Compensation for Asymmetry of Physical Line

802.1 AVB, 201103 IEEE 802 plenary

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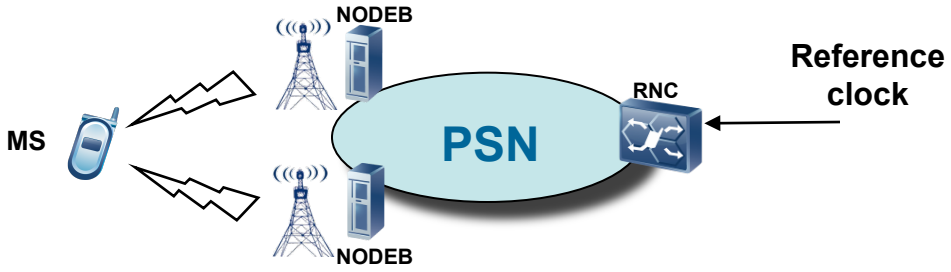
Agenda

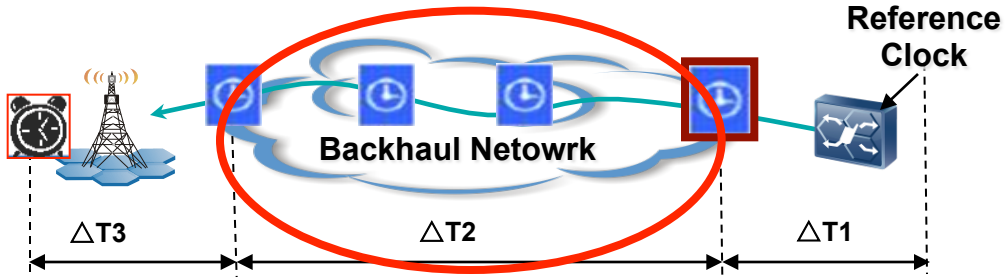
- **Current compensation method**
- **Requirement of automatic compensation**
- **Solution discussion**
- **Proposal**

Synchronization accuracy

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



- **Sync accuracy 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, it is necessary of physical synchronization support (e.g. Sync Ethernet) for frequency sync and packet-based synchronization (e.g. 1588v2) for time/phase sync.
    - Time sync between NodeB and Reference clock: +/- 1.5us
- **Sync accuracy requirement in backhaul network**
  - Considering RNC and NodeB will introduce time offset, PSN need more precise time synchronization: +/- 1us



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

Reason for compensation for asymmetry of physical line

- **PTP(1588v2) can’t eliminate delay asymmetry of physical fiber line**
  - 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

- **Some real data from 1588v2 trial in China Mobile backhaul network**
  - Some of physical lines had serious asymmetry, **whose error compensation was even up to 6us.**
  - Most of physical lines didn’t have to be carried out error compensation, **however, we had to measure every line to find whether error was zero.**

China Mobile has large backhaul network, compensation for asymmetry of physical line is really a mandatory requirement.

Current compensation method

- **Hop by hop compensation**
  - Through some measurement equipment, measure asymmetric error of every physical line between any two directly connected nodes
  - **Problems**
    - It is hard work to measure asymmetric error hop by hop
    - Accumulated error from measurement of every hop maybe considerable
- **End to End compensation**
  - Use GPS to measure the end-to-end compensation value at the endpoint (e.g. mobile base station)
  - **Problems**
    - It is hard work to measure compensation value at every endpoints
    - It is hard to get GPS signal in some places, e.g. subway
    - If data path switch to the redundancy one, the compensation should be measured again

Above methods are manual mode, which will lead to large work in the deployment of 1588v2. When network changes (e.g. repair fiber line break), compensation should be manually measured again.

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Requirement of automatic compensation

- **Requirement**
  - Automatically measure the compensation value caused by asymmetry of physical lines
  - Either “hop by hop” or “end-to-end”
  - When network changes, compensation measurement can run again automatically

- **Difficulty**
  - For duplex link, asymmetry of physical line is hard to measure through some software protocol, so it’s hard to do it automatically

