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Challenges with linuxptp on Telco RAN deployments

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Introduction

- LTE and 5G/NR puts rigorous time sync requirements
- Linuxptp is the standard IEEE-1588 implementation on Linux
- But it doesn’t address all telco recommendations
- Addressing gaps helps with compliance to timing specs
- Not addressing gaps leads to non-standard solutions

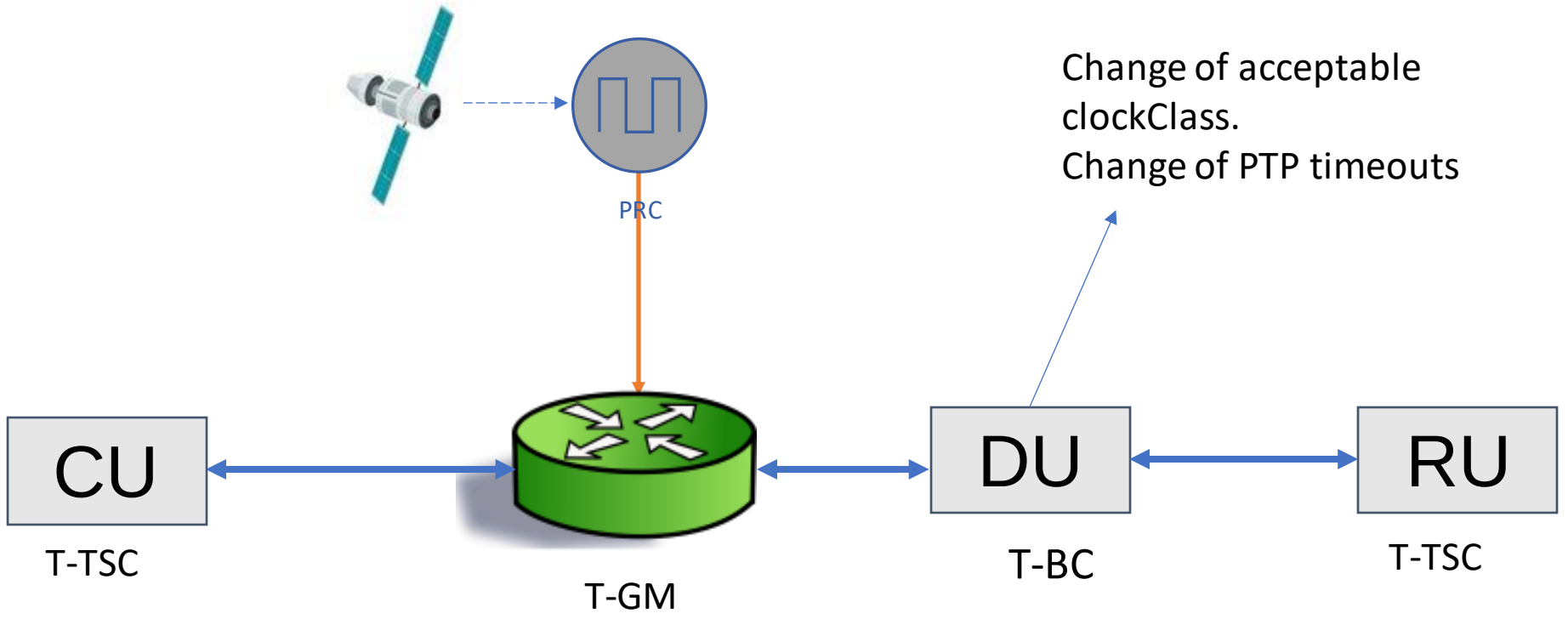
Linux PTP project

- ptp4l
  - Synchronize clocks using the PTP protocol (IEEE 1588)
- ts2phc
  - Synchronize a clock to the external time stamp signal (1PPS signals).
- phc2sys
  - synchronize two (or more) clocks
  - Can synchronize a system clock and a NIC clock
- pmc
  - PTP management client

Lack of support for dynamic configuration in ptp4l

- Static configuration using different profiles.
- Configuration change requires a service restart
- Restart may lead to loss of lock and affect radio operations
- Should include:
  - changing current dataset (supported using PMC protocol)
  - changing servo and its parameters
  - dynamically enabling and disabling corrections
- For example: When O-DU acting as BC and need to change the acceptable clockClass/PTP timeouts on Midhaul as depicted in Figure-1. Such change needs a restart of ptp4l upon changing the configuration in ptp4l config file.

