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Outline

- Discussions on performance monitoring of synchronization
- Discussions on OAM hierarchy and mechanisms

Overview

It is necessary to performance monitoring for synchronization particularly with ultra-high-level.

Challenge and requirement of performance monitoring for synchronization in NGFI architecture

- More accuracy: typical synchronization requirement towards 5G is ±130ns related to UTC such as inter-site CA, massive MIMO, CoMP, positioning technology with RSTD etc.;
- More complex: CRAN BBU pool, two CRAN domain including CU and DU promote many different type of reference and connectivity for synchronization.
- More sensitive: End-to-End synchronization index is tight so that it is likely to exceed the threshold

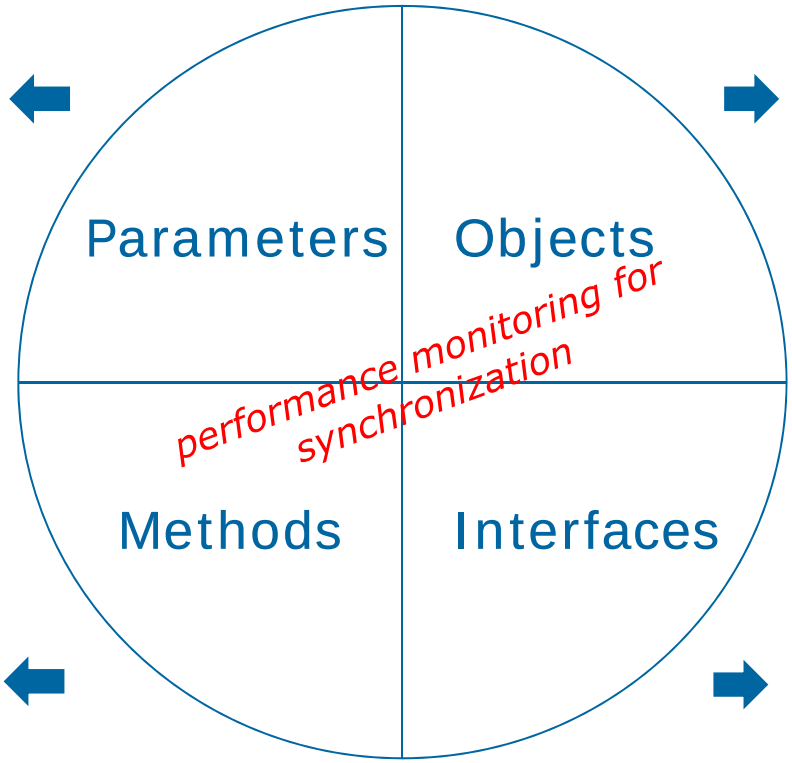
Activities of different standard organization towards performance monitoring of synchronization

- ITU-T SG15/Q13: SyncOAM draft is under study and clause 7.2 ,clause 8.2 and annex A are discussed;
- IEEE WG P1588: Performance Monitoring Options as annex M is drafted in IEEE Std 1588™-20XX.

Considerations for Performance monitoring

This presentation focus on the topics of objects and interfaces of performance monitoring of synchronization with ultra-high-level accuracy

- *Path delay*;
- *Offset from master*;
- *Original timestamp*;
- *Accuracy of time error such as max|TE|*;
- *Stability of time error such as $\sigma_x(\tau)$,TDEV(τ)*.



- FTN;
- *CU*;
- *DU*;
- *RRU*;
- Others.

- *In-band measurement such as passive TC, Reverse PTP on demand*;
- *Absolute measurement such as APTS, probe*.

- *Passive port of PTP interface*;
- *WR interface*;
- *1PPS+ToD*;
- Others.