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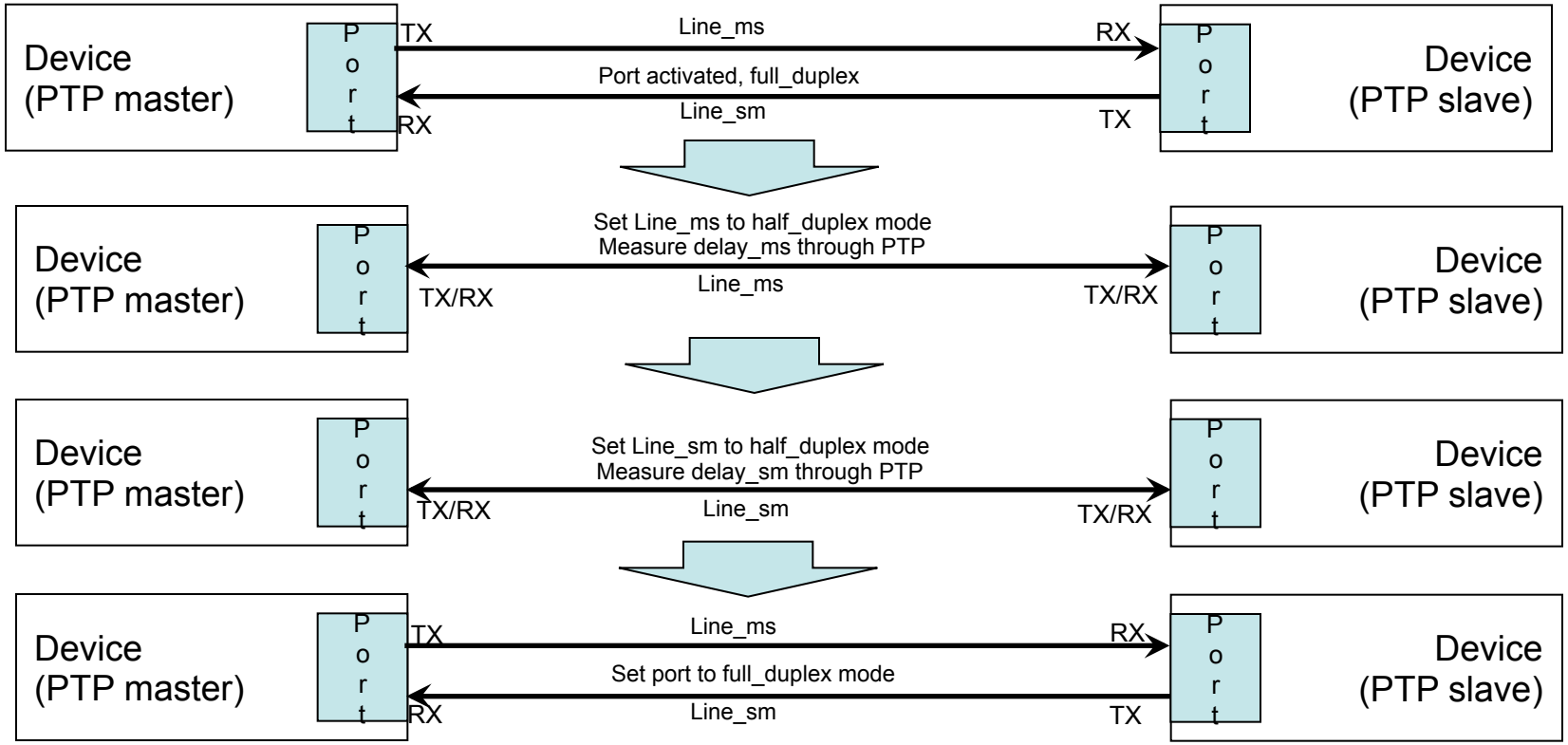
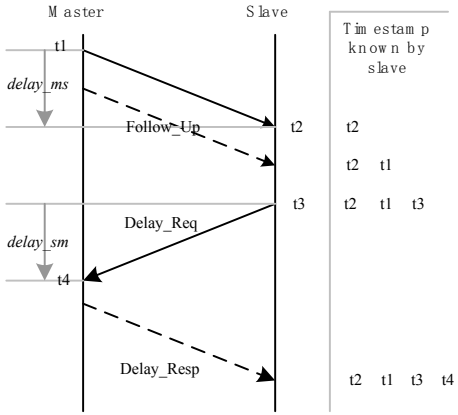
Solution_1

- **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.