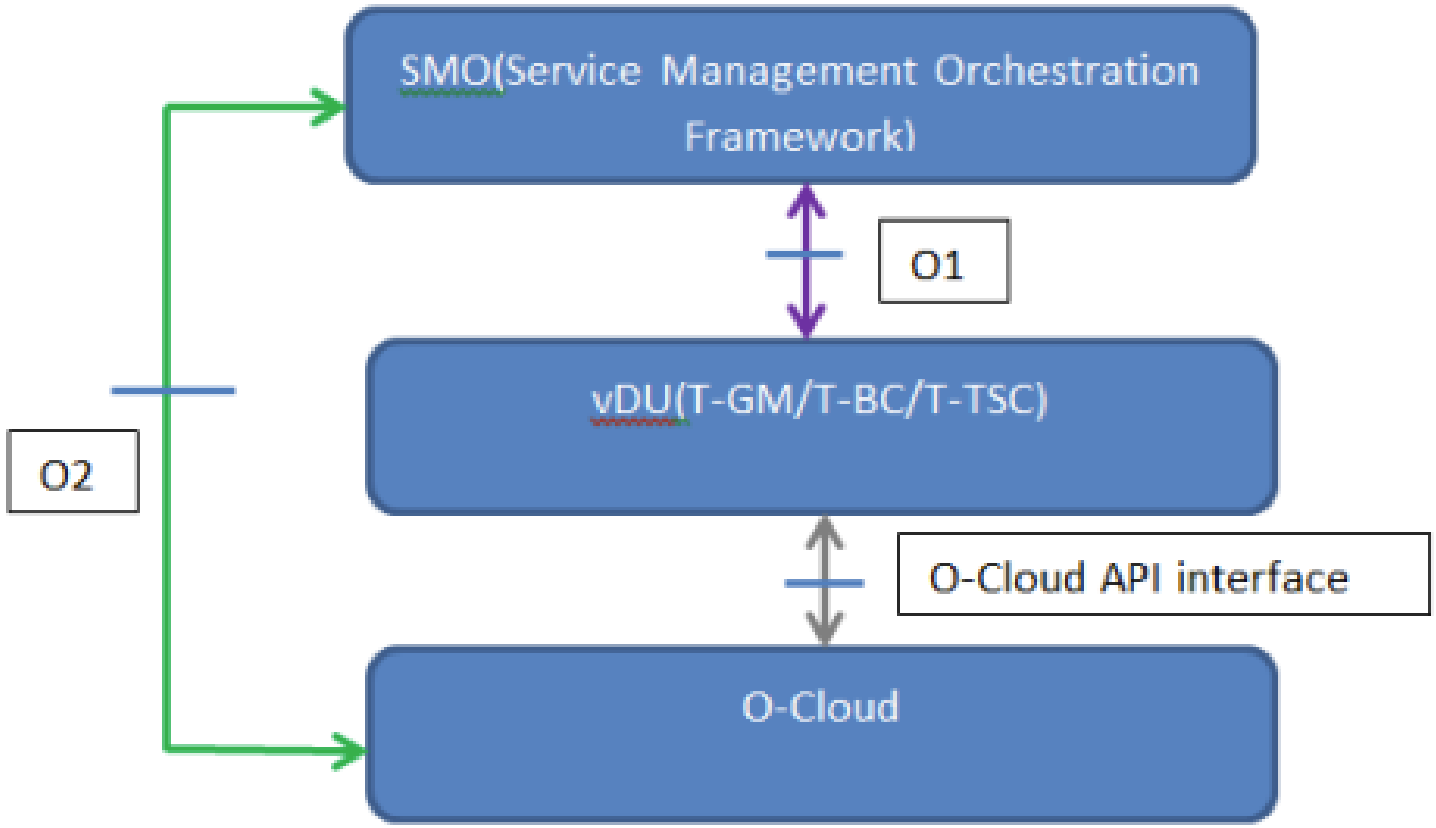
FIGURE-1: PTP config changes



Lack of support for system-level management

- Operators needs a mechanism and monitor S plane
- Define APIs to allow remote ptp4l programming
- Define set of APIs for state monitoring in phc2sys and ts2phc
- Push config from SMO using IMS to the remote nodes (vDUs).
- Manage dependencies between tools.

