

# Time Scale Orchestrator

## Management and Control Software for Time Scale System Operation

### Summary

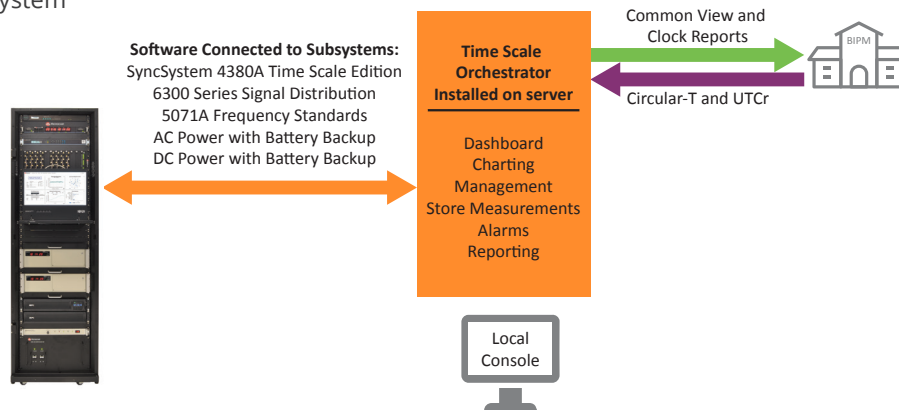
A time scale system is typically a system of systems that must work in an integrated manner. The Time Scale Orchestrator is a software platform that integrates the management, monitoring, alarming and reporting functions of the individual systems (products) that form a time scale system. This ensures that the operator has a single pane of glass that provides a complete view of the entire time scale system's performance and its management. An integrated database provides long-term storage of clock measurements for viewing and comparing clocks that are contributing to the time scale ensemble. Timing parameters can be entered through the Graphical User Interface (GUI) for steering the time scale to the selected truth source, such as UTC, as maintained by the Bureau International des Poids et Mesures (BIPM). When integrated as part of our Precise Time Scale System (PTSS), this software ensures that the overall system operation is meeting the tight timing margins required for a national time scale.

### Key Features

- Dashboard that provides a complete view of the system operation
- Real-time and historical plotting of the time scale performance relative to the selected truth source
- Measurement system for comparing clocks that are contributing to time scale ensemble
- Monitors and displays Global Navigation Satellite System (GNSS) observables to protect and secure GNSS reception
- Monitors timing signal outputs for status and potential disruptions
- Storage of common view reports, clock reports and TAIPPP reports for delivery to the BIPM
- Export data to the TimeMonitor software suite for signal analysis, including Maximum Time Interval Error (MTIE) and Allan Deviation (ADEV) measurements
- A member of our family of time scale products, including the Precise Time Scale System

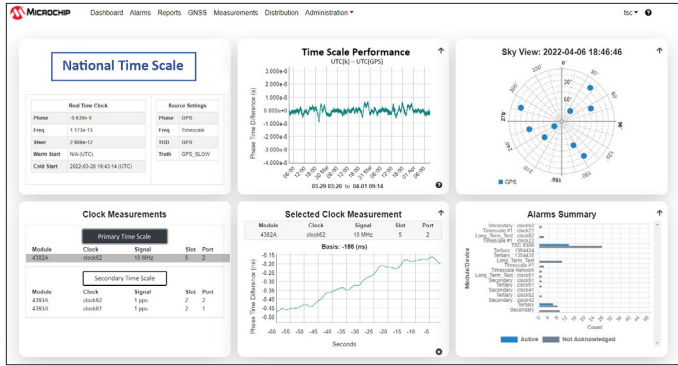
### Overview

Operation of a national time scale requires management of multiple high-performance technologies, including atomic clocks, precision measurement instruments, protected and secure GNSS reception, low phase noise signal distribution, alarm management and uninterruptible system power, to deliver reliable 24 × 7, 365-days-per-year uptime. These technologies are typically delivered in individual products to provide modularity and efficient operational maintenance. However, the operator of a time scale system needs a unified view of the entire integrated system. Using the Time Scale Orchestrator, time scale operators can manage and monitor the overall time scale system performance and quickly view the health and status of individual subsystems.