Solution_1

- **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



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

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

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

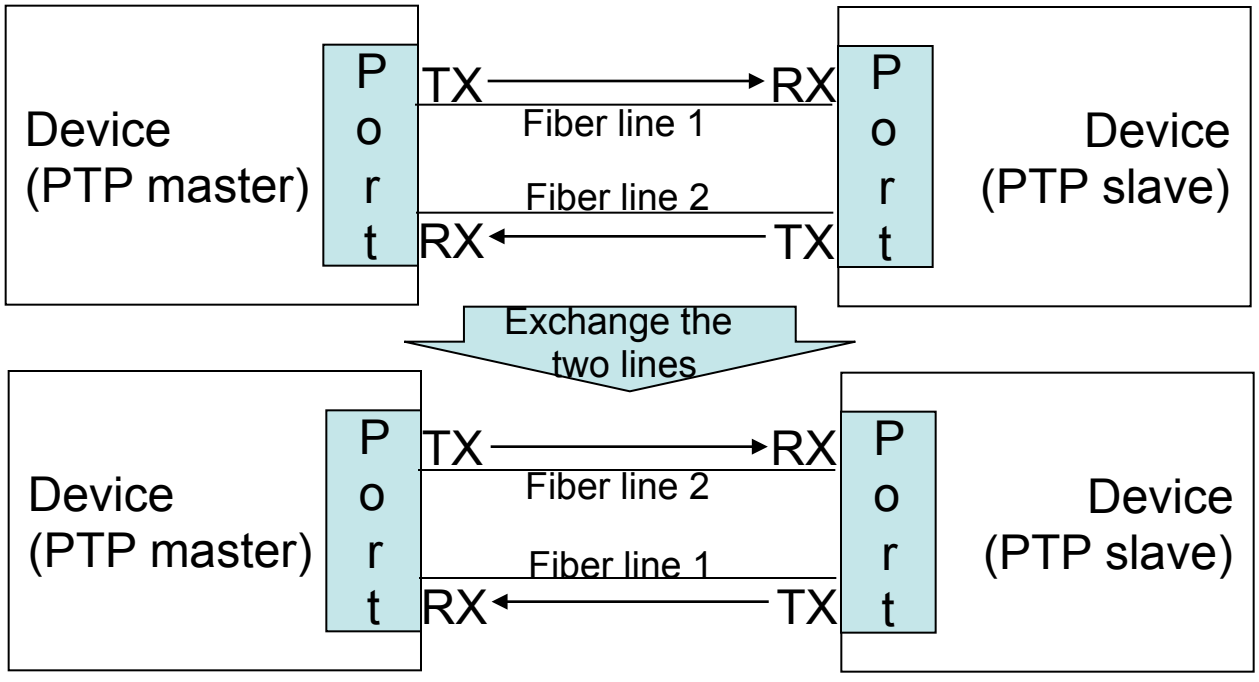
$$Offset = [(t2-t1)+m(t3-t4)]/2m$$

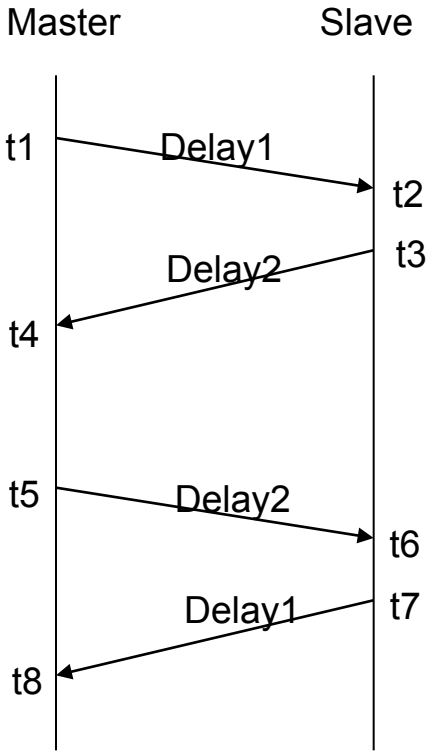
$$Delay\_ms = [m(t2-t1)+m(t3-t4)]/(m+1)$$

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

Solution_2

- **Mechanism**
  - As the mechanism of standard PTP, after getting t1,t2,t3,t4 timestamps, exchange the TX and RX fiber lines manually or automatically, then get t5,t6,t7,t8 to calculate the link delay respectively for the two fiber lines. As the following:



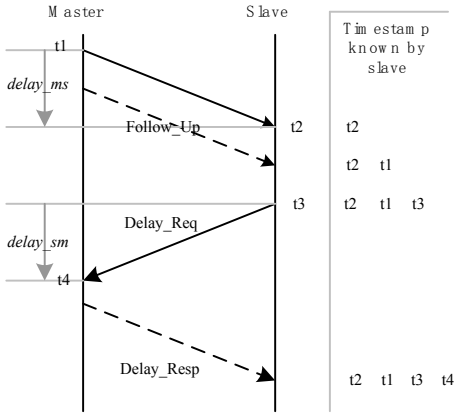


$$Delay1=(t2+t8-t1-t7)/2$$

$$Delay2=(t4+t6-t3-t5)/2$$

Solution_2

- **Processing Flow**
  - When the PTP port become active, run PTP to get t1,t2,t3,t34.
  - Exchange the TX and RX fiber lines manually or automatically, run PTP again to get t5,t6,t7,t8
  - Calculate delay1 and delay2 and then get the ratio of delay2 to delay1, which is saved for the following PTP calculation. (m = delay2/delay1)
- **Correction for PTP**
  - The corrected equation is



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

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

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

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

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

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

Solution_2

- **How to exchange the TX and RX fiber lines**
  - Manually
  - Automatically
    - Method_1: use a on-off switch inside the PTP device to exchange tx and rx line
    - Method_2: use a on-off switch inside the optical module to exchange tx and rx line
    - Method_3: use a on-off switch outside the PTP device to exchange tx and rx line which could be controlled by management system

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Proposal

- **We could use solution 2 (manual method) to compensate the link asymmetry**

- **For the PTP protocol, we propose to add the mechanism of asymmetry compensation:**
  - **Calculate line delay precisely through t1 to t8**
  - **Save the ratio of the two lines’ delay**
  - **Use the ratio in the future PTP calculation**

Thank you

Q&A