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Using PTP / SMPTE 2059: A practical experience perspective

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Topics

- Must you always have a GPS reference for the PTP master?
- Are PTP aware switches *always* necessary?
- Can you safely *not* use PTP Peer Delay request / responses?
- What is the effect of internal oscillator tolerance and stability when designing PTP client equipment?

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When you don't need a GPS reference for the PTP master:

- The PTP protocol synchronizes all clocks to the same master clock. PTP allows for a non-GPS referenced clock, called an *arbitrary* clock.
- On a closed LAN, for small systems or demonstrations, an arbitrary clock (non-GPS referenced) works fine.
  - ✓ Note: We have found a master clock at the default Linux start-up date and time of Jan 1, 1970, does *not* work for the standard 'ptp4l' client.
  - ✓ Be careful trying to use NTP to set the time of the PTP grandmaster, NTP deriving time over the internet may continuously wander around, destabilizing the PTP based media.

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When you need GPS reference for the PTP master(s):

- When you have media streams entering from or exiting to *other locations*, then you need a common clock across the different locations.
- Export/importing PTP over a WAN is technically possible, but a better solution is to use GPS reference PTP grandmaster at each location.

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Are PTP aware switches always necessary?

The answer depends on the need for absolute phase accuracy.

Cause of clock packet jitter:

- Incorrect QOS configuration, or insufficient strict priority switch output queue.
  - ✓ *Fix your QOS !*

- QOS priority inversion is the main contributor causing packet delay
  - ✓ Impact gets smaller with higher network speed.

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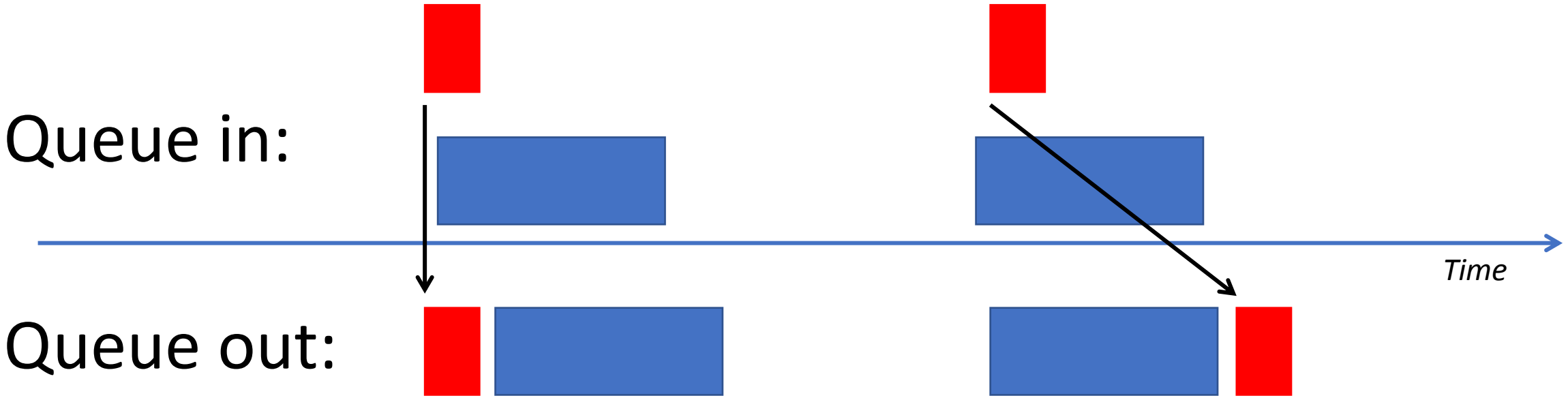
QOS priority inversion at switch output port queue:



The Maximum QOS priority inversion delay is the *output port wire speed time of a full size packet* multiplied by the *number of switches* the high priority packet passes through.

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PTP aware switches are not always necessary.

Clock packet jitter (variation in delay) can be effectively *filtered out* at the device.

Use a *statistical minimum* filter.

Ref: NTP 2.0. RFC 1119, RFC1128 (from *1989 !*)

Livewire clock has worked this way for almost 20 years.

