OSA Sync Survey

OSA Professional Sync Services

1. Background and Purpose

Oscilloquartz's Sync Survey is a service that gauges the synchronization performance of an existing network. Synchronization is an important feature for certain networks. For example, in mobile networks, base stations must be synchronous in frequency and phase; in the power industry, smart-grid technology requires synchronization for measuring AC phase and for locating grid failures; the financial industry has to comply with new regulations (MiFID II[1] from ESMA[2] and Rule 613 from SEC[3]) and therefore uses time-of-day distribution for tracing the time of financial transactions. For these networks to function correctly, their synchronization must comply with prescribed performance objectives.

The Sync Survey service measures synchronization performance in a defined number of network sites through synchronization probes and collecting data from these probes. The measurements are performed continuously over a defined period of time, which can range from hours to weeks or longer as needed. Measurement results are then analyzed and presented in a written report. This report provides a view of the synchronization performance of the network, which enables the network operator to take action when necessary.

As the Sync Survey includes the deployment of a certain number of sync probes at the end of the service, the probes can either be dismantled or transferred to the customer to use as a permanent in-service monitoring mechanism.

A Sync Survey is needed in several situations (use cases). For example, a Sync Survey may be required to assess the synchronization performance of an existing synchronization network. Another possible motivation is an upcoming network expansion. In this case, it makes sense to first gain a clear picture of the present synchronization performance before planning the expansion of the synchronization network. Another relevant case is a network expansion, which requires switching from frequency synchronization to phase synchronization, such as changing from LTE to LTE-A. In this case, the Sync Survey not only assesses the quality of the existing frequency synchronization, but also the network's ability to support phase synchronization (after adequate upgrades).

Customers may have other use cases than the ones mentioned above. These can be accommodated by tailoring the Sync Survey program to the customer's distinct requirements.

Sync Surveys are executed with Oscilloquartz sync probes and the associated management system, which implements a probing tool suite called Syncjack™. For details about Syncjack™ tools, see Annex A.

[1] MiFID II: Markets in Financial Instruments Directive II
[2] ESMA : European Securities and Markets Authority
[3] SEC: Securities and Exchange Commission, USA

2. Service Options

2.1. Service Options Overview

Different use cases require different service options and parameters, which are best determined during the offer process. Table 1 gives a summary of the different options available. More details are given in subsequent sections.

Table 1: Service Parameter Options

Service parameter	Options
Test type (choose any)	☐ Clock signal performance testing ☐ Network ability testing
Synchronization method (choose any)	☐ Physical-layer based frequency synchronization ☐ PTP based frequency synchronization ☐ PTP based phase synchronization
Number of measurement sites (choose/specify one)	Any number of sites
Measurement period (choose/specify one)	Any measurement period

2.2. Test Type

There is a difference between measuring the performance of a clock signal and evaluating the ability of a network to transport synchronization from a master clock to a slave clock. In the first scenario, a signal coming from an already integrated clock is being measured. While in the second scenario, the focus is on the network and the detrimental impact of packet delays on timing packet flows.

2.3. Synchronization Method

2.3.1. Physical-Layer-Based Frequency Synchronization

When implementing the physical-layer-based frequency synchronization method, frequency synchronization is transferred and carried by the data rate of the physical-layer line signal. This is the case in SDH, SONET, and Synchronous Ethernet (SyncE). The reference frequency is generated by a primary reference clock (PRC). Synchronization is distributed through a tree of slave clocks of different types – SSU, SEC, and EEC.

2.3.2. PTP-Based Frequency Synchronization

When implementing the PTP-based frequency synchronization method, frequency synchronization is transferred using PTP packet flows containing timestamps. The PTP packet flows may be one-way or two-way. A PTP grandmaster (GM) acts as the synchronization reference source, where the PTP packet flows begin. The network nodes (routers) on the paths are PTP-unaware, which means that the nodes forward PTP packets without doing anything specific with or to them.

2.3.3. PTP-Based Phase Synchronization

When implementing the PTP-based phase synchronization method, phase synchronization is transferred using two-way flows of PTP packets containing timestamps. A PTP GM acts as the time reference source, where the PTP packet flows begin. Depending on the PTP profile used, the intermediate nodes (including the routers and switches) may or may not be required to have specific PTP functions, such as boundary clock and transparent clock.

2.4. Number of Probing Sites

The number of probing sites depends on the use case. For assessing the overall performance of a synchronization network, the approach is to choose sample sites using these guidelines:

- Distributed over the entire network
- Representative of all the sites under consideration

In some cases, it is more useful to choose sites located along a specific synchronization path going from the reference source, such as a PTP GM, to the most remote slave clock. Here also, the path chosen is representative for all other paths in the network.

