


SKYWIRE

Deployment of SkyWire™ Technology

Use cases for deployment of the BlueSky® GNSS Firewall with TimePictra® Platform to deliver accurate clock alignment

Summary

This application note describes how SkyWire™ technology is implemented within the BlueSky® GNSS Firewall to enable secure, high precision timing across a range of deployment scenarios, and how this capability is managed and visualized using the TimePictra® software platform. The BlueSky GNSS Firewall 2200 is a cost effective, inline overlay solution that protects downstream GNSS dependent systems from jamming and spoofing by acting as a firewall between untrusted sky based signals and protected infrastructure. With software release 4.0, the integration of SkyWire technology adds precise clock comparison and alignment across geographically dispersed locations, with traceability to Coordinated Universal Time (UTC) as maintained by national timing laboratories. TimePictra software performs the required common view calculations, data aggregation and visualization, while the firewall simultaneously enforces GNSS signal validation and BlueSky performance monitoring, delivering an integrated, resilient defense against GNSS based threats.

BlueSky Technology:

- **BlueSky GNSS Firewall Functionality:** Like a traditional network firewall, the BlueSky GNSS Firewall 2200 acts as a barrier between the GNSS antenna and the GNSS receiver/ system. It filters and validates incoming satellite signals, blocking those that are suspicious or potentially harmful.
- **Anti-Jamming and Anti-Spoofing:** The device detects and mitigates attempts to jam (block) or spoof (deceive) GNSS signals, ensuring that only authentic and reliable signals are passed through to the protected systems.

SkyWire Technology:

- **Clock Comparison Across Locations:** SkyWire enables BlueSky GNSS Firewall units to compare timing signals (clocks) across multiple, geographically dispersed sites.
- **UTC Traceability:** The system ensures that all connected sites remain synchronized and traceable to Coordinated Universal Time (UTC), as maintained by national timing laboratories.

TimePictra Software:

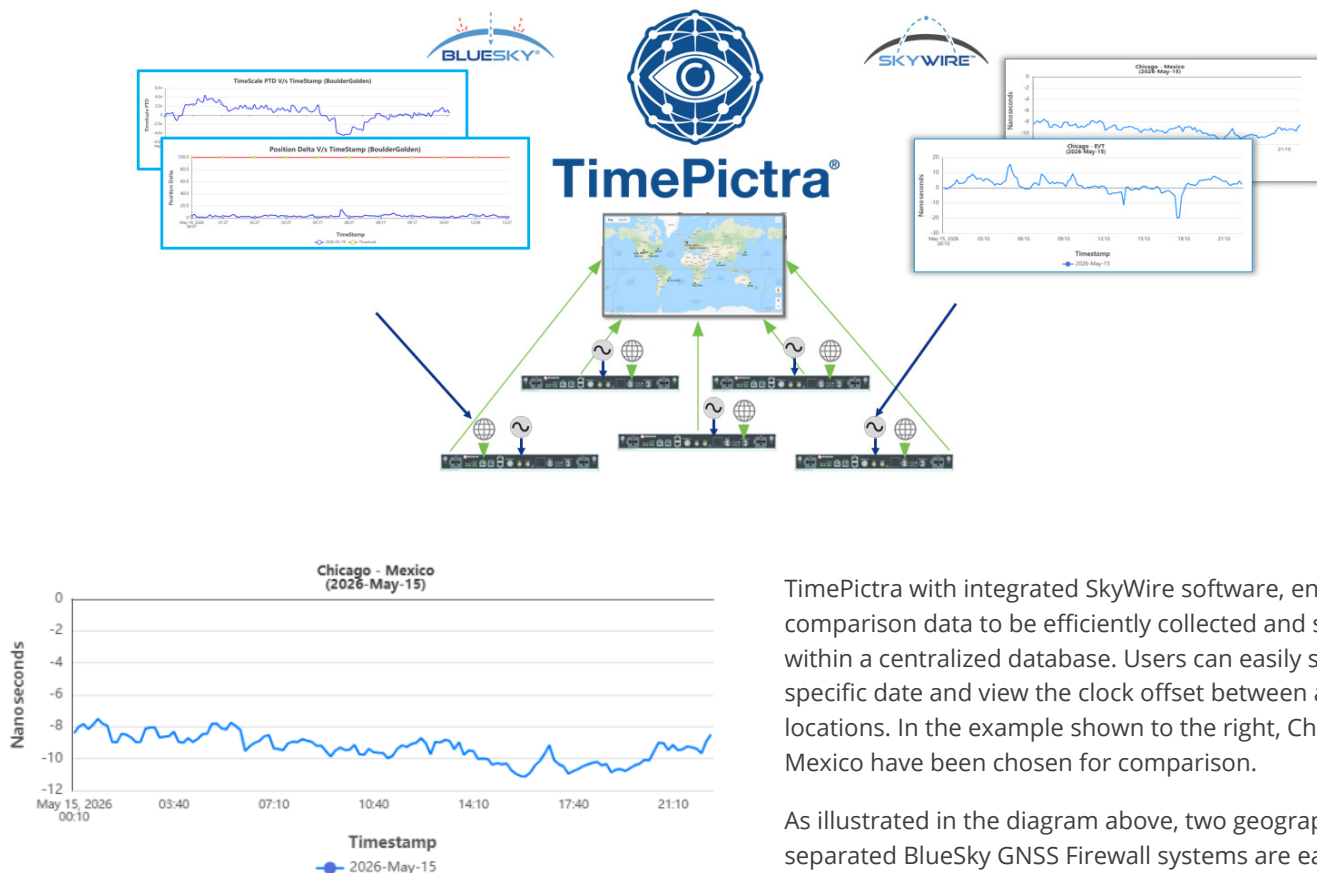
- **Centralized Time Visualization and Analytics:** TimePictra aggregates SkyWire measurement data and visually displays clock offsets, trends and historical performance.
- **Real Time Monitoring Across Large Networks:** Continuously monitors hundreds of distributed clocks from a single interface.
- **Date Selectable Clock Analysis:** Users can select a specific date/time window and instantly view the offset between any two locations.

