

Meeting 5G Edge Clock Synchronization Challenges with Hardware-Enhanced Precision Time Protocol (PTP)

Solution Benefits

- Open Source
- Cost-effective Ethernet network-timing solution
- Interchangeable Drivers with Intel® Ethernet Network Adapter XXV710-DA2
- Innovative time stamping solution with 1PPS Boundary Clock synchronization

Tight latency requirements across 5G implementations have proven to be a challenge, especially in Edge servers. Maintaining accurate time synchronization at a cost-effective price point is one avenue to help address application latency requirements.

Challenge

The tight latency requirements across 5G implementations are a challenge for many operators due to the traditional high cost of Central Office timing solutions.

Many of these applications use the ptp4l utility for a synchronization or timing solution that meets the bare-minimum prerequisites for some lower-bandwidth applications.

Solution

The Intel® Ethernet Network Adapter XXV710-DA2T (code name Edgewater Channel) provides a cost-effective network timing solution on the backbone of traditional, widely accepted Intel Ethernet Technology. It is designed to be a high-accuracy timing solution that enhances the 1588 PTP timing mechanism that is inherent in the adapter.

The XXV710-DA2T can be used alone or alongside one or more Intel Ethernet Network Adapters (XXV710-DA2, code name Harbor Channel) to implement world-class timing solutions in a commercial off-the-shelf server, without rewriting the current application.

UDP applications in particular can benefit from the time stamping accuracy this solution provides. This is also a potentially elegant solution when tracking time-stamped packets is important for synchronization, or retransmission is critical.



Lower costs and greater agility

Traditional central office timing solutions can cost several thousands of dollars per installation. The dramatic increase in the number of base stations, to effectively field 5G as intended, is astronomical. The market has been waiting for an open-source solution that makes it cost-competitive, with accurate results.

The Intel Ethernet Network Adapter XXV710-DA2T with hardware-enhanced Precision Time Protocol (PTP), is functionally a drop-in replacement for the Intel Ethernet Network Adapter XXV710-DA2. The adapter is designed to seamlessly integrate into 25GbE or 10GbE solutions designed with the XXV710-DA2 adapter. Edgewater Channel, with its 1588 PTP enhancements, can provide a highly-accurate native Linux timing solution to meet stringent 5G accuracy and synchronization requirements.

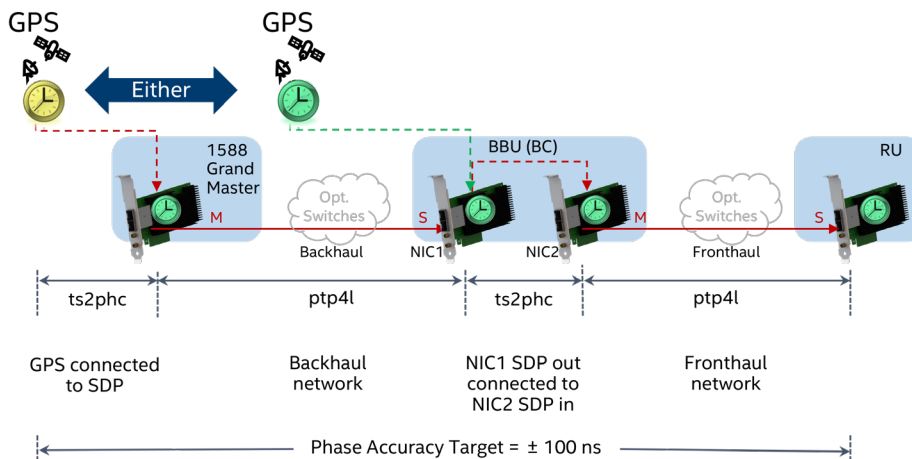
A TCXO oscillator works with the ptp4l code to produce a boundary clock solution. Applications make use of 1PPS holdover performance, or any number of distributed timing or timing master scenarios, such as:

- **GPS input to grandmaster**
- **Boundary clock**
- **Remote radio unit**
- **1588 test vehicle**
- **TSN translator**
- **Various O-RAN implementations with a phase accuracy goal of +/- 100nsec**

Solution Architecture

RAN configuration options based on Intel Ethernet Network Adapter XXV710-DA2T in RAN solutions.

