Timing and Transport in 5G Fronthaul

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About Fibrolan

• Established in 1996
• HQ in Israel
  • Presence in US, Austria and Poland
  • Local partners worldwide
• Key areas of expertise:
  • Timing & Sync
  • Edge Transport
• Partnerships:
  • Vendors, System Integrators & Research Institutes
Overview
Architecture

- Typical 5G Fronthaul deployment
  - O-RAN configuration LLS-C3
  - In-band sync (typically O-RU)
  - OOB sync (typically O-DU)

- Benefits of LLS-C3
  - Simpler Timing integration
  - Higher accuracy
  - Flexibility & Scalability
  - High availability
## Timing requirements: Backhaul vs Fronthaul

<table>
<thead>
<tr>
<th></th>
<th>Backhaul</th>
<th>Fronthaul</th>
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<tbody>
<tr>
<td><strong>Bandwidth</strong></td>
<td>Low (&lt;1Gbps)</td>
<td>High (&gt;6Gbps)</td>
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<tr>
<td><strong>Transport</strong></td>
<td>Typically L3</td>
<td>Typically L2</td>
</tr>
<tr>
<td><strong>Time Error Target</strong></td>
<td>1.5us</td>
<td>20-260ns</td>
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<tr>
<td><strong>Timing Sensitivity</strong></td>
<td>Medium</td>
<td>High</td>
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</table>
• PTP – Complete Timing signal (Frequency, Phase, ToD)
• SyncE – Frequency Stability, Short Convergence time, Longer Holdover
• Currently supported by some O-RU (mostly mmWave)
• Can be supported in Boundary and Transparent PTP nodes
Lessons learned
Use of ptp4l

- Commonly used in conjunction with phc2sys
- Performance is HW dependent (NIC, CPU, oscillator, etc.)
- Requires proper integration and configuration
  - Interface binding
  - Message Rate matching
  - Attribute mismatch (Domain, Step mode, DMAC, etc.)
- Internal Sync interruptions
  - From services like NTPd and Chronyd
  - When service not running continuously on the same core
  - Process priority
Some Interop issues encountered

• Timing Issues
  • PTP operating parameters: message rate, Domain, Step mode, etc.
  • PTP profile conversion
  • Non-Standard PTP implementations (e.g. Multicast, Unicast)
  • Partial SyncE support

• Transport issues
  • Low quality field infrastructure (e.g. fiber run)
  • SFP compatibility (e.g. ER SFPs in RU)
  • FEC support (25Gbps)
GNSS as a Timing source

- Proper installation (antenna, cables, arrestor, splitters)
- Receiver should be optimized for Timing
- Support for multi-constellation
- Single band vs. Dual band
- Consider spoofing and jamming
  - Susceptible to malicious or random interruptions
- Outages – oscillators benefits (OCXO, Rb)
Transport challenges

• Network effects on Timing
  • Traffic load – in case of congestion
  • QoS – PTP prioritization
  • Fronthaul must be fully PTP aware

• Cu SFPs block SyncE transmission
  • Creates different clock domains

• Asymmetric links
  • Long distance fibers (numerous splicing, patch panels)
  • WDM
  • Single fiber connections
Getting it right
How to do it right?

• Combined platform: PTP Grandmaster + Carrier Ethernet Switch
  • Support all O-RAN LLS configuration (C1, C2, C3 and C4)
  • Extensive monitoring options (Timing and Transport)
  • Flexible and diverse Timing interfaces (Ethernet, Serial, 1PPS, 10MHz)
  • Multiple profile support (simultaneously)
  • Comprehensive Source types (e.g. GNSS, PTP, ToD, etc.)

• The Falcon-RX

One platform, any architecture
Falcon-RX/G main features

- Switching fabric: 200G/FDX, non-blocking
- Dual, redundant, hot swappable PSUs, AC or DC
- Built-in Stratum 3E clock (OCXO)
- Rubidium oscillator expansion module
- Advanced switching and protection capabilities
- Unique SyncCenter capability for Timing source selection and prioritization
- Synchronous Ethernet
  - G.8261, G.8262, ESMC (G.8264)
- HW based 1588/PTP:
  - Grandmaster (integrated GNSS receiver)
  - Ordinary Clock (master, slave)
  - Transparent Clock (Class C/D)
  - Boundary Clock (Class C/D)
- TSN capabilities
- NTP server
Thank you!