Figure-2: O-RAN Interfaces on vDU(O-RAN.WG6.CAD-v02.02)



State machine not fully compliant to ITU-T G.8275.1/G.8275.2

- Dataset doesn’t automatically reflect system state due to which the O-RUs connected to O-DU running LinuxPTP shall get impacted and leading the degrading of KPIs/effecting SLAs of the Operators.
- Default clockClass advertised regardless of overall system status
- With default dataset peer BC/followers moves out of lock
- ptp4l uses s0/s1/s2/s3 instead of lock/HO/freerun
- And doesn’t reflect the state in announceMessage

Clock Class transitions not as per G.8275.1/G.8275.2

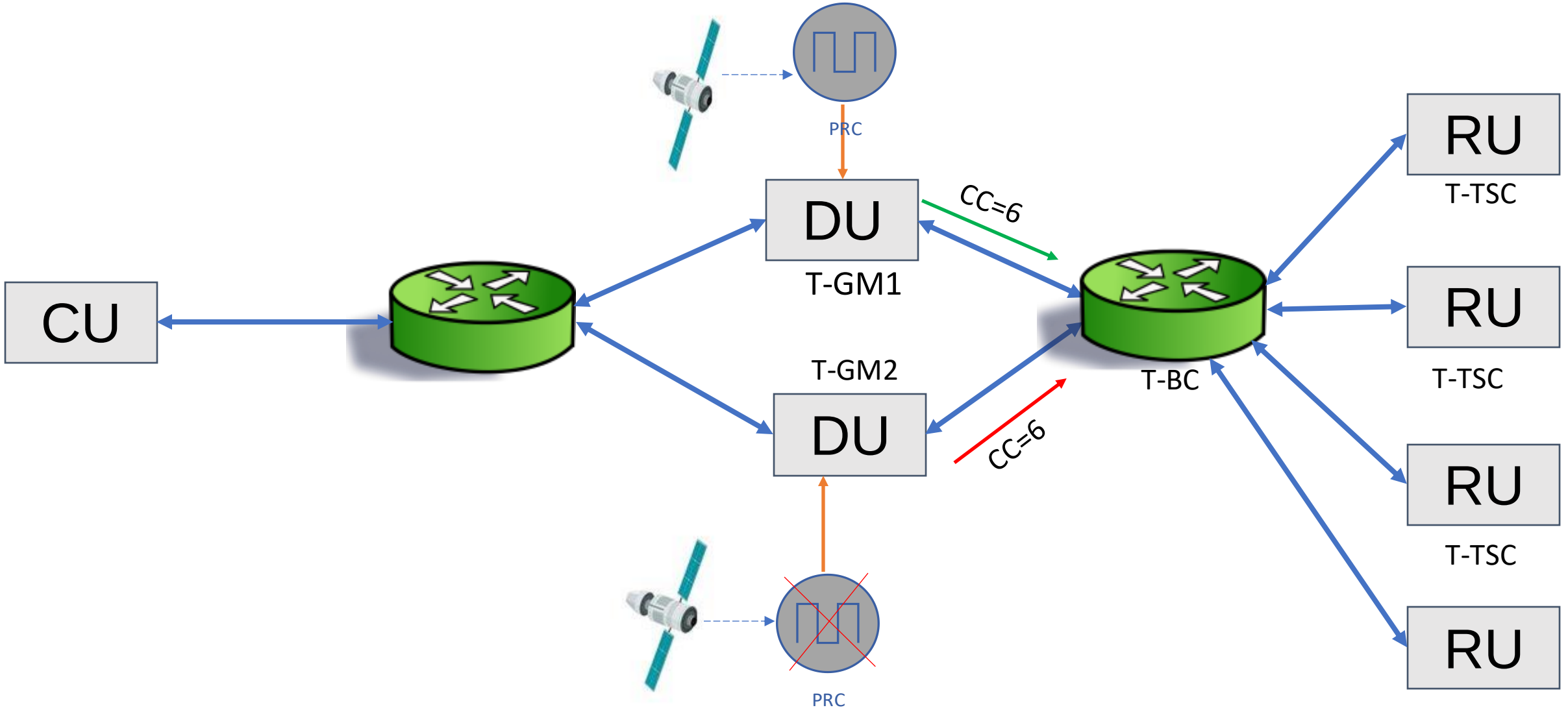


FIGURE-3 O-RAN LLS-C2 deployment with multiple DUs connecting to multiple O-RUs.