The chosen number of sites is subject to agreement between the customer and Oscilloquartz.

2.5. Measurement Period

The term measurement period defines the total interval of time during which the sync survey measurements are performed. The minimum period of a meaningful survey is 24 hours. Network conditions, such as traffic load, change with time. Changing network conditions impact the performance of synchronization. The strongest observed variations are diurnal, where typical network peak hours are taken into consideration. There are also variations over the week due to changing traffic patterns, such as between working days and weekends. In addition, there are long-term changes due to long-term trends in the usage of network services by the end customers. The optimal measurement period depends on what kind of variations one intends to capture.

The number of says chosen is subject to agreement between the customer and Oscilloquartz.

3. Deliverables

The final deliverable is a written report with the measurement results and the electronic files of the formatted measurement data.

In the report, the measurement results are represented by means of standard metrics, such as MTIE. These metrics are calculated from the raw data. Therefore, the number of data points is reduced to a manageable quantity. The metrics also facilitate the interpretation of the results. The electronic files contain the calculated metrics.

4. Process Flow

A Sync Survey consists of these phases:

1) Definition Phase
2) Installation Phase
3) Measurement Phase
4) Analysis Phase

4.1. Definition Phase

In the definition phase, the sites where the sync probes are installed are determined. Ideally, this is performed as part of the offering process. If this was not completed previously, the sites are determined at the beginning of the project. Furthermore, additional details are defined, such as the measured interface and signal with the related technical details.

Note: The OSA 5410 represented in Figure 1 is typically used as a sync probe. Detailed information about the product can be found in the product data sheet.

Outcome: A list indicating the measurement sites and the measured interfaces and signals.

4.2. Installation Phase

The installation phase is when the sync probes and the communication and management systems are installed and commissioned. At this stage, it is decided whether to use active[4] or passive probing[5]. The communication and management systems consists of the following:

- A data collection server (ftp/sftp) installed somewhere on the data communication network (DCN), which collects the measurement data generated by the sync probes
- Transfer of data from the data collection server to OSA 5410
- IP connections from all sync probes to the data collection server over the DCN

The sync probes are configured to run the measurements automatically and to send the measurement results automatically to the data collection server.

Outcome: A fully operational measurement set-up including the sync probes and the communication and management systems for the data collection.

4.3. Measurement Phase

During the measurement phase, measurements and the collection of the measurement results are carried out. First, the measurement parameters are configured. Afterwards, the measurement and the transfer of the measurement results to the data collection server occur automatically. The server is flushed periodically by transferring the data files to the OSA 5410 servers running the FSP NM (with the Sync Manager option) for further processing.

Outcome: The data files with raw measurement are ready for processing by the OSA 5410.

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[4] Active probing: The sync probe acts as a PTP slave and terminates the PTP flow being tested.
[5] Passive probing: The PTP flow being tested is mirrored by a router or switch, and the mirrored packets are sent to the sync probe.

4.4. Analysis Phase

The analysis phase is when the measurement results are processed and presented in a useful format. Standard metrics, such as MTIE, are calculated and presented with the relevant performance limits. The results are compiled and displayed in a written report. The customer receives both the report and the electronic files with the processed results in a common file format.

Outcome: A report presenting the formatted measurement results and electronic files with the formatted data.

5. Responsibilities

Table 2: Default Responsibility matrix

Task / result	Oscilloquartz	Customer	Jointly
Agreement of service parameters			X
Provision of information about the target network		X	
Installation and commissioning of sync probes and their management system	X		
Configuration of network elements on the synchronization path, such as routers		X	
Installation and commissioning of the data collection server (ftp/sftp)			X
Configuration of sync probes: Setting up the measurements and the transfer of the results to the data collection server	X		
Setting up and executing the transfer of the measurement results from the data collection server to Oscilloquartz			X
Analysis of the measurement results	X		
Findings and report	X		

Annex A: Sync Assurance with Syncjack™ Technology

The powerful Syncjack™ performance monitoring suite includes various tools to test the performance of clock signals and the usability of networks. The OSA 54xx product line includes three Syncjack™ probing functionalities: Clock Accuracy, Clock Analysis, and PTP Network Analysis (see below). These probing functions are complemented by the powerful synchronization network analysis and display tools of the FSP Network Manager with its FSP Sync Manager option. Figure 1 presents the various OSA 54xx products, including OSA 5410, OSA 5405, and OSA 5401, which are typically used as sync probes in Sync Surveys.

Figure 1: OSA 5410 / 5405 / 5401 used as sync probes

Clock Accuracy

The Clock Accuracy measures the frequency or phase accuracy and stability of the physical-layer timing signals relative to a synchronization reference, which can be internal, external, recovered, or originating from a GNSS signal.

