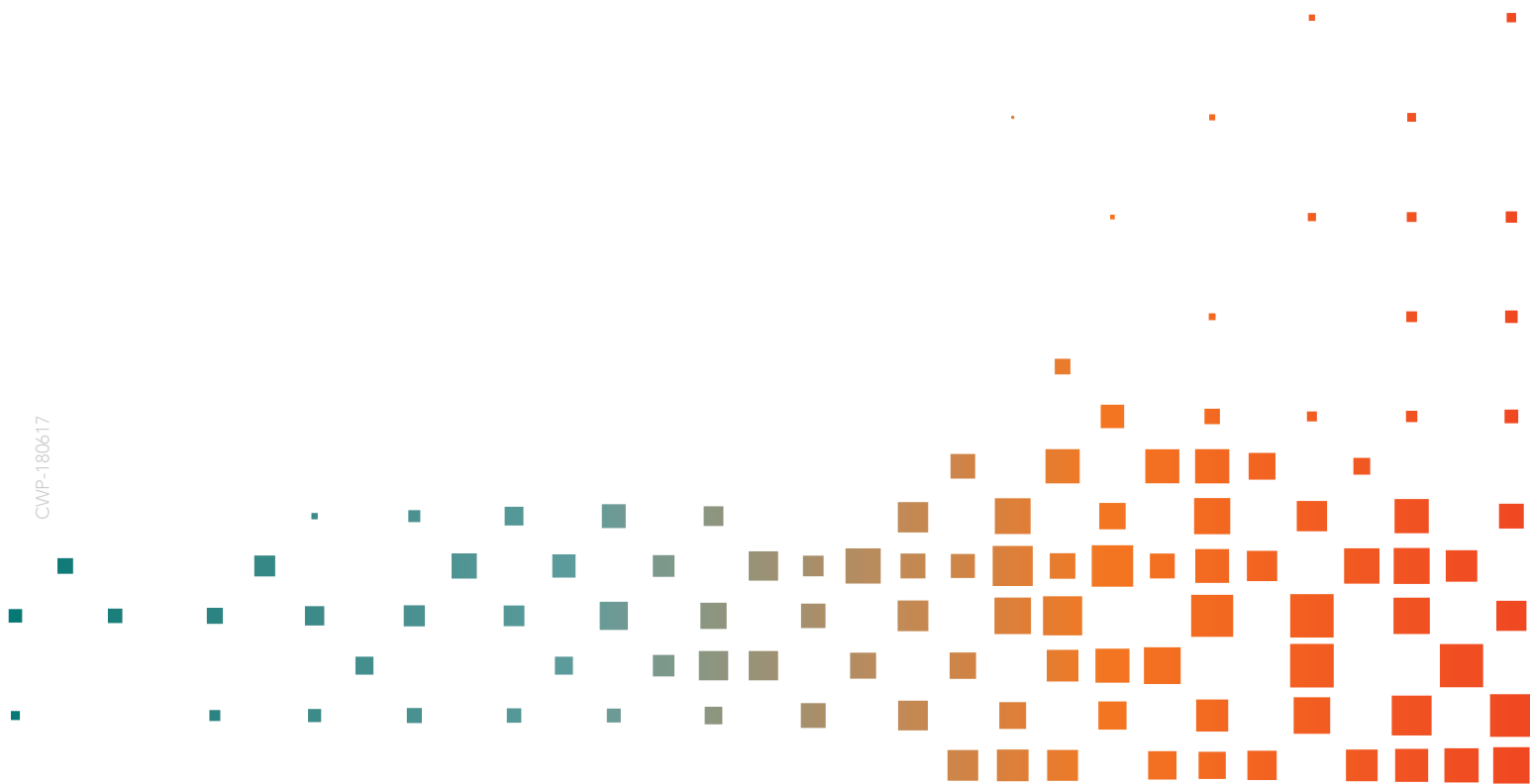




Corvil Coordinated Universal Time (UTC) Clock Synchronization Report



Introduction

In an increasingly algorithmic and machine-driven world, the integrity of time has become critical. Time precision and consistency has long been a factor in measuring and optimizing high performance environments (lest clock drift lead to negative latencies), but it has become the basis for auditability, accountability, and determining causality in digital business of all types.