O-RAN C3 with Edgewater Channel

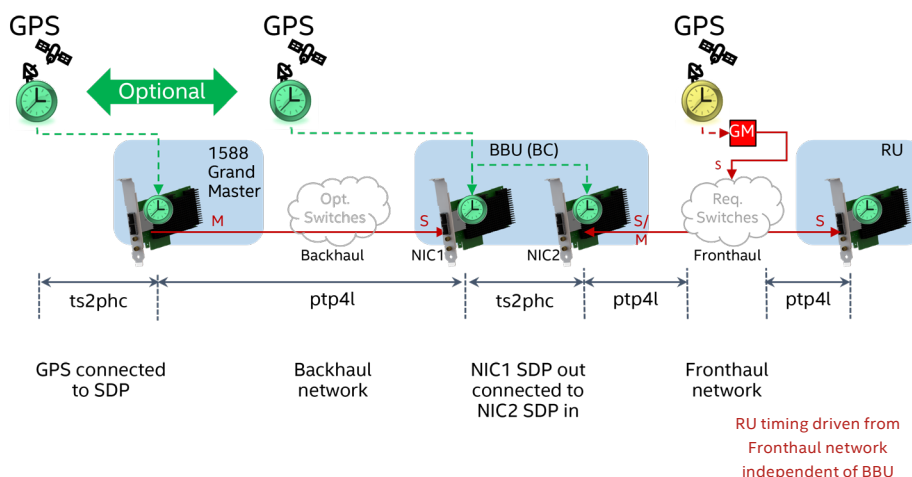


Testing Profile:
G.8275.1 (w/o SyncE)
SYNC rate: 16 Hz
Min. Clients: 16

Note: NIC1 and NIC2 may be separate cards or separate ports on the same PCIe card

Note: One or more PTP-aware switches could be installed in the fronthaul or backhaul links

