Precise measurement of physical link delay

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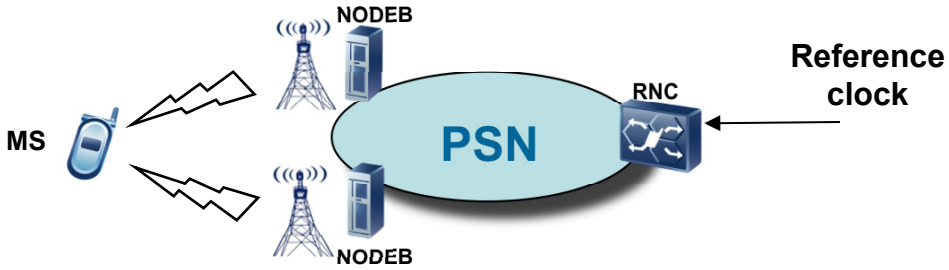
Agenda

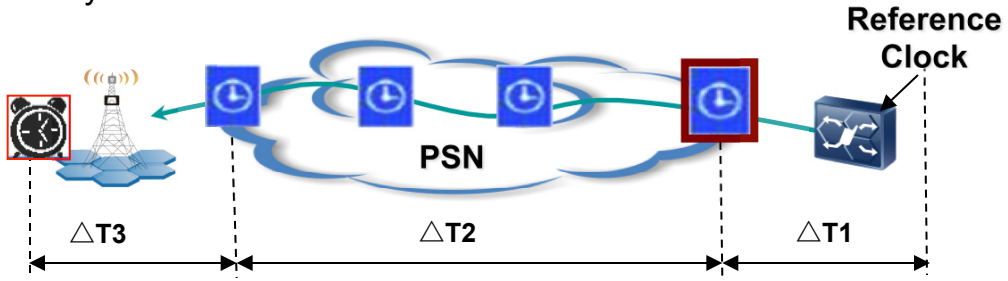
- **Synchronization Requirement**
- **PTP & its Limitation**
- **Precise Measurement of Physical Link Delay**

Synchronization Requirement

- **3G/TD-SCDMA Access Networks**



- **Sync Requirement in 3G/TD-SCDMA**
  - Base stations need frequency sync: +/- 0.05ppm, and phase sync: +/- 3us
  - For base stations, reference clock is distributed via PSN, need physical synchronization support (e.g. Sync Ethernet) for frequency sync or packet-based synchronization (e.g. 1588v2) for time/ phase sync.
    - Time sync between NodeB and Reference clock: +/- 1.5us
- **Sync Requirement in PSN**
  - Considering RNC and NodeB will introduce time offset, PSN need more precise time synchronization: +/- 1us



Suggestion:
|△T1| < 200ns
|△T3| < 300ns
|△T2| < 1000ns

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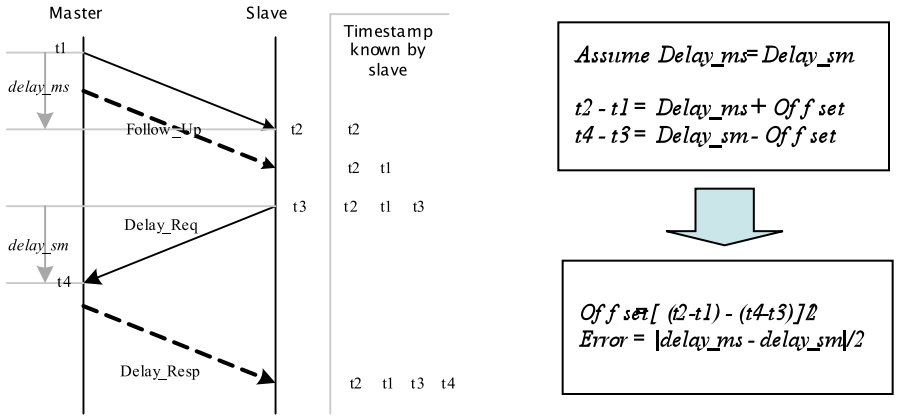
PTP Solution & its Limitation

- **PTP can make the time synchronization accuracy to the grade of sub-microsecond, but there is a very important assumption: the time delay from master to slave is equal to that from slave to master**