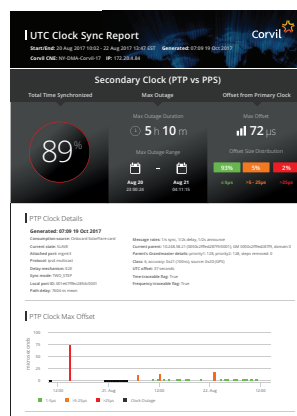
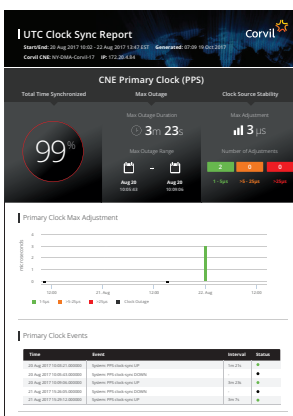
Market transparency and surveillance, AI oversight, and cybersecurity forensics all depend on proper sequencing of events that happen in short timescales (thousandths or millionths of a second in many cases). Regulators for the Financial Services industry have taken the first steps in requiring time precision and integrity as a critical component of transparency. These regulations begin with a requirement to establish clock synchronization with a Coordinated Universal Time (UTC) source.

Compliance teams, business teams, and technical teams alike benefit from having independent and continuous assessment of their synchronization status – that is, traceability to UTC. Whether for meeting European Securities and Markets Authority (ESMA) MiFID II or Securities and Exchange Commission (SEC) Consolidated Audit Trail (CAT) requirements, or simply ensuring appropriate oversight of a foundational business technology, Corvil takes the complexity and guesswork out of obtaining that independent insight.

Corvil's clock synchronization reporting capabilities simplify daily compliance and risk assessment as well as on-demand audit reporting for any time period. The reported metrics deliver evidence of a level of granularity and an internal operational standard even tighter than regulatory requirements, providing a strategic investment to address future needs.

Corvil's UTC Traceability Solution and Reporting provides business, compliance and technical operations teams:

- Independent oversight of the critical foundation of accurate timestamping of order records (i.e., clock synchronization)
- On-demand audit reporting for any time period
- The ability to identify, analyze and respond to anomalies with clear linkages to potentially impacted order records
- Additional forensic insight of algorithmic, artificial intelligence and cybersecurity issues



Corvil UTC Clock Sync Report

Report Details

The Corvil's UTC Clock Sync Report details multiple aspects of clock synchronization integrity so that stakeholders can rapidly and accurately grasp the operational status of the system that is being monitored. This approach reduces the risk of too much summarization, which can leave stakeholders unaware of critical failure points or without ample auditability for internal or external authorities. It also enables productive interactions between stakeholders and operations about specific situations.

The report contains the following information:

Total Time Synchronized: The percentage of time the monitored clock is synchronized during the timeframe of the report. In normal operation, one should expect this to be 100%. Outages and microsecond-level inaccuracies in the time signals identified by Corvil will lower this percentage.

Maximum Outage: Reports the duration, start time and end time of the most significant outage that occurred during the report's timeframe. It provides a record of when synchronization may have been questionable. Stakeholders can use this insight to inform decisions as to when they require additional oversight or follow up with the operations team to understand the actions that were taken when the alert occurred.