O-RAN C1/C2 with Edgewater Channel

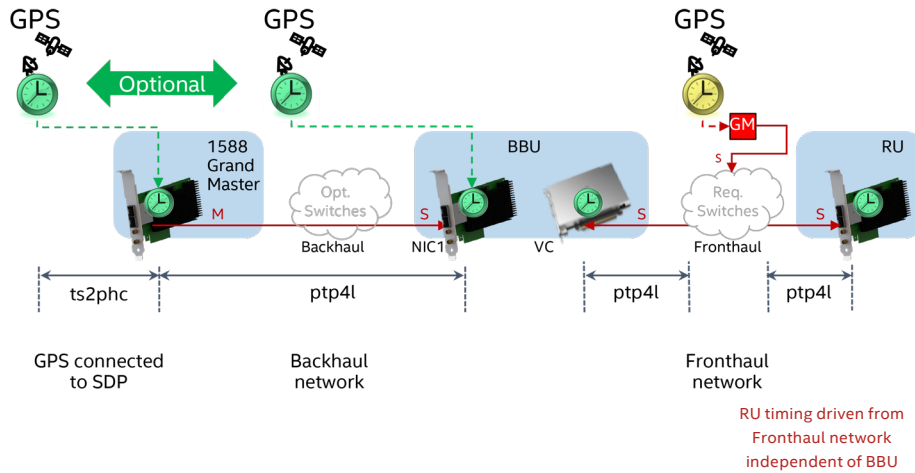


Testing Profile:
G.8275.1 (w/o SyncE)
SYNC rate: 16 Hz
Min. Clients: 16

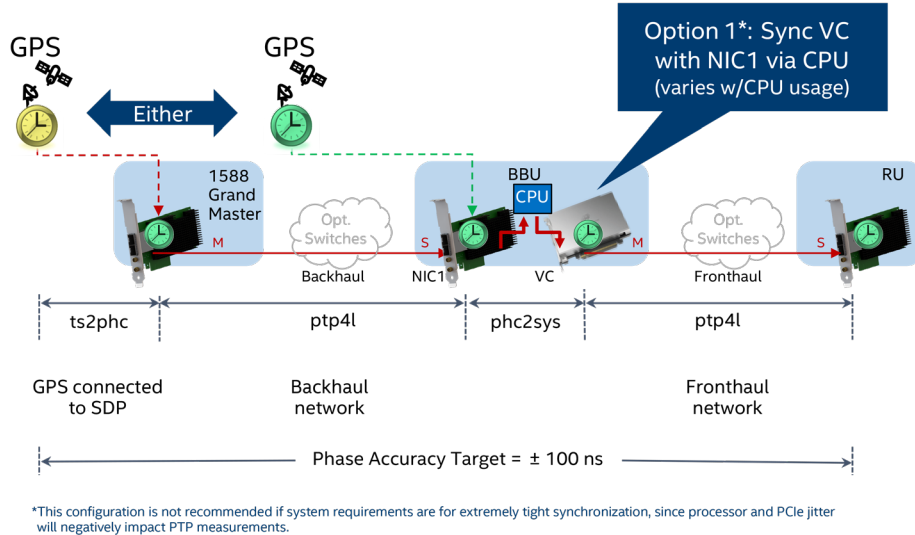
Note: NIC1 and NIC2 may be separate cards or separate ports on the same PCIe card

Note: One or more PTP-aware switches could be installed in the fronthaul or backhaul links

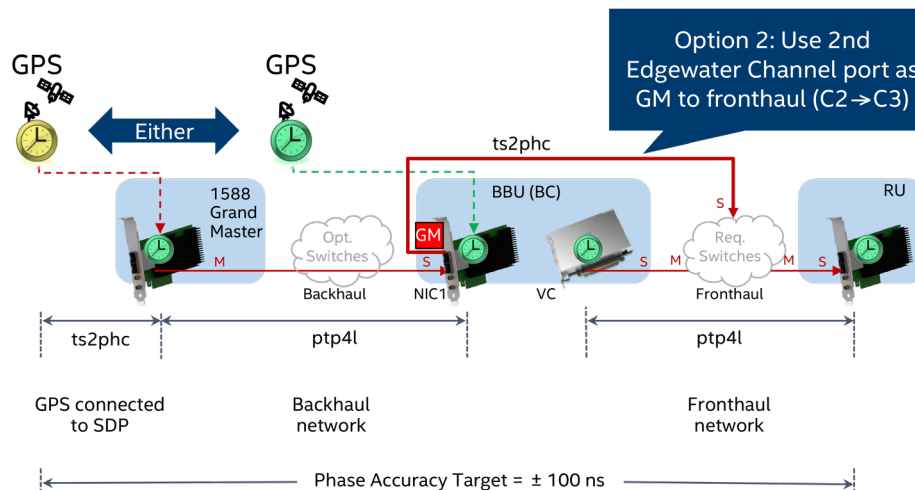
O-RAN C3 with Vista Creek



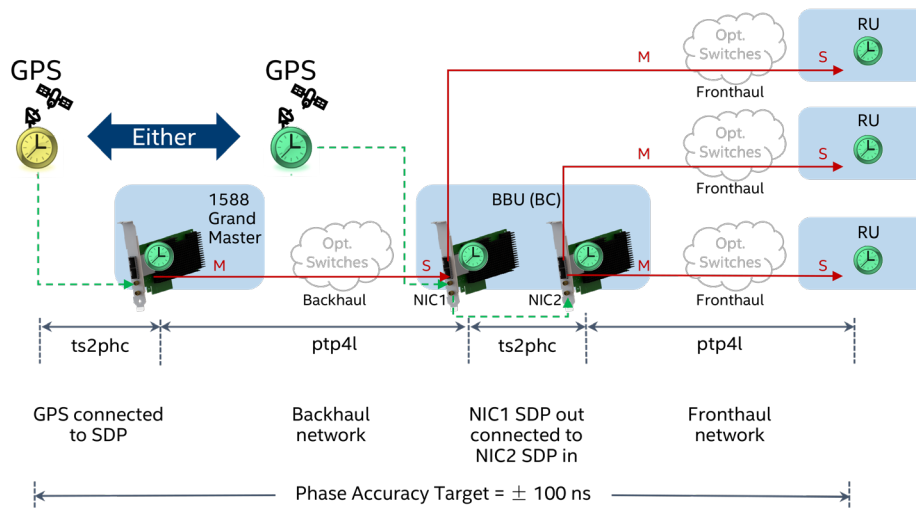
O-RAN C1/C2 with Vista Creek (Option 1)