- **Mechanisms of avoiding the delay asymmetry introduced by inner process of devices**
  - Physical level timestamps
  - Boundary clock
  - Transparent clock
- **PTP can't eliminate delay asymmetry of physical links**
  - Ethernet ports are usually full-duplex, which means upstream and downstream packets go through different physical links, such as fibers
  - The transport delay of optical fiber is 5us per 1km, so 100 meters length difference will introduce 250ns error

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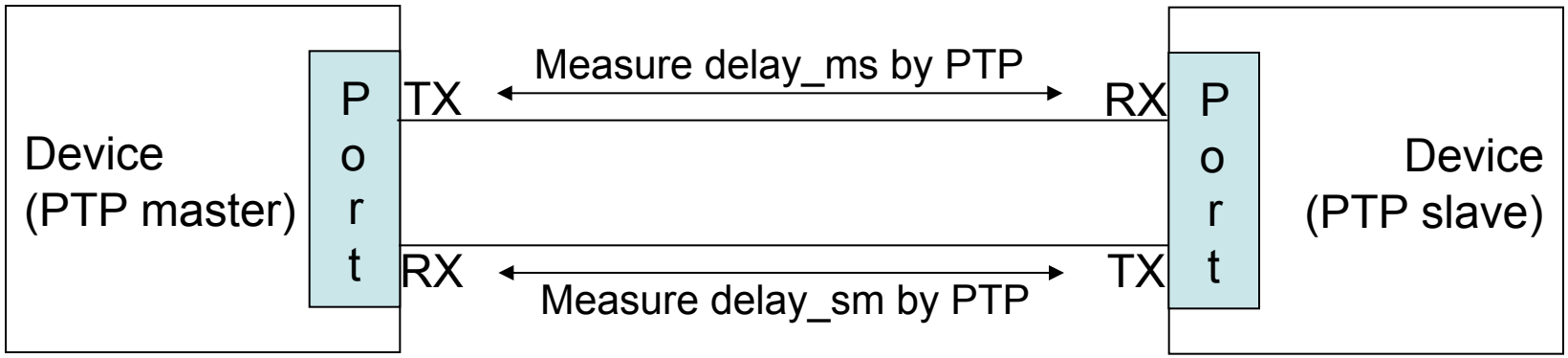
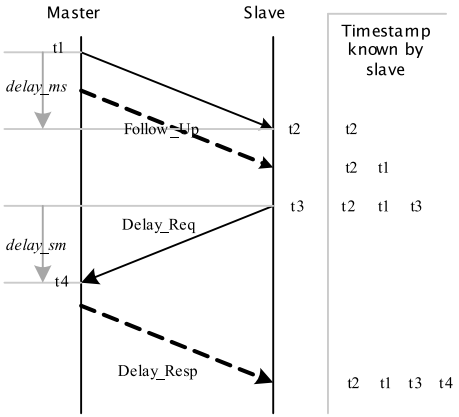
Precise Measurement of Physical Link Delay

- **Mechanism**
  - When a PTP port is becoming active (up), its RX and TX line are respectively set to be half-duplex. Then PTP is used to measure the RX and TX line delay respectively. Because in half-duplex mode the upstream and downstream packets go through the same physical line, we can get the precise delay of RX and TX line. After that, the PTP port become active and is set to be full-duplex.



Precise Measurement of Physical Link Delay

- **Processing Flow**
  - When the PTP port become active, its RX and TX line delay are measured in half-duplex mode.
  - The ratio (m) of delay_ms to delay_sm is saved for the following PTP calculation. (m = delay_ms/delay_sm)
  - Then the PTP port is set to full-duplex mode and work normally.
- **Correction for PTP**
  - As shown in slide 6, the corrected equation is



$$Delay\_ms/Delay\_sm = m$$

$$t2 - t1 = Delay\_ms + Offset$$

$$t4 - t3 = Delay\_sm - Offset$$

$$Offset = [(t2-t1)+m(t3-t4)]/2m$$

$$Delay\_ms = [m(t2-t1)+m(t3-t4)]/m(m+1)$$

$$Delay\_sm = [(t2-t1)+(t4-t3)]/m(m+1)$$

Thank you

Q&A