

SynchroNet: High Performance Distributed Synchronization System

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INTRODUCTION

Given the trend in spreading services over larger coverage areas and in controls automation, a central issue in designing such complex networked systems is the ability of keeping each node of the network synchronized with respect to a given reference system time scale granting performances. The problem is even more critical when the synchronization performances impacts directly a whole higher system or service; for this reason synchronization performances shouldn't be considered only in terms of raw time offset estimation accuracy but also in terms of availability, reliability and security of the synchronization products and services.

In particular, in the context of GNSS systems, time and frequency can be viewed at two different levels:

As System infrastructural feature/service

- Time and frequency synchronization is required for Time Of Flight based ranging techniques
- Synchronization of networked and functionally distributed Ground Segments

As a GNSS system byproduct:

- Navigation systems intrinsically carry accurate timing information that can be exploited to transfer time and frequency along large baselines allowing synchronization of geographically distributed high performances atomic clock

In this paper a distributed synchronization infrastructure is proposed.

SYNCHRONIZATION ALGORITHMS

While synchronizing two co-located clocks could be as easy as measuring 1PPS offsets over time by mean of an accurate Time Interval Counter (TIC), synchronizing several kilometers away clocks could be much more difficult.

To solve the problem of keeping two clocks synchronized even across long baselines with nanosecond accuracy and precision performances, GNSS based techniques have been preferred over other methods for many reasons, among which:

- availability of the GNSS navigation signals
 - performances
 - diagnostic information about GNSS system health
- GNSS based synchronization could be carried out by mean of Common View techniques which exploits navigation signals broadcasted by GNSS SVs (Space Vehicles) which are in a condition of "common view"

from the observation points of the two sites to synchronize.

SYNCHRONET ARCHITECTURE OVERVIEW.

SynchroNet is a distributed approach to synchronization with centralised monitoring and control facilities

To provide a synchronization system that is able to provide

- high accuracy synchronization performances (nano and pico seconds accuracy) techniques
- flexible and scalable service topology
- ease of integration in pre-existent infrastructures
- ease of customization both at user level and at system level in terms of performances and security
- fault tolerance and run time network configuration and monitoring

SynchroNet implements a networked infrastructure around the core time transfer algorithms and distributes the synchronization process over a hierarchic network with hierarchic network nodes roles. This approach allows to distribute and keep balanced the processing load and limits the propagation of failures.

PERFORMANCE & VALIDATION TEST RESULTS

This paper will present some results of both validation test results and of performance assessment of SynchroNet algorithms using IGS product as reference.

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