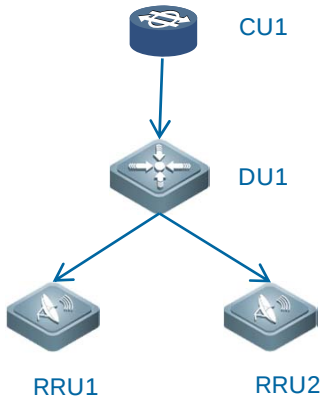
Objects of performance monitoring

In NGFI architecture, different objects are monitored to control the time error

- The architecture becomes more complex because packet transmitted equipment may be reused and two domains are divided in fronthaul networks by CUs and DUs;
- Three cases indicate that the upper bound of actual time error depends on different objects on account of common reference and connectivity.

Case I

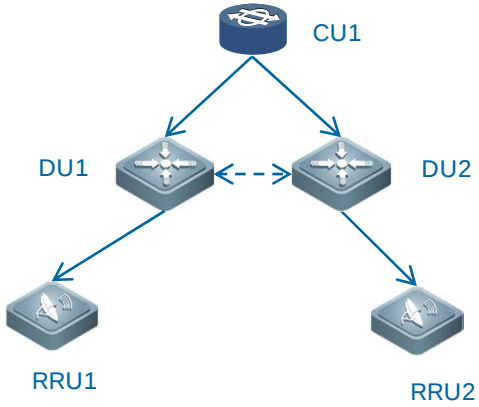
Upper bound of time error depends on the objects as RRU and FTN



$max|TE_{RRU1,RRU2}| \le max|TE_{RRU1,DU1}| + max|TE_{RRU2,DU1}|$

Case II

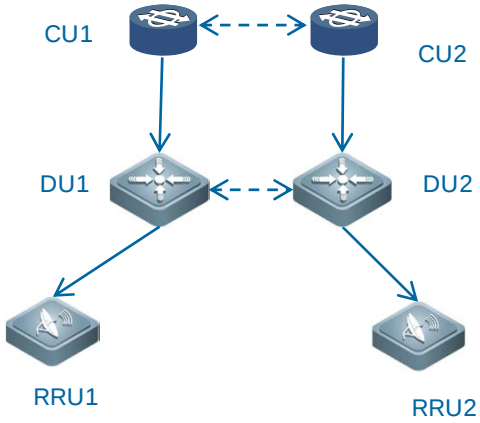
Upper bound of time error depends on the objects as RRU,DU and FTN



$max|TE_{RRU1,RRU2}| \le max|TE_{RRU1,DU1}| + max|TE_{DU1,DU2}| + max|TE_{RRU2,DU2}|$

Case III

Upper bound of time error depends on the objects as RRU,DU CU and FTN



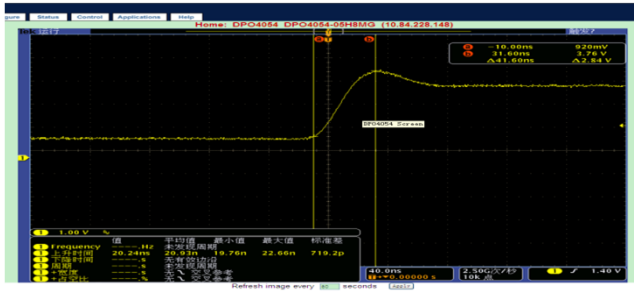
$max|TE_{RRU1,RRU2}| \le max|TE_{RRU1,DU1}| + max|TE_{DU1,CU1}| + max|TE_{CU1,CU2}| + max|TE_{CU2,DU2}| + max|TE_{RRU2,DU2}|$

Interface of performance monitoring

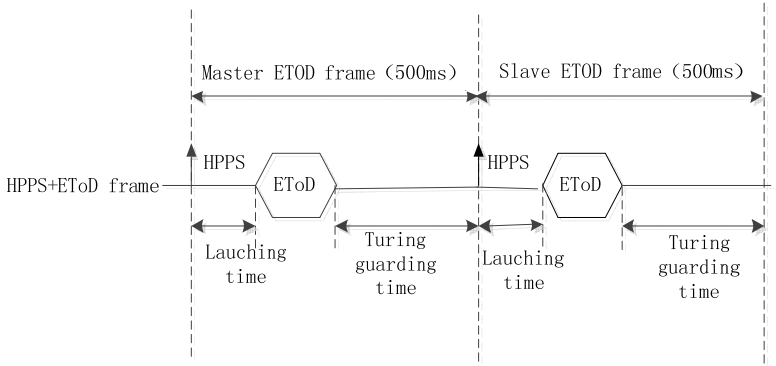
ultra-high-level accuracy synchronization monitoring requires stringent interface as well, where 1PPS+ToD interface is improved to enhance the accuracy of measurement and monitoring