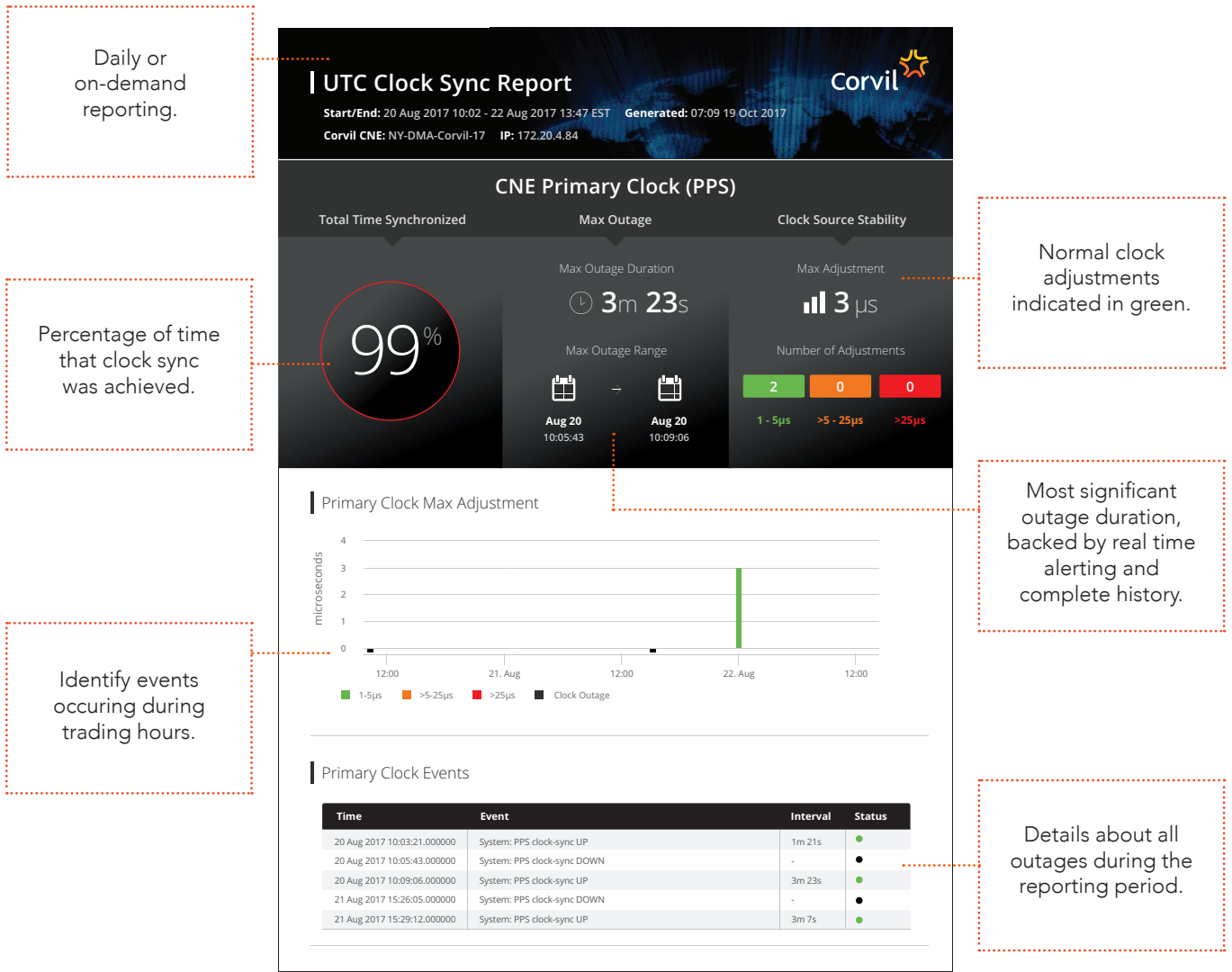
Clock Source Stability / Max Adjustment: Adjustment metrics measure how much work the system's "pacemaker" has to do to maintain a regular heartbeat. By monitoring the stability of the Corvil CNE Primary Clock with hardware support, microsecond-level inaccuracies in PPS or PTP signals can be detected and reported.

Offset from Primary Clock: Offset is a measure of how much the monitored clock is deviating from the designated baseline clock. The maximum offset is the largest deviation measured during the report's timeframe. The offset size distribution metrics indicate how often the clock experiencing normal (green), medium (orange) or large (red) deviations during the reporting timeframe.

As a result, this report simplifies daily assessment of UTC clock synchronization compliance and provides the type of information needed to demonstrate active, responsible oversight to regulators. The normal, medium and large offset tolerances shown are intentionally much lower than current regulatory requirements, which should provide confidence that the investment will satisfy not only current requirements but the expected tighter regulations of the future.

Time-Series Chart: Visualizes when the outages occurred and how the clock stability metrics varied over the course of the reporting period. Visualizing patterns of events often provides additional context for business, compliance, and operational stakeholders. For example, outages occurring during business hours may represent much higher business risk that those occurring during non-business hours. Additionally, it is easy to distinguish a one-time event from recurring patterns indicative of chronic problems or deteriorating problems.

Clock Events: This table lists all of the outage-related events occurring during the reporting period. By continuously monitoring for clock-synchronization input, and alerting on outages, operations teams get immediate notification of problems with time synchronization.



