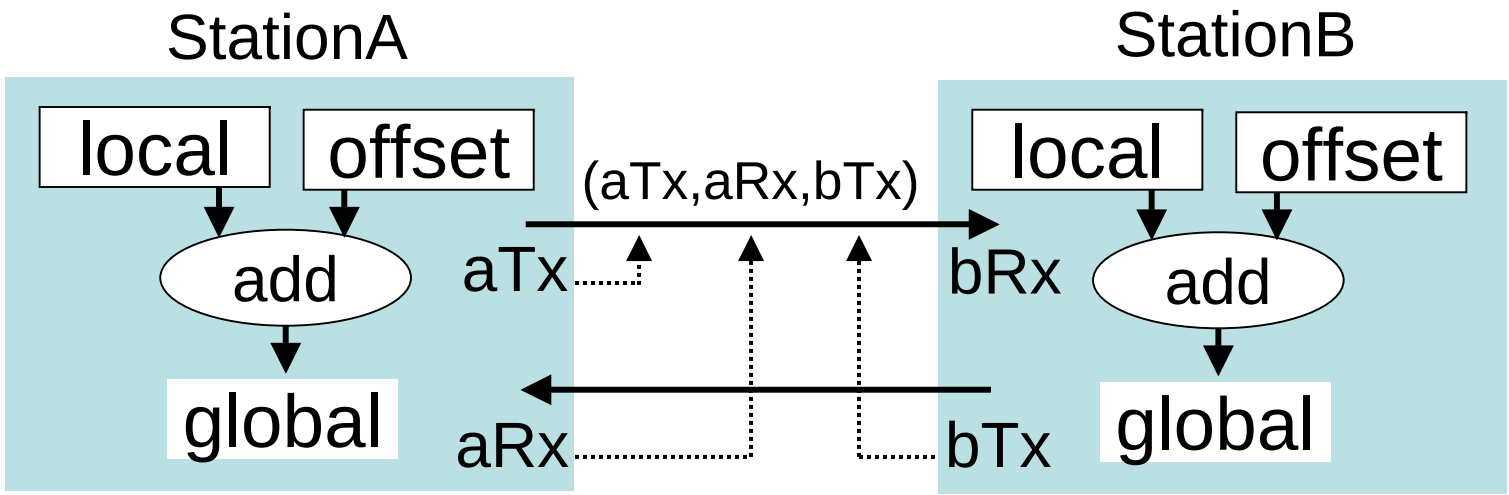


Adjustable *timeOfDay* timer



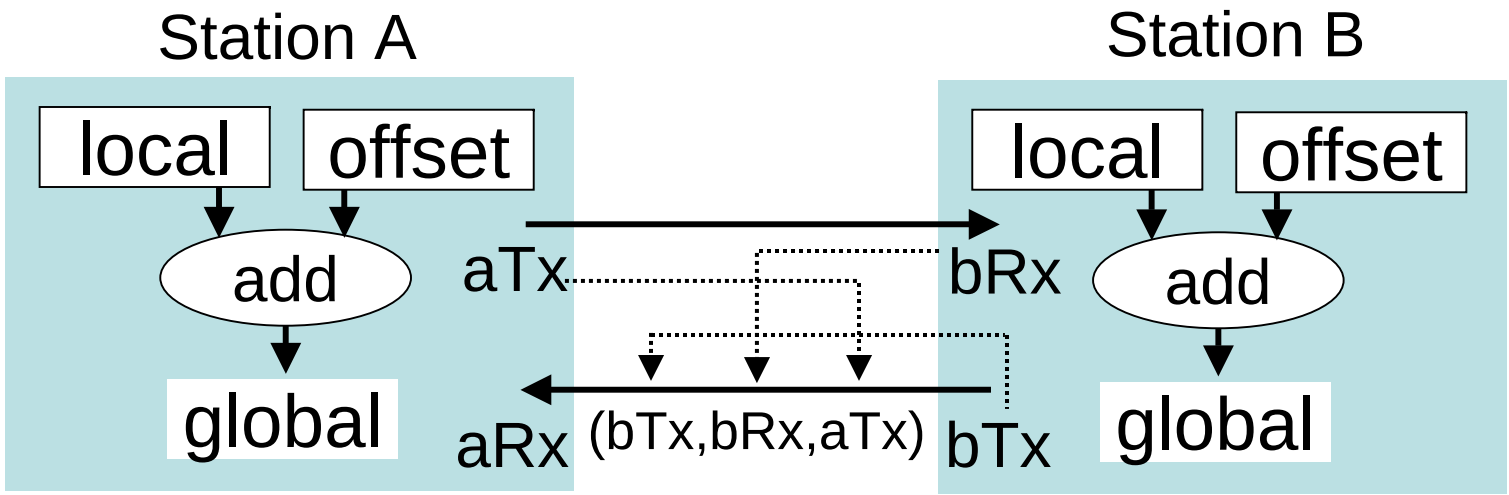
Adjacent-station synchronization

Snapshot value distribution