O-RAN C1/C2 with Vista Creek (Option 2)



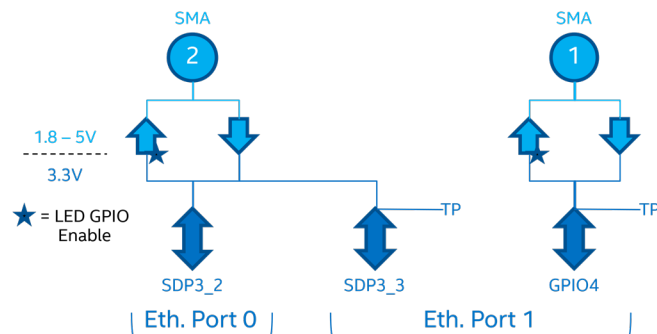
O-RAN C1/C2 with Edgewater Channel + 3x FH



Note: One or more PTP-aware switches could be installed in the fronthaul or backhaul links

SMA connector configurations for 1PPS input vs output for various use cases.

SMA Configuration

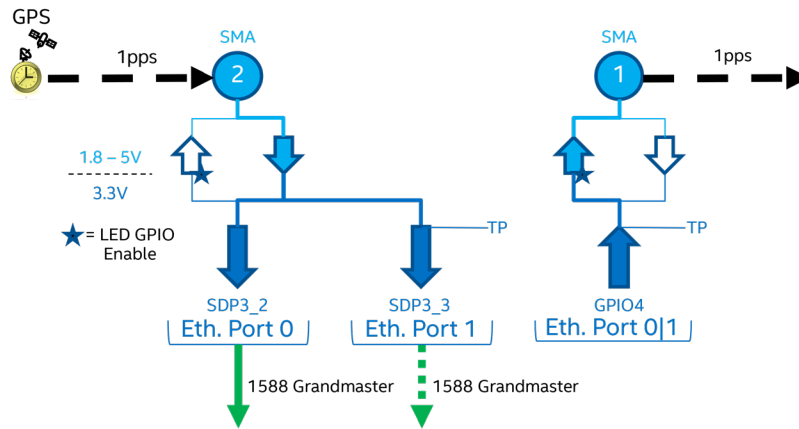


Notes: Port 0 is the top port and Port 1 is the bottom port. For the support circuitry, LED3_1 and LED2_1 are the GPIOs for Port 0; LED3_0 and LED2_0 are for Port 1. Configuration of the SDPs/GPIOs may initially be done through Ethertool utility, with Linux interface hooks added later.

Edgewater Channel SDP and GPIO configuration will be handled through driver configuration and new hooks into Linux interfaces.

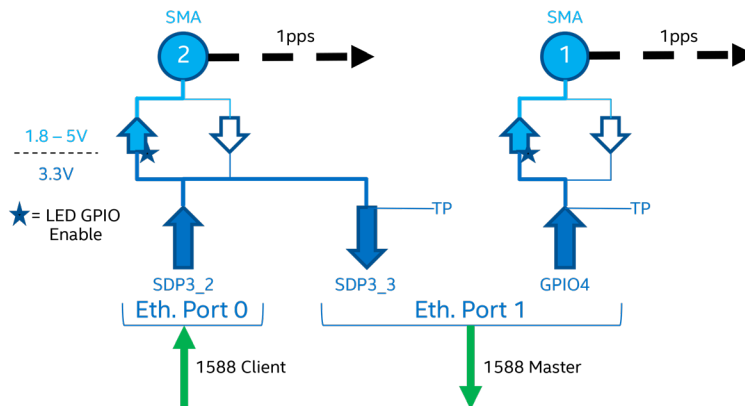
SDP= Software Defined Pin
GPIO = General Purpose
Input/Output [pin]