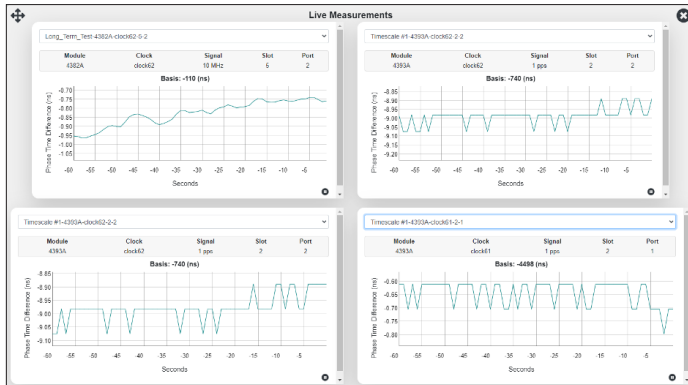
The Time Scale Orchestrator Provides a Unified View of Time Scale System Operation

The Time Scale Orchestrator displays a dashboard that provides a view of the health and summary status of the system. It includes time scale performance metrics, clock performance, GNSS satellites in view and system alarm status. The dashboard can also be customized to include the customer's logo.



Time Scale Orchestrator—Dashboard

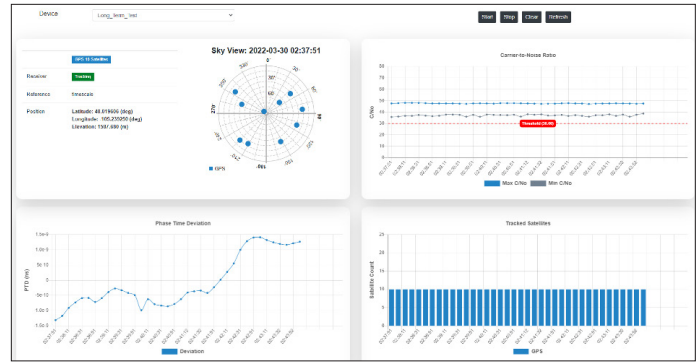
From the dashboard, the user can access more details about system performance. For example, the user can view individual clock performance simultaneously to help prevent a poorly performing clock from impacting the clock ensemble and, ultimately, the time scale performance.



Live Measurements of Individual Clock Performance

The Time Scale Orchestrator includes a listener process so that clock measurements are collected every second for data storage in the database. The Time Scale Orchestrator software can store more than 10 years of data. Storing data for longer periods of time is possible depending on the server infrastructure capacity.

Another example of performance management is the ability to view GNSS observables to ensure that GNSS reception is not disrupted. Tracking metrics such as satellites in view, Carrier-To-Noise (C/N<sub>0</sub>) levels and live-sky time reception are all available through the web interface. By actively monitoring GNSS observables, the user can quickly detect problems caused by unintentional events or possible intentional threats such as jamming and spoofing.



Viewing GNSS Observables

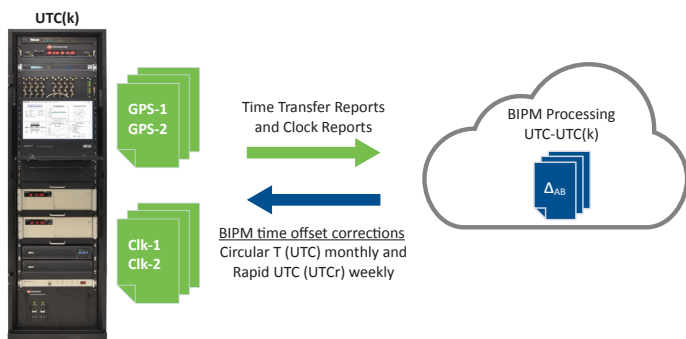
## System Alarm Management

Alarm management uses a network based architecture that monitors all elements of the system. This architecture consists of a system manager, local managers, various subagents embedded in the Time Scale Orchestrator and the alarm user interface. The database contains the definition of every chassis and module in the system and each component's state. Every module that is capable of being monitored has alarms associated with it, corresponding to the status or error conditions that pertain to that module. When a condition is detected, the alarm is activated and sent to the system manager. Soft alarms are used to represent conditions that are not associated with a physical module, such as exceeding the system accuracy specification.

