Timing and Synchronization

Application Note

Synchronization is becoming a mandatory requirement in the current Mobile Networks. One of the solutions is the distributed Primary Reference Time Clock (PRTC) approach. It implements a Global Navigation Satellite System (GNSS) receiver in the end application. Due to its simplicity and flat distribution hierarchy, it has been widely deployed.

The PRTC approach has some limitations such as the requirements for an antenna with a wide-angle view to the sky, the need to address lightning protection and, in general, the issues related to the antenna cabling. Moreover, due to its complete dependency of navigation system, it might bring some vulnerabilities in some extreme situation such as war. For the 5G mass deployments, a Packet-based Solution with Timing support on intermediate nodes would be more suitable.

IEEE 1588v2 Precision Timing Protocol (PTP) is a proven technology for distributing time and frequency synchronization over packet-based backhaul networks to mobile network elements that require synchronization. The version 2 of IEEE 1588 introduces the concept of "profile", which specifies some particular scenarios. The ITU-T G.8265.1 telecom profile is specified for frequency synchronization whereas the ITU-T G.8275.1/G.8275.2 are for phase/time synchronization.

ITU-T G.8275.1 is a PTP profile that enables the stringent time and phase requirements to be met over a network from a centralized PTP Grandmaster(T-GM)(with GNSS primary reference). Maintaining precision and accuracy is achieved through deployment of "full on-path support" of the PTP timing signals. On-path support is provided by a T-BC(Boundary Clock) function embedded in every network element in the path between the grandmaster and the client, including all switches, routers, etc.. Having T-BC at every node in the chain between PTP Grandmaster and PTP Slave, results in reduction in time error accumulation through the network.

ITU-T G.8275.2, on the other hand, is another profile which provides Partial Time Support. It does not need PTP to be deployed on each node of the network. It can be easily leveraged by some existing networks to achieve packet-based time synchronization. Unlike ITU-T G.8275.1 using multicast, ITU-T G.8275.2 uses unicast mode, hence nodes using G.8275.2 are not required to be directly connected.

SyncE (Synchronous Ethernet) is a physical layer based technology providing frequency synchronization in packet-based Ethernet network. It is covered in the proposed ITU standard as providing frequency reference support for better performance. Also as it is close to the physical layer, it has the benefit of stability and can provide more accurate frequency synchronization.

IPI Solution

OcNOS-SP3.0 supports the timing features needed to achieve the +/- 1.5 microsecond accuracy for 5G network.

OcNOS-SP3.0 support PTP with ITU-T G.8275.1 profile, with the clock type telecom grandmaster(T-GM), telecom boundary clock (T-BC).

For time and phase requirements of T-BC, OcNOS-SP3.0 is a G.8273.2 compliant implementation. It can support class A, B, C & D for T-BC profile ITU-T G.8275.1.

For T-GM, OcNOS-SP3.0 conforms with ITU-T G.8272. PRTC+T-GM, can support PRTC-A(100ns) using GPS as time source.

For SyncE, OcNOS-SP3.0 conforms with ITU-T G.8262 defining the SyncE clocks and ITU-T G.8264 which describes the specification of Ethernet Synchronization Message Channel(ESMC).

All OcNOS-SP3.0 PTP and SyncE features are supported on 1G, 10G, 25G, 40G and 100G interfaces. RFC8173 MIB has been integrated to read PTP information via SNMP.

Use Cases

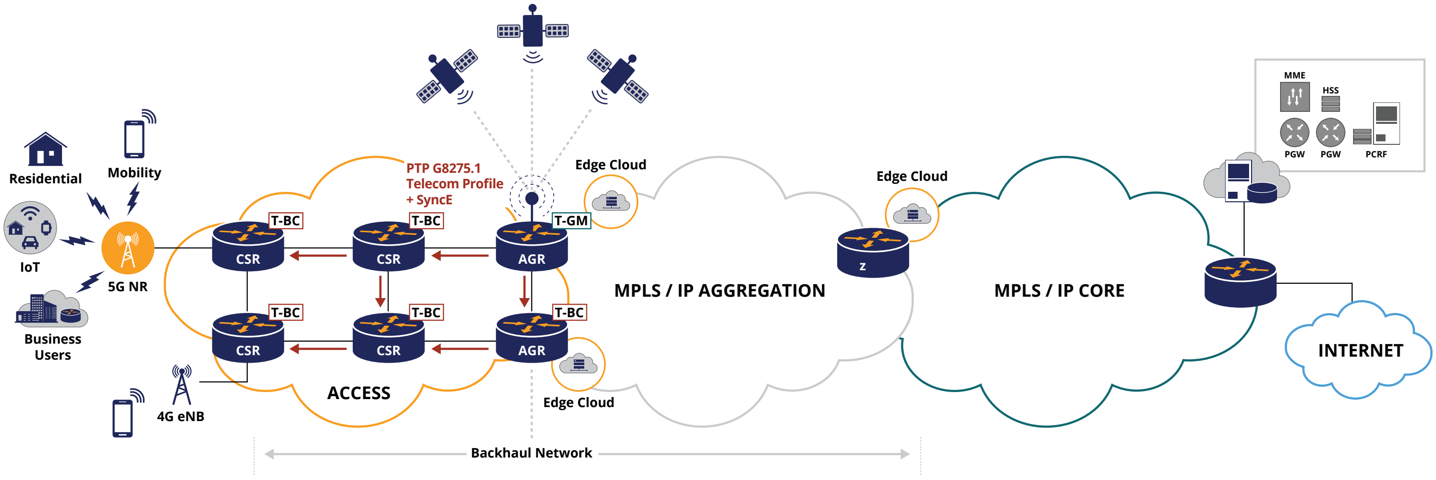

Diagram 1: Deployment of Time/Frequency synchronization in mobile backhaul

Here is a deployment for an Asia carrier providing high accuracy time and frequency synchronization in an Access Mobile Network.

The signal is received by the GPS receiver via antenna in the T-GM node. Due to the the T-GM support in OcNOS, there is no need for another device to act as aT-GM. Also, OcNOS can account and compensate for the delay due to cable length of the GPS antenna.

The other nodes in the Access Network will be configured as T-BC to transmit the time and frequency.

- Configuration on the T-GM will have one port as a GPS clock port instead of the normal data port.
- Node which is T-GM should always act as master and its interfaces should not be configured as input-sources except the GPS interface which is connected to the GNSS.

4G eNB act as slave clocks and receive the time synchronization information from T-GM over the network.

Sample configurations

Boundary clock (T-BC)

```
synce
interface xe8
  synce
    mode synchronous
    input-source 10
    wait-to-restore 1
    exit
   exit
interface xe9
  synce
    mode synchronous
    output-source
    exit
  exit
ptp clock profile g8275.1
 number-ports 4
 clock-port 1
  network-interface xe8
  exit
 clock-port 2
  network-interface xe9
  exit
```

Grandmaster Clock (T-GM)

```
synce
synce-interface gps
  mode synchronous
  quality-level QL_PRC
  input-source 9
  wait-to-restore 1
  exit
ptp clock profile g8275.1
  number-ports 4
  clock-port 1
    network-interface gps
    exit
  clock-port 2
    master-only
    network-interface xe8
    exit
  clock-port 3
    master-only
    network-interface xe9
    exit
```


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