Service Infrastructure #9 Spec.
Design & Test Report

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1 Public Abstract

SynchroNet is a Thales Alenia Space Italia patented solution for an high performance, scalable and resilient time and frequency transfer system.

The SynchroNet system addresses a network of nodes equipped with atomic clock(s) (from cheapest rubidium to more expensive Active Hydrogen Maser) and that can potentially cover large baselines up to thousands of kilometres between two “adjacent” nodes.

![SynchroNet Diagram](image)

**Figure 1-1: TSI#9 - SynchroNet scaling scheme and hierarchical architecture**

SynchroNet uses GNSS (Global Navigation Satellite Systems) Signal in Space to perform time transfer but doesn’t rely on these signal complete availability or quality by computing an internal statistical model for each node of the network. This model is continuously monitored and updated to guarantee integrity of service and QoS.

The goal of SynchroNet is to provide an integrated synchronisation solution covering all requirements domains that are to be taken into account in system design or system evolution studies:

- **Performance**: accuracy up to 5ns and with stability up to 1e-14 ADEV at 24 hours (depending on nodes clock performances)
- **Availability and robustness**: to be able to offer very good level resilience against threats affecting GNSS SiS like service interruption, jamming and interferences and spoofing
- **Scalability**:

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to scale in number of nodes: the network can scale up or down without interrupting the overall service)

- to scale on geographical coverage: SynchroNet hierarchical structure can grow to allow covering very long baselines reaching 10 thousand of kilometres baselines

- reconfigure the network: allows to rebalance the network with the service by logically moving nodes around within SynchroNet hierarchical network

- Performances scalability: each node can be up or downscaled in terms of clock performances. This allow to upgrade each node performances when higher accuracy or resilience is needed

- Scaling limited impact: scaling up or down is guaranteed to have localized impacts on the network thanks to the distributed approach to synchronisation. At most two other nodes need to be reconfigured and with no interruption.

- Maintainability: thanks to the scalability feature it is quite easy to move out one node for maintenance

- Security: SynchroNet offers a multi-layer approach to authentication, integrity and confidentiality. All layers are implemented through different asymmetric crypto certificates. All communications are point to point and each point-to-point link takes place on a dedicated virtual network, all data transmitted is signed using and certification authority is kept internal to the system (all nodes of the network are manually pre-loaded with CA keys). In addition, the distributed and redundant monitoring and computation schemes require breaking three point-to-point links (and all security layers for each link) in order to be able to spoof or compromise the service. In any case, given the point-to-point nature any security breach is kept as much as possible localized.

- Integration: SynchroNet is not designed only for new systems or new installation but is easy to integrate in already operational systems. It requires a GNSS antenna, a small rack and a network connection with just two other nodes of the network. This means that SynchroNet is able to overlay and adapt its logical infrastructure to existing ones.

SynchroNet, hence, provides high accuracy synchronisation of geographically distributed atomic oscillators and guarantees ease of integration, robustness, availability, integrity and flexibility. SynchroNet provides the logical infrastructure around the synchronisation mechanism, for this reason it can be suitable for a large range of application domains where synchronisation is required (or will be required) either in terms of accuracy or in terms of scalability.

This document includes an overview of SynchroNet logical and physical architecture as well as its declination to the DEMETRA project particularly concerning the focus on User Need analysis and KPI monitoring.