(information for stationB)

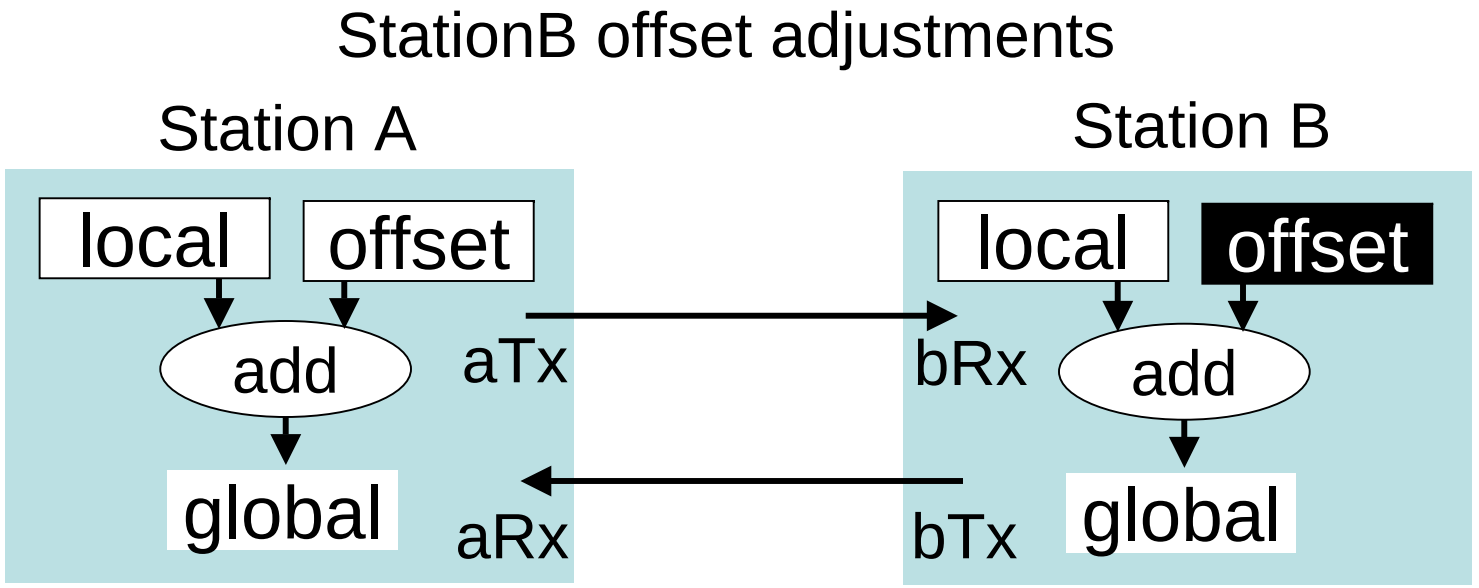


Adjacent-station synchronization

Snapshot value distribution
(information for stationA)