The alarm user interface detects a change and updates the active alarm page to show the active alarm. The alarm remains active and displayed on the alarm status page until the alarm condition clears. An alarm can also be acknowledged on the active alarm page which enables operators to know whether an alarm has been addressed or when an alarm is new.

## Reporting and Contributing to UTC

The Time Scale Orchestrator includes several features to make interfacing with the BIPM for contribution to UTC a reliable and simplified process for the time scale operator. As defined by BIPM, there are specific reports with defined formats that the user must submit on a timely basis. These reports include common view reports (abbreviated as CGGTS reports), clock reports and TAIPPP reports. In return, the BIPM publishes comparisons between a local laboratory's performance and UTC as defined by the BIPM [UTC - UTC(k)]. These reports come in two formats. One report, referred to as *Circular T*, is provided monthly and shows performance over a five-day period. The second report referred to as *UTC<sub>r</sub>*, is provided weekly and shows daily performance.



### Reporting and Data Exchange with the BIPM

The following reports are stored in the database of the Time Scale Orchestrator:

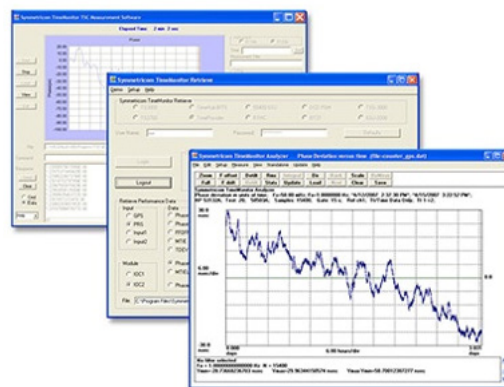
REPORT NAME	DESCRIPTION
<b>GNSS common view report</b>	Enables two sites to simultaneously observe the same satellites and calculate their respective time offsets Reports may be submitted to BIPM for calculation of UTC-UTC(k)
<b>Clock report</b>	Measurements of the individual clocks being used by the time scale Reports may be submitted to BIPM for inclusion in its realization of UTC computation of International Atomic Time (TAI)
<b>TAIPPP report</b>	Uses daily generated Receiver Independent Exchange Format (RINEX) files that may be post processed and used to track the site antenna position

All the reports can be viewed from within the Time Scale Orchestrator or downloaded for offline processing and sharing with BIPM.

The Time Scale Orchestrator also allows users to enter measurements that represent the truth source toward which the system will be steered. Examples of truth sources are the BIPM's Circular T or UTCr correction reports. Using the GUI of the Time Scale Orchestrator, steering parameters from alternative truth sources can also be entered. This is a typical requirement where time scale systems are deployed as site timing systems and need to be synchronized with each other. Additionally, scheduling of automatic entry of steering parameters can be configured which is useful when steering parameters are more frequently updated.

## TimeMonitor Software

Many time scale operators are interested in analyzing the timing performance of individual clocks and the time scale system in detail. Measurement data stored in the Time Scale Orchestrator can also be easily imported into our TimeMonitor Software for more detailed analysis. This tool can display various performance metrics such as ADEV, TDEV and MTIE. Additionally, results from multiple measurements can be overlaid on the same graph enabling multiple clocks to be compared and analyzed together.



TimeMonitor Measurement Analysis

## Additional Information

The Time Scale Orchestrator is a part of our larger product family of time scale and site timing system products. Please refer to the following for more information about this offering:

**Precise Time Scale System**—This fully integrated timing system can provide timing accuracies comparable to the world's best national laboratories.

**SyncSystem 4380A Time Scale Edition**—This system generates an autonomous time scale derived from combining several highly accurate independent clocks.

**SyncSystem 4380A With Multi-Channel Measurement**—The SyncSystem 4380A, equipped with 4382A and 4393A modules, can be connected to the MeasDB software to provide a powerful and versatile database measurement platform.

**6300 Modular Distribution System**—The 6300 system is a hot swappable, modular distribution chassis that supports high-performance RF, 1 PPS and IRIG distribution. Designed for metrology applications, the 6300 Modular Distribution System delivers high-performance signal distribution without degradation.