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IT'S ABOUT TIME

Timing and Transport in 5G Fronthaul

Presented by:

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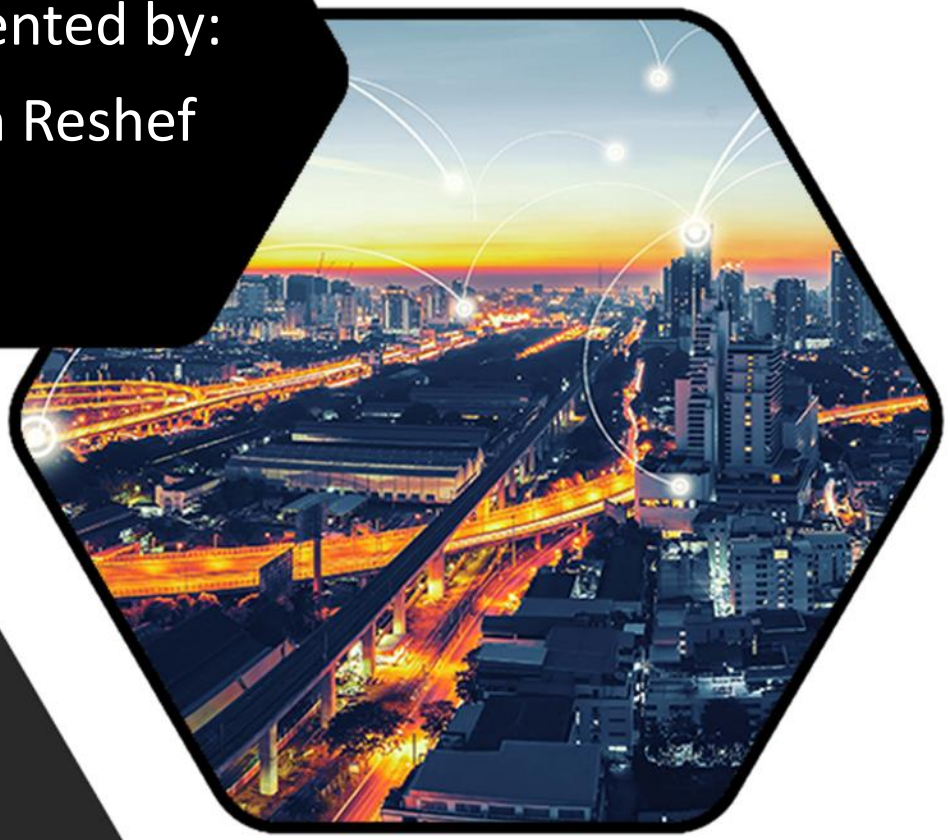