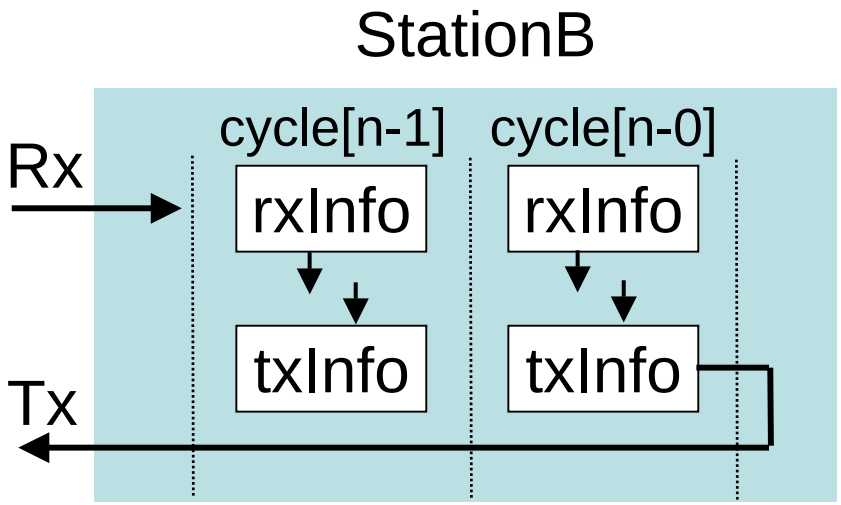


Adjacent-station synchronization

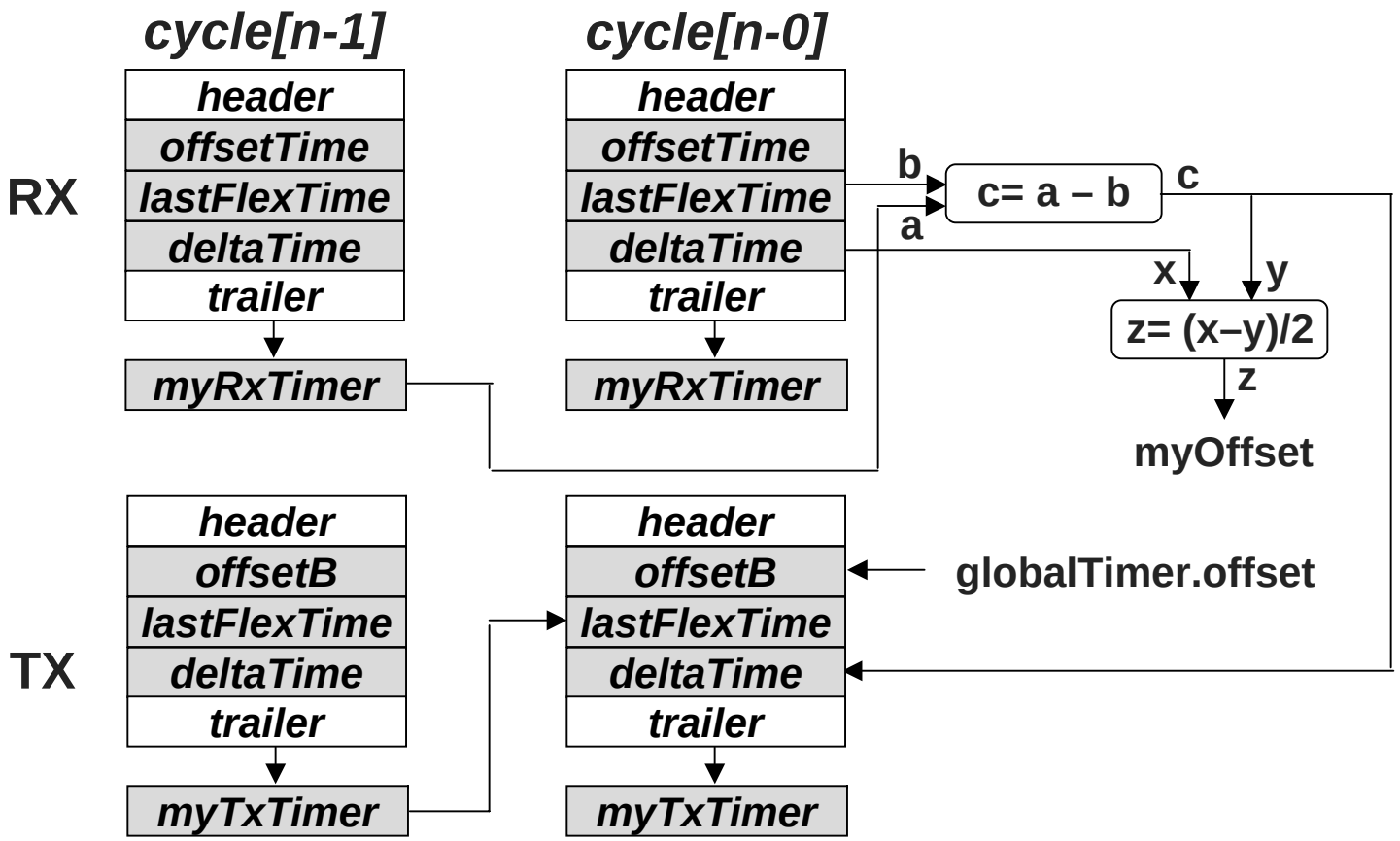


- rxDelta = (bRx – aTx);
- txDelta = (bTx – aRx);
- clockDelta = (txDelta – rxDelta) / 2;