- The first improvement is enhancing the pulse width of 1PPS with more steep rising edge.
- The second improvement is updating the measurement of 1PPS+ToD to duplex negotiation which can compensate the delay induced by cables and internal processing of nodes

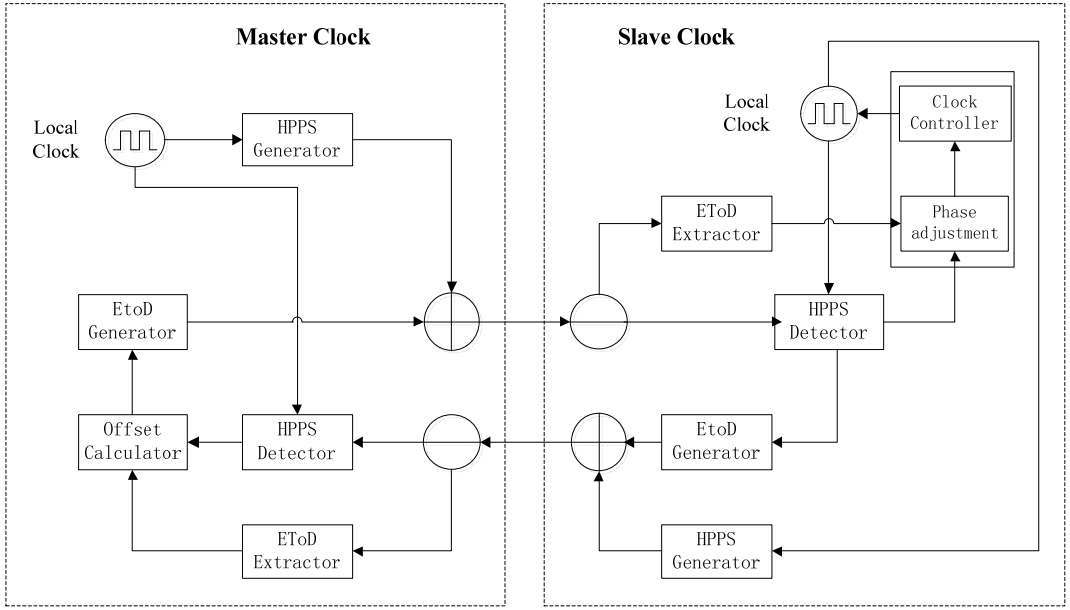
Enhancing the rising edge of 1PPS



Specifying the Half 1PPS(HPPS) and Enhanced ToD(EToD) in dual direction 1PPS+ToD measurements



Compensating the delay and adjusting the phase offset between objects to improve the accuracy of performance monitoring