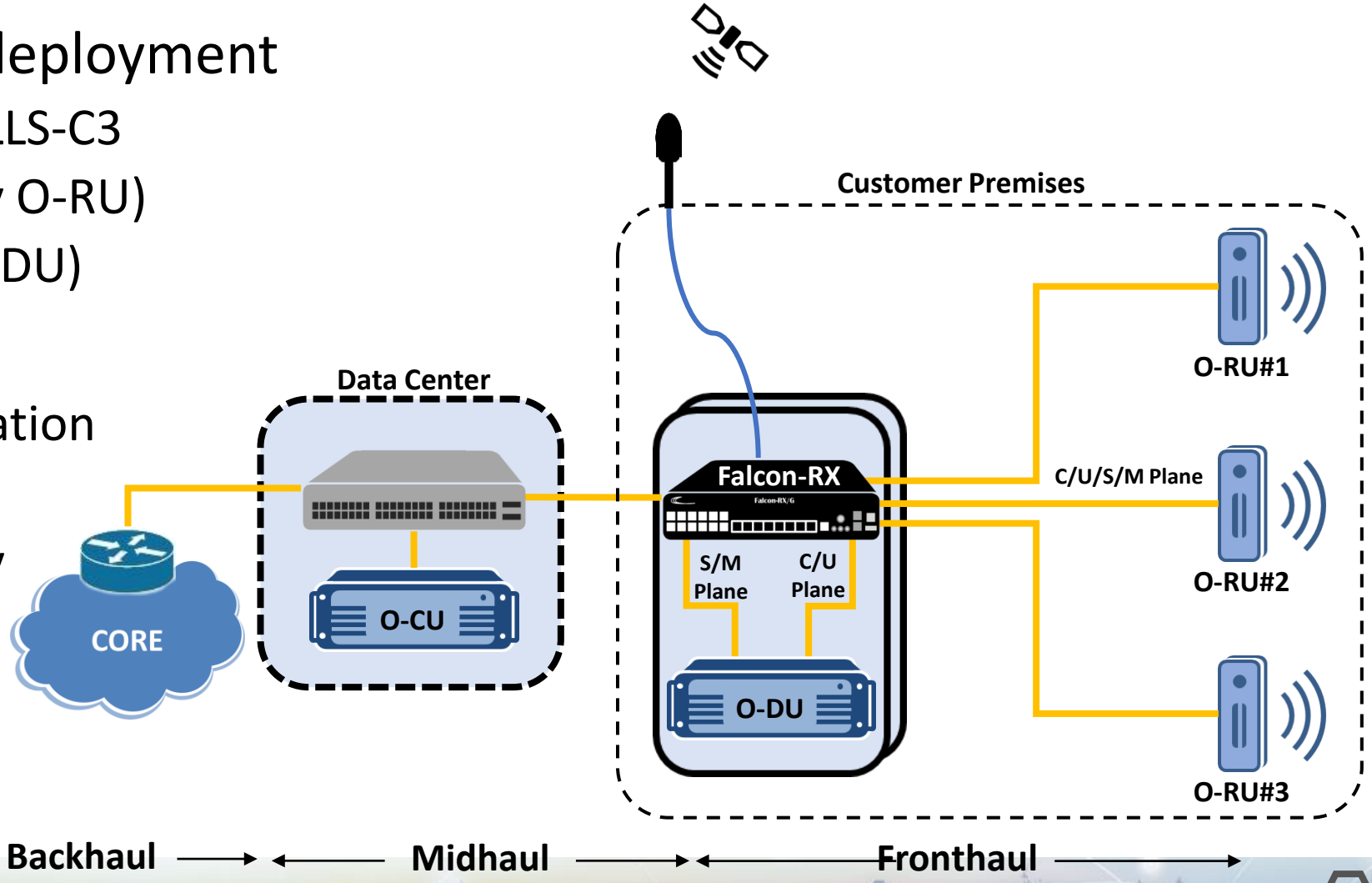
About Fibrolan

- 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

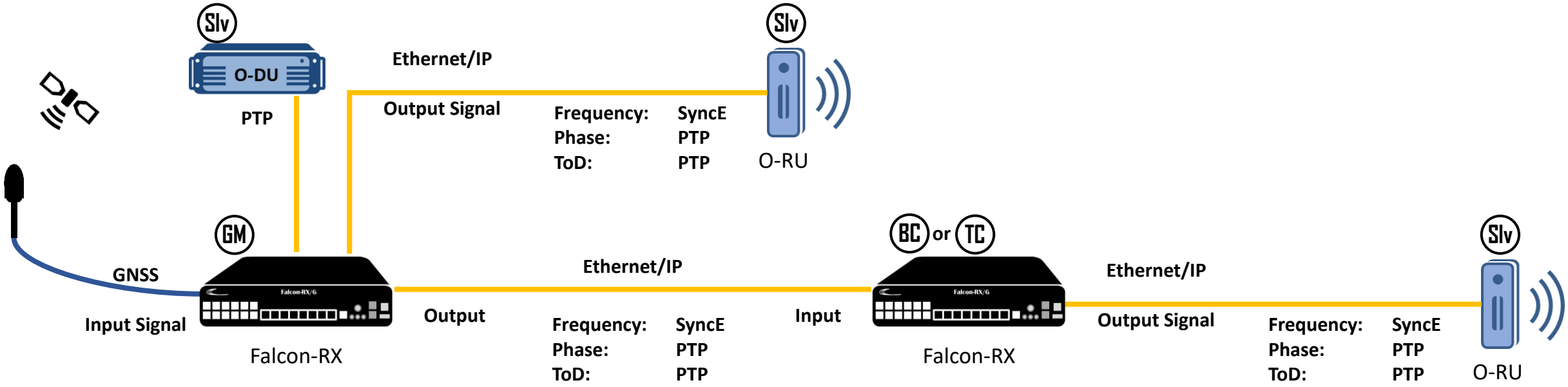


Timing requirements: Backhaul vs Fronthaul

	Backhaul	Fronthaul
Bandwidth	Low (<1Gbps)	High (>6Gbps)
Transport	Typically L3	Typically L2
Time Error Target	1.5us	20-260ns
Timing Sensitivity	Medium	High

PTP and SyncE - Hybrid Timing

- 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

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Thank you!