Link Aggregation(LAG)/Aggregation Ethernet(AE) Support

- LAG/AE refers to combining multiple physical links into a single logical datalink as LAG/AE interface.
- Advantages of LAG:
  - Increased BW
  - Resiliency/Redundancy
  - Load Balancing
- No support for synchronization over LAG logical/pseudo interface.
- Number of ptp4l instances active/listening depends on the member links based on the clock mode the device is in.
- Existing method defeats the purpose of BMCA to select the best clock among the LAG members.

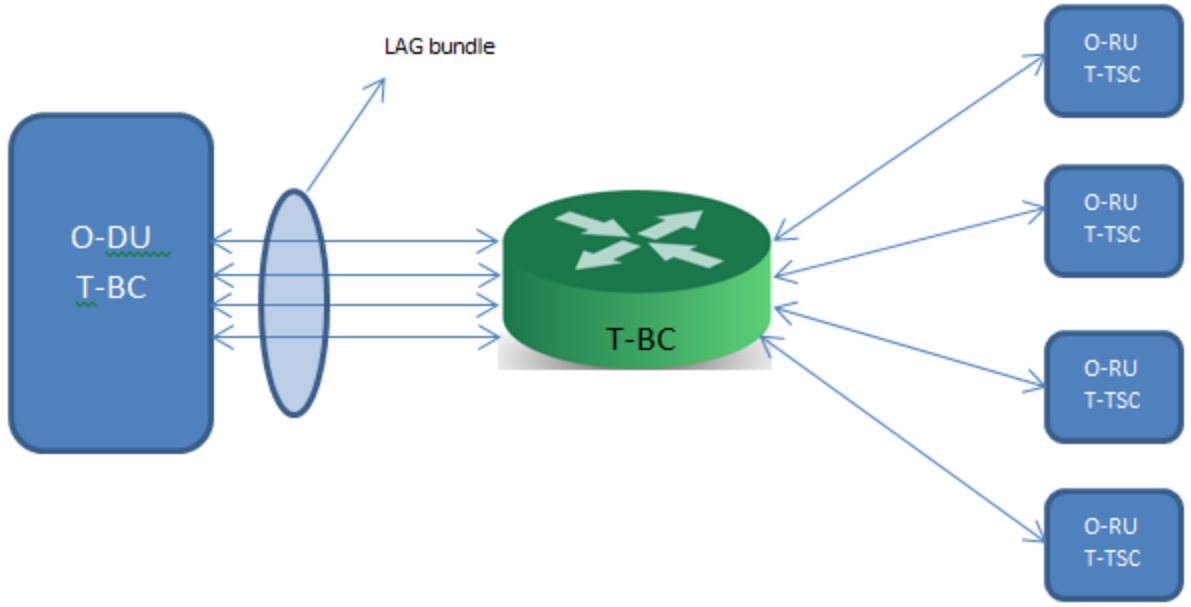


FIGURE-4 LAG use case in vRAN Fronthaul

Required support for ITU-T G.8273.4(APTS/PTS) for resiliency or redundancy

- In most common O-RAN LLS-C1/C2 deployments, operators shall chose to have sync redundancy/resiliency in case of any primary timing source failures in order not to impact the cell KPIs and/or meet Operator SLAs.
- For achieving Sync resiliency over sync network, ITU recommends PTS and APTS clocks.
- ptp4l doesn't have ability for monitoring and switching between primary and backup sync modes for handling switchover/switchback cases.
- No support for time synchronization across multiple profiles(G.8275.1/G.8275.2) due to which switchover/switchback between primary(G.8275.1) and backup sources(G.8275.2) is not possible.
- Doesn’t support SyncE/ESMC monitoring for achieving PTS clock support to provide frequency backup.