GPS Input to Grandmaster



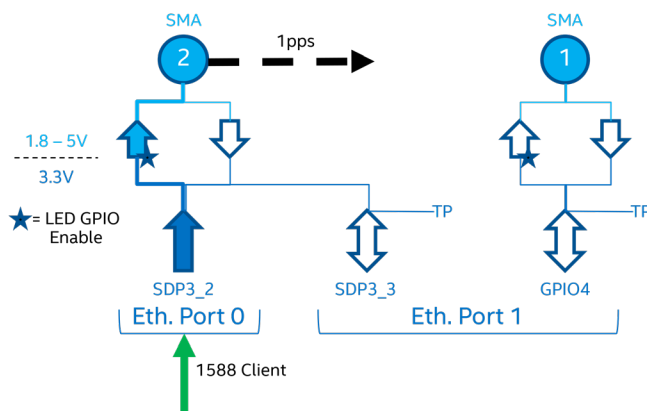
- SDP3 can be configured to be part of Port A or Port B.
- SDP3 output can be compared to GPS input to compare phase accuracy of either port [but only one at a time].

Boundary Clock Functionality



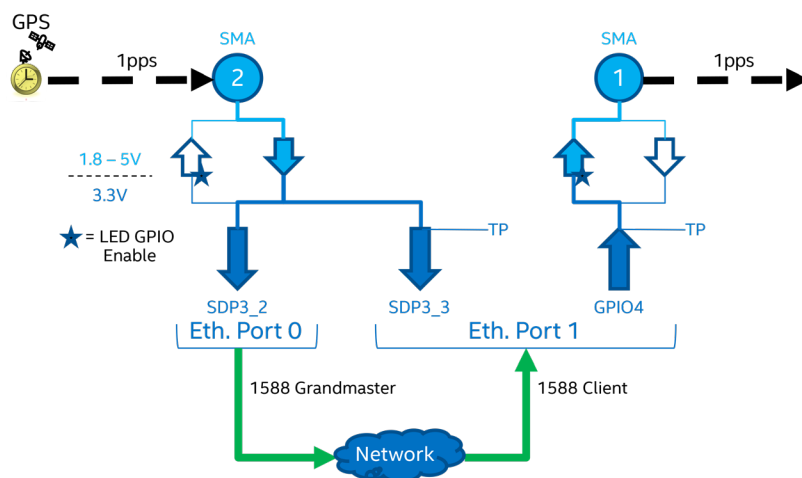
- SDP2 brings 1pps output from SDP1 into the Port B PHC timescale.
- Software reads timestamped SDP2 transitions to change INCVAL for Port B.
- SDP3 shows Port B 1pps output for comparison w/SDP1.

Remote Radio Unit Functionality



- The remote radio unit (RRU) is just a 1588 client.
- This is essentially a small subset of the boundary clock functionality.
- The output from SMA1 will be compared to other 1pps signals.

All-in-one 1588 Test Vehicle



Port A acts as the Grandmaster and Port B is the end 1588 client. Since SDP2 measures GPS time according to Port B's timescale, [future] software could measure error without an oscilloscope.

Summary

Intel Ethernet Network Adapter XXV710-DA2T provides a low-cost timing synchronization solution for 5G edge that can solve many of the latency requirements at a price point that can sustain 5G buildouts.

Learn More

[High Accuracy Network Timing with Intel® Ethernet Network Adapters Video](#)

[Intel Ethernet Network Adapter XXV710-DA2T Product Brief](#)

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