Daily or on-demand reporting.

Percentage of time that clock sync was achieved.

Normal clock adjustments indicated in green.

Most significant outage duration, backed by real time alerting and complete history.

Identify events occurring during trading hours.

Details about all outages during the reporting period.

**Section 1:
CNE Primary Clock (PPS)**

Clock Details: This is a snapshot of the clock information and other metadata that Corvil obtains from the PTP protocol. Corvil timestamps every captured message and flags those which may be of questionable synchronization status. Accordingly, in addition to having an audit record of clock synchronization integrity, there is a forensic record of data whose timestamps may not be compliant.

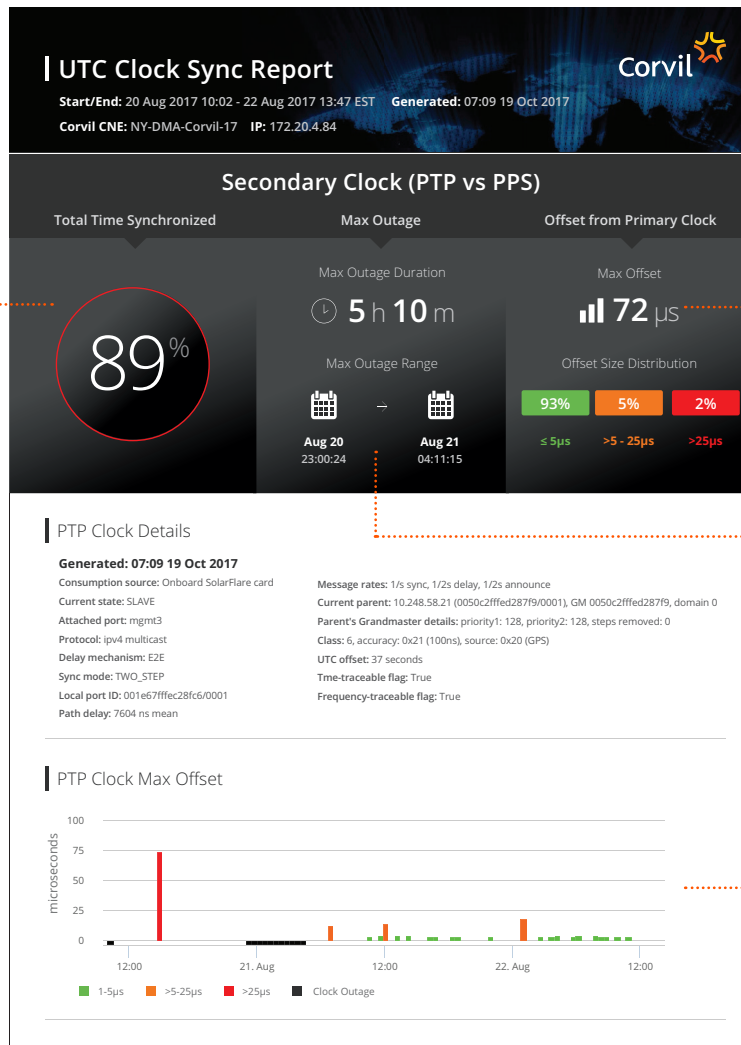
Example Scenario

What follows is an example of how business, compliance and IT management stakeholders would interpret and act on the information provided by the Corvil UTC Clock Sync Report.

Section 1: CNE Primary Clock (PPS)

Having a stable baseline time source is a critical first step in monitoring the health of a clock synchronization system. If the baseline time source is becoming unstable, then the offset calculations used to demonstrate compliance will be inaccurate.

A quick review shows that while the total time synchronized is not a perfect 100%, there is nothing to indicate that further oversight is required. There are only two relatively short



Summarizes synchronization, outage and clock offsets for non-technical stakeholders.

Estimate compliance impact based on regulatory requirements.

Estimate business impact based on time of outage.

Unusual patterns of behavior may indicate need for additional action.

Section 2: Secondary Clock (PTP vs PPS)

outages and the clock stability metrics are all in the green zone (less than 5 microseconds). Therefore, the stakeholders reviewing this section can be confident that they have a stable baseline for validating UTC traceability.