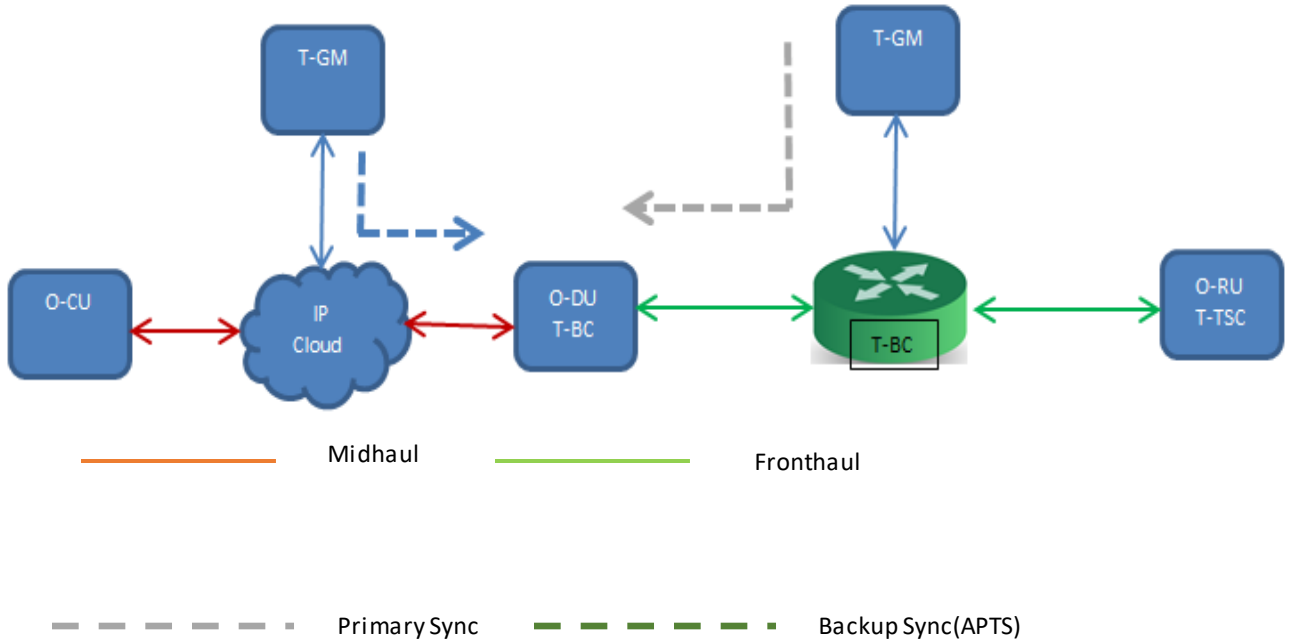


FIGURE-5:Example deployment of APTS network

Noncompliance to O-RAN WG4 CONF Spec

- Its usual expectation for Operators expecting O-RAN eco system partners (RAN/RU/Cloud Platform/System Integrators) to meet the O-RAN WG4 CONF Spec and IOT spec compliance and certification.
- ptp4l/ts2phc doesn’t comply to O-RAN WG4 CONF spec for Section 3.3 S plane conformance tests.
- All O-DU(s)/O-RU(s) running ptp4l needs to comply to Sync states defined for S plane in O-RAN WG4 CONF spec for various sync states when device is operating in any of T-GM/T-BC/T-SC clock modes.
- Need changes to ptp4l/ts2phc for defining O-RAN state machine to comply with PTP/SyncE, Sync states as defined in O-RAN CONF Spec.

Missing SyncE and ESMC support

- In O-RAN LLS-X configurations, O-DUs act as clock source and O-RUs as client/follower(slave) clocks,
- G.8275.1 is most commonly used profile in fronthaul networks
  - PTP for phase synchronization
  - SyncE for Frequency synchronization
- For SyncE implementations, it needed automatic source selection and failover/failback for SyncE Source(s), monitoring SyncE quality levels, extending the holdover periods.
- LinuxPTP doesn't have SyncE/ESMC support. (Intel is working on bringing the SyncE4L support to upstream which is WIP).

Summary

- The linuxptp project is the most widely used PTP implementation on today's Linux-based networks.
- shortcomings may force the network operators to search for different solutions (some proprietary solutions already exist).
- Let’s continue working together, focus on the mentioned areas to address these problems.
- That would help to drive the O-RAN adoption of linuxptp.

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END

THANK YOU

BACKUP

Non-compliance to ITU-T G.8265.1 Standard

- A PTP Master compliant to G.8265.1 profile, must support one-way and two-way timing transfer.
- Existing ptp4l implementation doesn’t have support for One-way timing transfer mode leading to interop issues.
- Unnecessary overhead for the applications with additional propagation delay calculations and messaging
- Operators needing Frequency only configurations (like LTE FDD/NR TDD) only need 1-way timing transfer but not 2-way timing transfer to avoid unnecessary overheads.

Need support for multiple domains.