- cableDelay = (txDelta + rxDelta) / 2;
- offsetB = offsetA + clockDelta;

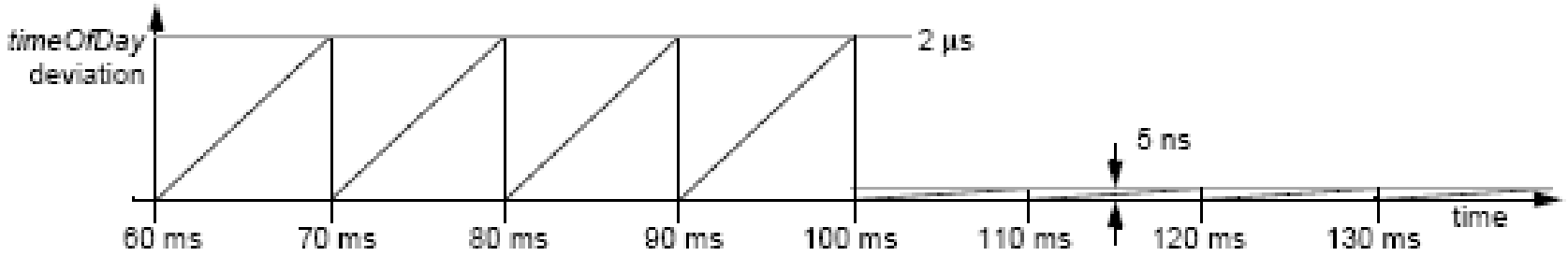
Clock slave details (1)



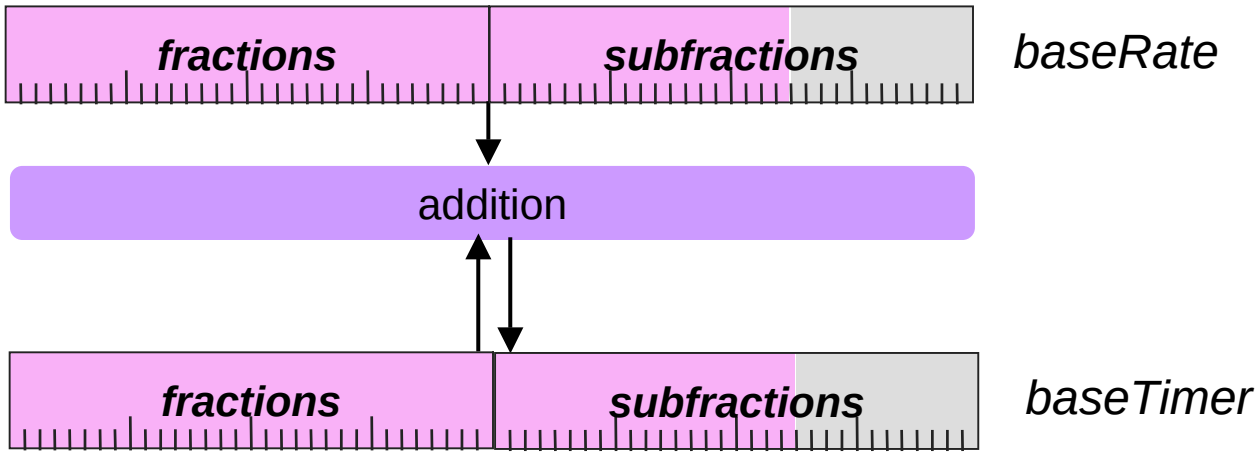
Clock-slave details (2)