Section 2: Secondary Clock (PTP vs PPS)

The clock was synchronized for only 89% of the reporting timeframe, the discrepancy timeframe for which is clearly indicated by the 5 hour outage and the medium and large sized deviations occurring during 7% of the reporting period.

However, the actual business and compliance risk associated with these problems is fairly low. Firstly, the outage occurred overnight outside of trading hours, therefore transaction reporting and order record keeping would be unaffected. Secondly, the maximum offset of 72 microseconds is still below the tightest tolerances set by MiFID II or SEC CAT, which minimizes the impact from compliance perspective. As a result, no additional action would be required.

From a technology oversight perspective, the time-series graph provides more insight. Visualizing the offsets and outage sequence makes it easy to see that the clock stability pattern is very different before and after the outage. The measured offset appears to be more variable after the outage when compared to the single large spike in an otherwise stable offset of zero before the outage. The insight enables IT leadership to take action to get a clearer understanding of the situation and facilitate decision-making.

The next step for the compliance team would be to identify all of the order records impacted by this event. This task is dramatically simplified with Corvil's integrated order record keeping and automated synchronization status tracking. As seen in the Corvil dashboard, all types of trading events (i.e. orders, accepted, rejects, cancels) are automatically captured along with trading details (such as OrderID, ClientID, order quantity, and pricing), the UTC synchronization status and timestamp with nanosecond resolution. A single click provides full details recorded for every event.

As a result, complete information about impacted events is available on demand, without the need for extensive system log consolidation or manual correlation, thereby improving the productivity of the compliance team.

1 Nanosecond UTC Timestamps

2 All Order Events Captured

3 Full Decode of Order Fields

4 Per-event UTC sync status

Corvil

DASHBOARDS DATA SEARCH DISCOVERY LENS INSPECT DATA STREAMS ADMIN

CIH.Trading 30 Oct 15:44:11.620 49s 961ms DATA FILTER 49S 961MS

Start typing... SEARCH

3,021 events found

Timestamp	Event Name	decoder	session	clordid	ordid	wiresymbol	orderqty	price	side_raw	execid
2017/10/30 15:44:11.620.362.612	order	OUCH	L20601	4g		DNAI	120		S	
2017/10/30 15:44:11.620.376.659	accepted	FIX	DLAL-1:DMA-1	DLAL-1.6		DNAI	120		S	2
2017/10/30 15:44:11.620.394.539	accepted	OUCH	L20601	4g		ALCO	120		S	
2017/10/30 15:44:11.624.316.184	order	OUCH	L20607		45	ALCO	120		S	
2017/10/30 15:44:11.624.349.071	accepted	OUCH	L20607		45	ALCO	120		S	
2017/10/30 15:44:11.630.593.114	filled	FIX	CNRD-1:DMA-1	CNRD-1.6		NAVI		11.72		2 m137
2017/10/30 15:44:11.630.654.960	order	OUCH	L20605	3j		HBK	120		B	
2017/10/30 15:44:11.635.949.195	filled	OUCH	L20607		45	ALCO		42.6	S	133
2017/10/30 15:44:11.636.392.880	order	OUCH	L20604	3j		DSKY	120		B	
2017/10/30 15:44:11.636.416.679	accepted	OUCH	L20604	3j		DSKY	120		B	
2017/10/30 15:44:11.638.206.250	filled	OUCH	L20601	4g		DNAI		18.26	S	144
2017/10/30 15:44:11.638.506.394	filled	FIX	DLAL-1:DMA-1	DLAL-1.6		DNAI		18.26		2 m144
2017/10/30 15:44:11.660.081.338	order	FIX	ELKH-1:DMA-1	ELKH-1.6		KLIC	120	11.48		2
2017/10/30 15:44:11.660.857.871	order	OUCH	L20601	4h		KLIC	120		S	
2017/10/30 15:44:11.660.889.878	accepted	OUCH	L20601	4h		KLIC	145		S	
2017/10/30 15:44:11.660.893.070	accepted	FIX	ELKH-1:DMA-1	ELKH-1.6		KLIC	120			2
2017/10/30 15:44:11.676.452.085	filled	FIX	BRCH-4:DMA-1	BRCH-4.7		CASI		1.12		2

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Corvil's Integrated Record Keeping and Synchronization Status Tracking