- FDD and TDD networks can be deployed using a single clock source
- clock sources needs to distribute G.8275.1 and G.8275.2
- For redundancy purpose, sometimes DU shall chose to sync over PTS network when the primary FTS source fails and needs to convert the PTS clock to FTS and vice-versa.
- LinuxPTP doesn’t have support for providing the clock synchronization with multiple domains across multiple ports.
  - cant act as clock source converting from PTS to FTS vice-versa

Support for multiple domains(G.8275.1/G.8275.2)

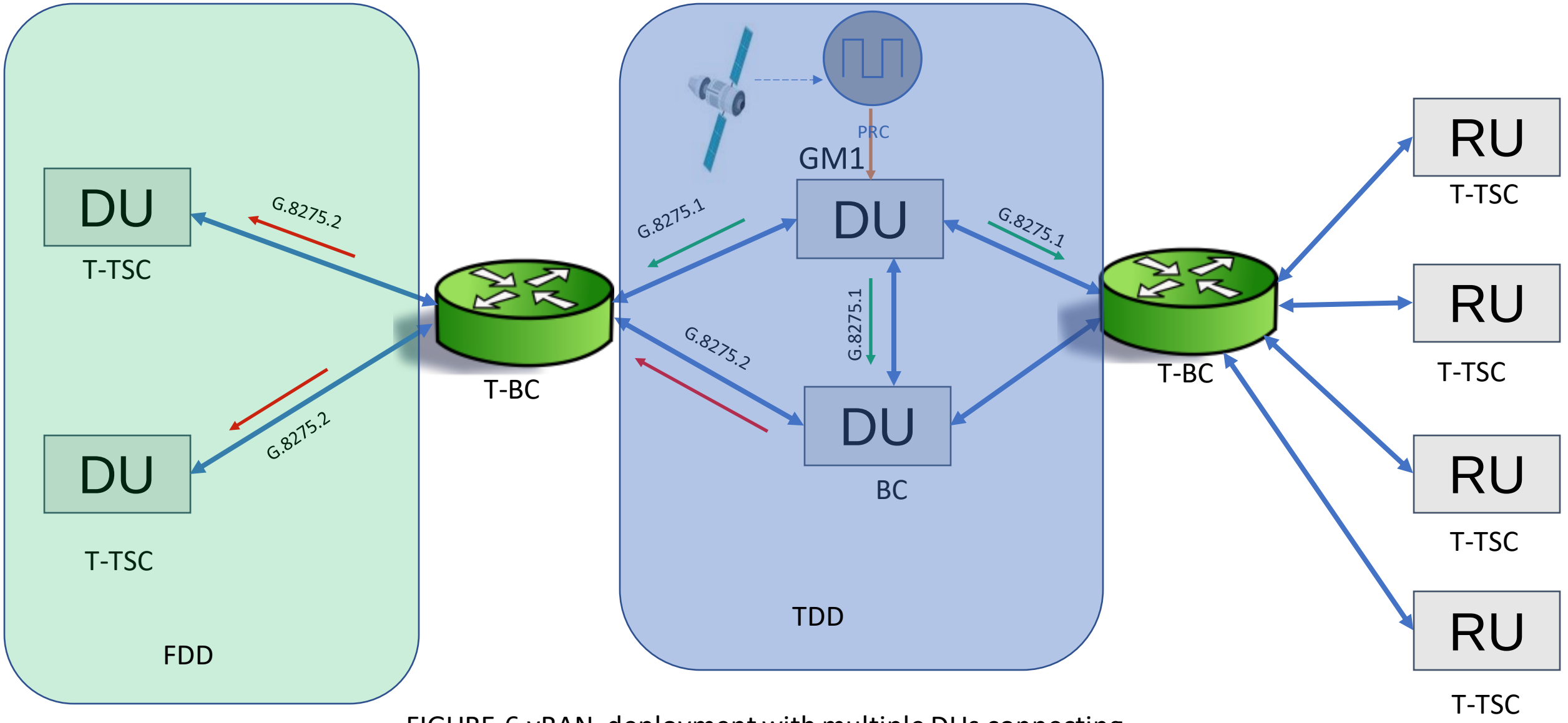

FIGURE-6 vRAN deployment with multiple DUs connecting to multiple O-RUs for TDD and FDD networks.

Multiple follower/slave ports

- In RAN split architectures, DU(BBU) typically will have multiple Fronthaul/Midhaul ports that need to carry sync plane traffic along with CUM Plane traffics. It's essential for DU running ptp4l, to have the ability to listen on all ports by default when configured as T-TSC/T-BC clock for selecting the best clock.
- Existing ptp4l implementations with a single ptp4l instance don't have such ability for T-TSC clock mode. For T-BC, ptp4l expects a list of devices to listen on.
- Port role shall be decided based on the announce messages carried in the PTP messages