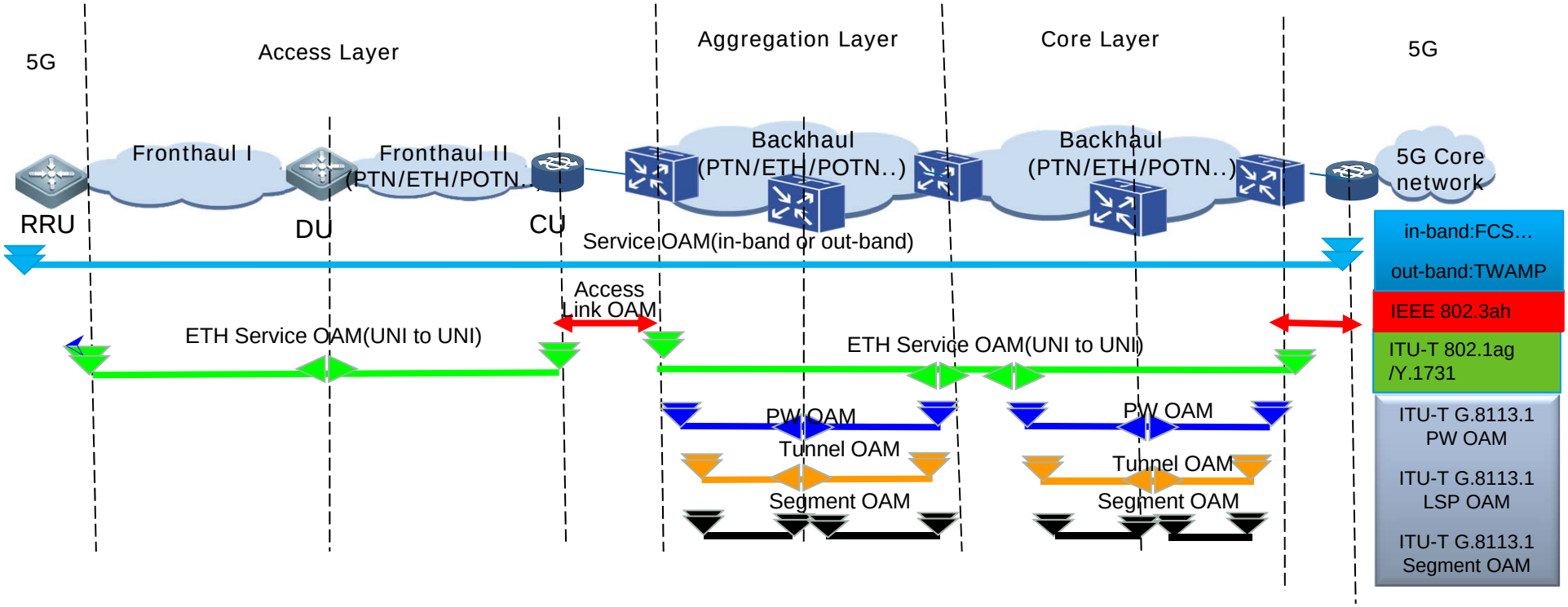


Outline

- Discussions on performance monitoring of synchronization
- Discussions on OAM hierarchy and mechanisms

Considerations for OAM hierarchy and mechanisms

- Hierarchical OAMs are important mechanisms for fronthaul and backhaul networks to enhance end-to-end fault and performance management capabilities.
- To provide hierarchical fault and performance monitoring, achieving fast fault detection and troubleshooting



Summary

Essential to study performance monitoring for synchronization in NGFI architecture

- 5G-oriented services require stringent synchronization while performance monitoring is an enabler;
- Synchronization network will become more sensitive while performance monitoring is a guarantee.

Proposing issues on performance monitoring of synchronization with ultra-high-level accuracy

Parameters, objects, methods and interfaces are four important aspects for performance monitoring;

- Objects and interfaces are discussed in this presentation;
- Parameters and methods will be discussed later on.

Monitoring different objects in NGFI architecture

- Single object is not ”one fits for all” as different equipment, complex connectivity and various common reference may coexist in NGFI architecture;
- Different cases indicate that RRU, DU,CU and FTN may be monitored to control the time error and potential risks of exceeding the budget.

Improving interface as 1PPS+ToD to enhance the accuracy of monitoring

- Electrical characteristics can be improved such as decrease the rising time of 1PPS;
- Dual measurement and adjustment is proposed by redefining 1PPS+ToD interface.

Addressing some views on OAM hierarchy and mechanisms

- Hierarchical OAMs are important mechanisms for entire network to enhance E2E fault and performance management capabilities.
- To provide hierarchical fault and performance monitoring, achieving fast fault detection and troubleshooting