Clock Analysis

Clock Analysis relates to these use cases:

- Measuring the frequency or phase quality of a PTP packet timing signal directly at a master or a slave port to evaluate the quality of the associated PTP master or slave clock being tested.
- Gauging the performance potential of a PTP packet flow, which was transported over a network, by estimating the frequency or phase quality of the timing that a PTP slave clock would recover from the PTP packet flow being tested.
- Monitoring the state of the OSA internal PTP slave clock and estimating the quality of the internal timing recovery function without using a synchronization reference. TIE, TE, and MTIE measurements are based on timestamps embedded in the PTP packets, which are

compared against a synchronization reference signal (typically GNSS). Additionally, performance scores provide an easy interpretation of the results.

PTP Network Analysis

PTP Network Analysis is used for analyzing the packet delays in the packet transport network. Since packet delay variation and packet delay asymmetry need to be constrained, their analysis provides information about the usability of the packet network for the transport of PTP. The results are based on timestamps embedded in the PTP packets, which are compared against a synchronization reference signal (typically GNSS). The results are presented in the form of various statistical functions.

Active and Passive Modes

Both active and passive modes are possible in clock analysis and PTP network analysis. Both options are supported in parallel. The techniques are specified in ITU-T Rec. G.8273. Active probing is the preferred method for sync surveys. Passive probing is used only in very specific cases.

- Active technique: A sync probe device participates in the packet exchange and performs measurements at the same time as it transmits and receives the timing packets.
- Passive technique: A sync probe device monitors packet exchanges over a communication link and acts as an observer; to this effect the PTP flow being tested is mirrored by a router or a switch, and the mirrored packets are sent to the sync probe.

FSP NM Sync Manager

The FSP Network Manager is the management system for all ADVA and Oscilloquartz equipment. The option FSP Sync Manager adds Syncjack™ functionality to the FSP NM and is required for running Sync Surveys. It complements the probing functions in the sync probes to form a complete tool suite. Next to other tools, the FSP Sync Manager provides these functions related to sync probing:

- Efficient provisioning of sync probes, including initialization and scheduling of Syncjack™ test procedures
- Graphical display and analysis of standard performance metrics, such as MTIE
- Collection of TE and TIE measurements

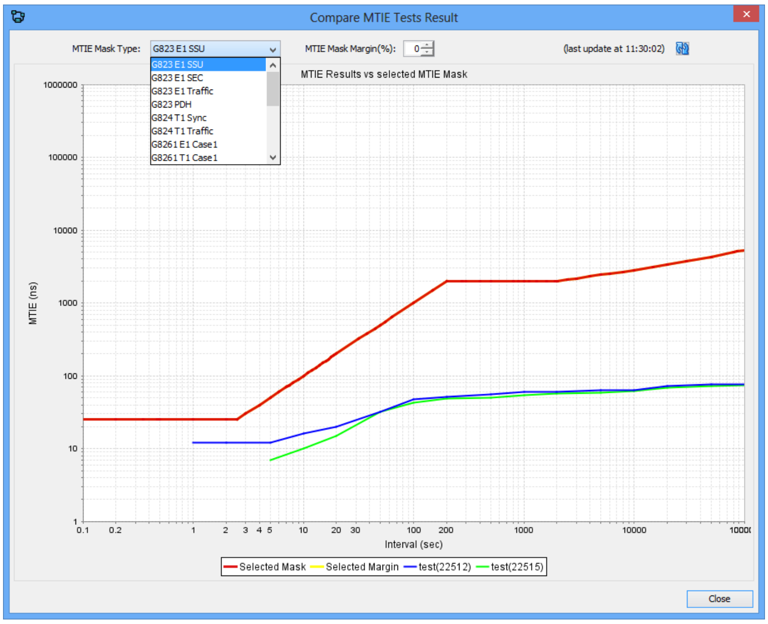

Figure 2: Example of a FSP Sync Manager window

Abbreviations

2wayTE	Two Way Time Error
APTS	Assisted Partial Timing Support
BC	Boundary Clock
DCN	Data communication network
EEC	Ethernet Equipment Clock
FPP	Floor Packet Percent
FTS	Full Timing Support
GM	Grandmaster
MTIE	Maximum Time Interval Error
PRC	Primary Reference Clock
PTP	Precision Time Protocol
PTS	Partial Timing Support
SDH	Synchronous Digital Hierarchy
SEC	SDH Equipment Clock
SSU	Synchronization Supply Unit
SyncE	Synchronous Ethernet
TC	Transparent Clock
TE	Time Error