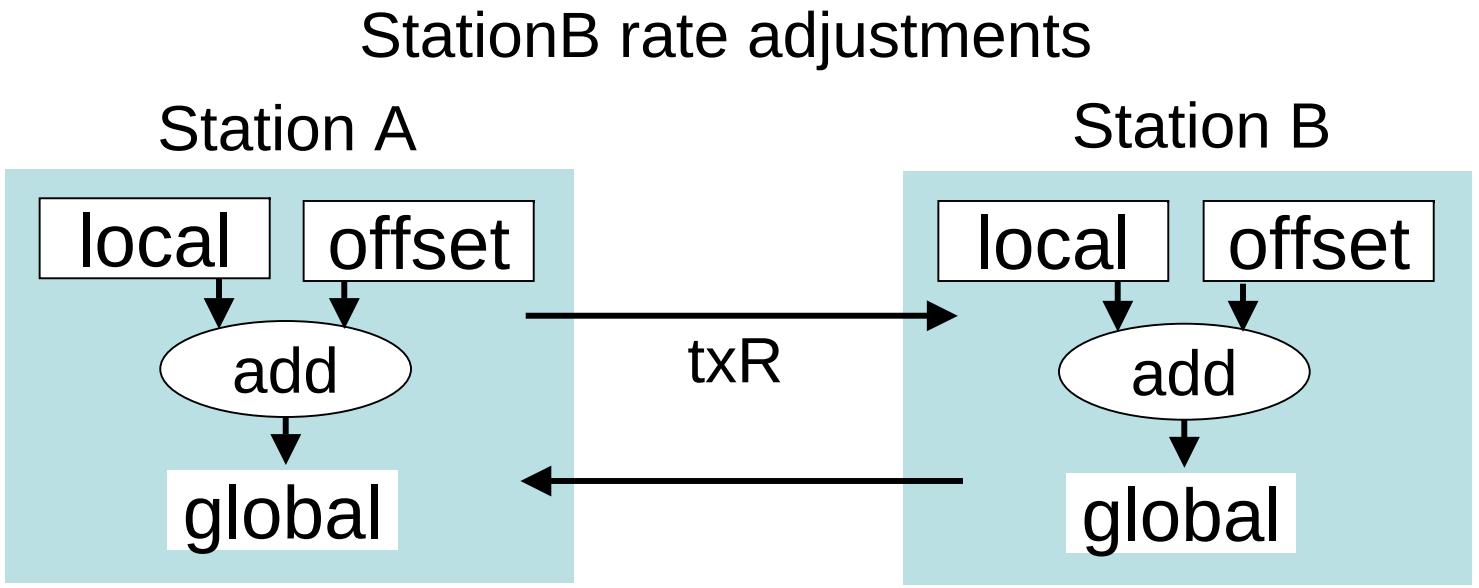
Rate calibration rationale



Rate-calibration timer

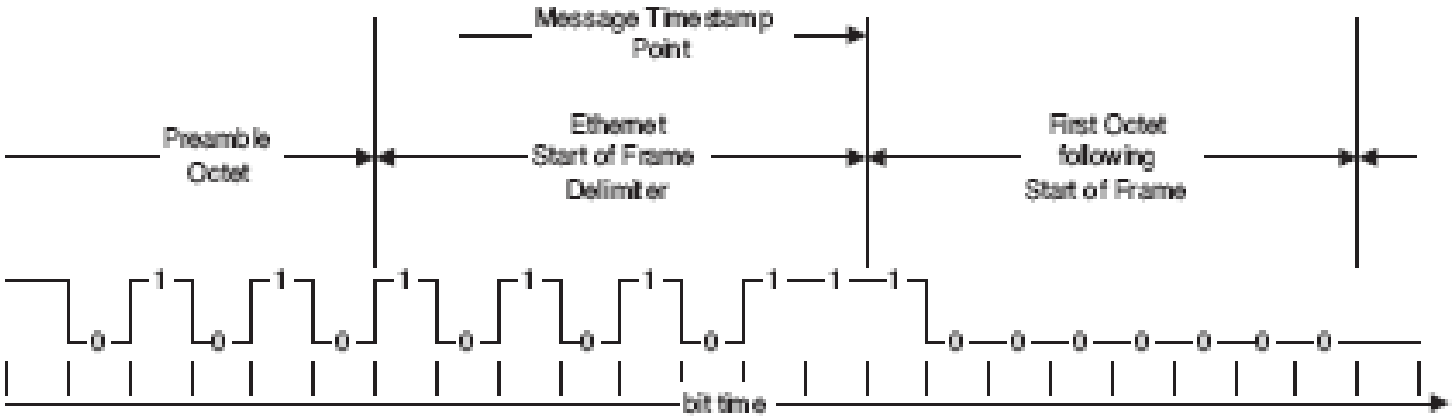


Adjacent-station synchronization



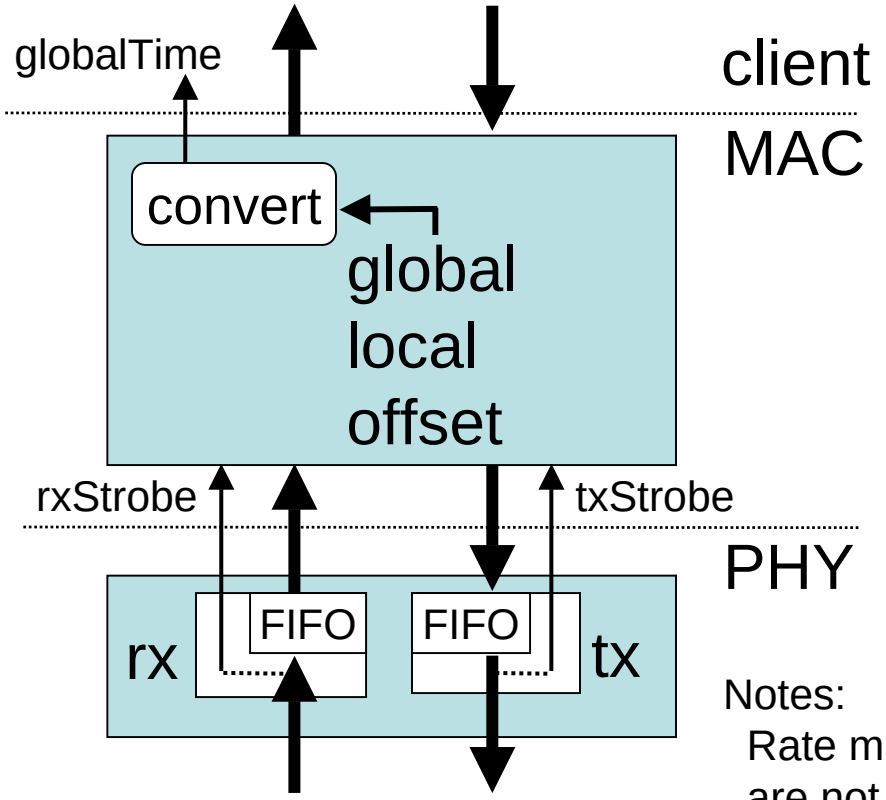
- aDelta = (localA[n+1] – localA[n+0]);
- bDelta = (localB[n+1] – localB[n+0]);
- diffRate = (bDelta – aDelta) / aDelta;

Timing specifics…



(from IEEE 1588-2002, subclause D.1.1, page 127)

A viable design model



Notes:
Rate matching FIFOs
are not within our scope.

For more information:

Latest white paper at:
dvjames.com/esync