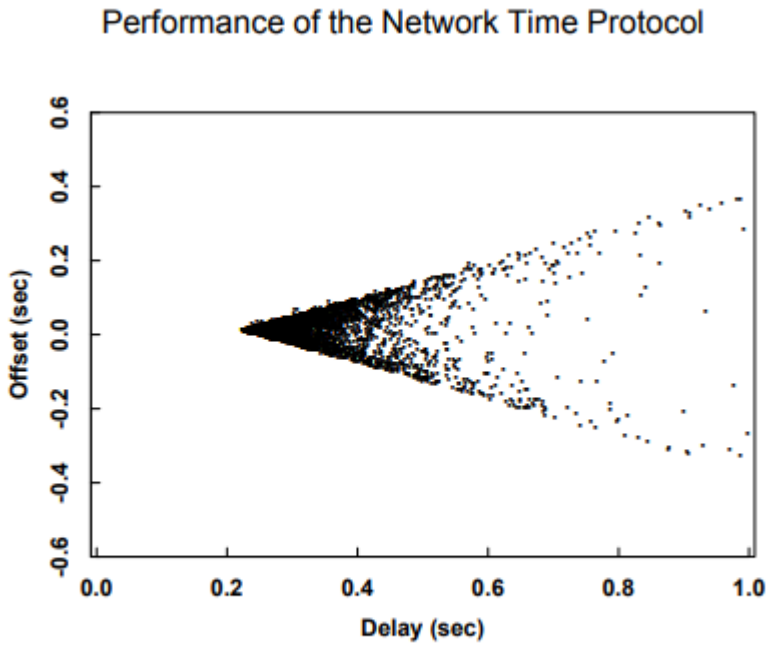

Figure 3. Offset vs Delay

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Can you safely *not* use PTP Peer Delay request / responses?

- PTP Peer Delay compensates for network travel absolute time, which on a LAN is typically a few tens of microseconds.
- RTP timestamps are not affected. There are no digital audio processing or interface phase alignment errors that result.
- Peer Delay mainly affects *absolute phase alignment of analog transducers*, (microphones and speakers.)
- For audio, tens of microseconds corresponds to a few audio samples. One 48Khz audio sample is 20.8us, which is *7mm in air* (about ¼ “).
- ✓ Evaluate if your audio application is sensitive to the physical placement of microphones and speakers to an inch or two. ***If not, then not using PTP Peer Delay should not affect your audio.***

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Can you safely *not* use PTP Peer Delay request / responses?

- The PTP standard *allows* for not using Peer Delay. (Not using peer delay should be specified in the PTP profile.)

Here is the kicker: Using PTP Peer Delay can make audio *worse* !

- Audio is very sensitive to *phase stability.* More sensitive than to absolute phase error.
- PTP time sync at a slave involves recovering accurate time from the phase noise injected by packet timing jitter.
- Using peer delay *adds two more sources* of packet jitter induced phase noise: the arrival time of the peer delay request, and the arrival time of the peer delay response, on top of the arrival time of the PTP sync.

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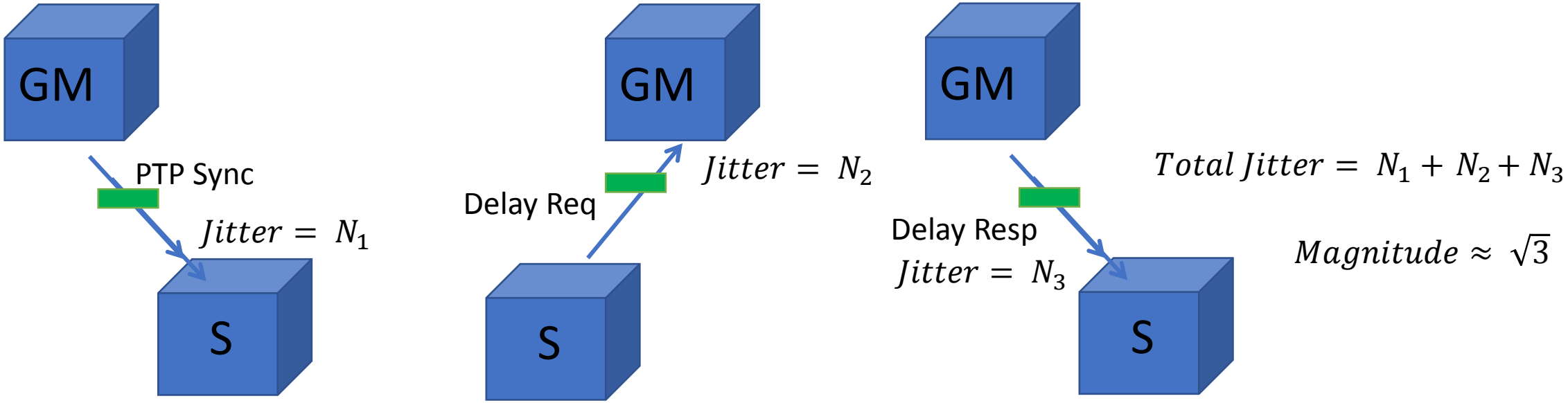
PTP packet jitter is *time noise*.



An audio clock recovered from PTP using peer delay will be less stable than an audio clock recovered from only the PTP sync packets.

✓**The tradeoff of using PTP peer delay is lower absolute phase error, but greater *variable* phase error.**

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What is the effect of internal oscillator tolerance and stability when designing PTP client equipment?

- The PTP clock recovery process has to ‘steer’ a local slave clock to match the PTP master clock.
- There are two sources of errors that are being ‘steered out’: The errors resulting from the time delays over the network, and *the local clock instability (wandering around).*
- A more stable local reference oscillator reduces the error the PTP recovery process has to deal with, and results in a better quality (higher phase stability) recovered synchronized audio clock.
- A ‘typical’ crystal oscillator of +/-50ppm tolerance, is less stable and can wander around 10ppm or more moment to moment.
- ✓ A TCXO (temperature compensated) of +/- 2.5 ppm tolerance costs a few dollars and eliminates the local wandering around error into the PTP recovery.

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Thank You !

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