GNSS Firewalls with SkyWire Technology

For critical infrastructure deployments, maintaining a broad geographical perspective is essential. TimePictra provides an efficient and comprehensive solution for managing these complex environments. The BlueSky GNSS Firewall with integrated SkyWire technology works seamlessly with the TimePictra management system, delivering robust protection and advanced monitoring capabilities.

Our TimePictra software serves as a centralized platform for overseeing networks equipped with BlueSky technology and SkyWire technology. The BlueSky software within TimePictra enables rapid identification of sites affected by GNSS anomalies, whether issues arise simultaneously at multiple locations or recur periodically at different sites.

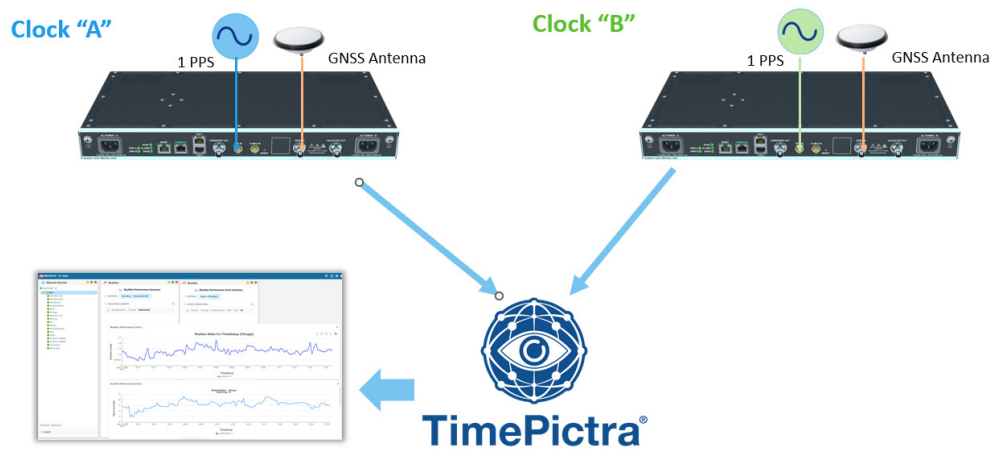
Additionally, TimePictra allows users to visualize and efficiently compare multiple clocks across their infrastructure. Measurement data from SkyWire technology, embedded in the BlueSky GNSS Firewall, is aggregated and analyzed within TimePictra, enabling direct comparison of any clocks in the network. The software computes and visually displays time differences between all clocks, supporting precise time alignment and simplifying the management of complex timing systems.



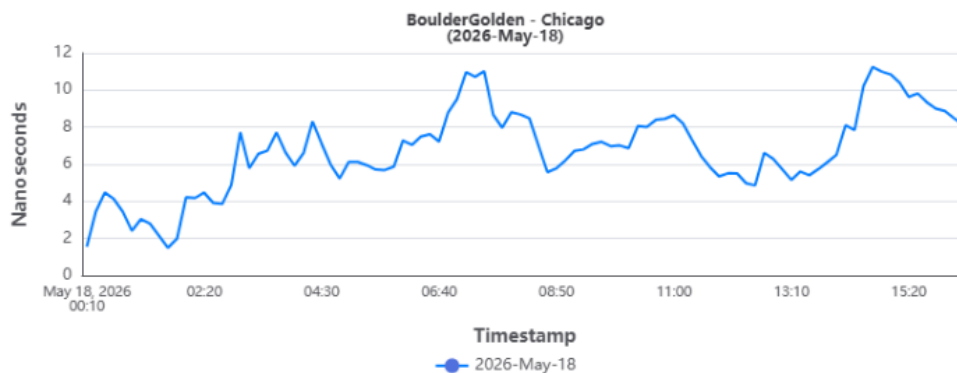
TimePictra with integrated SkyWire software, enables clock comparison data to be efficiently collected and stored within a centralized database. Users can easily select a specific date and view the clock offset between any two locations. In the example shown to the right, Chicago and Mexico have been chosen for comparison.

As illustrated in the diagram above, two geographically separated BlueSky GNSS Firewall systems are each connected to an external reference clock—Clock A at the left hand site and Clock B at the right hand site. Using

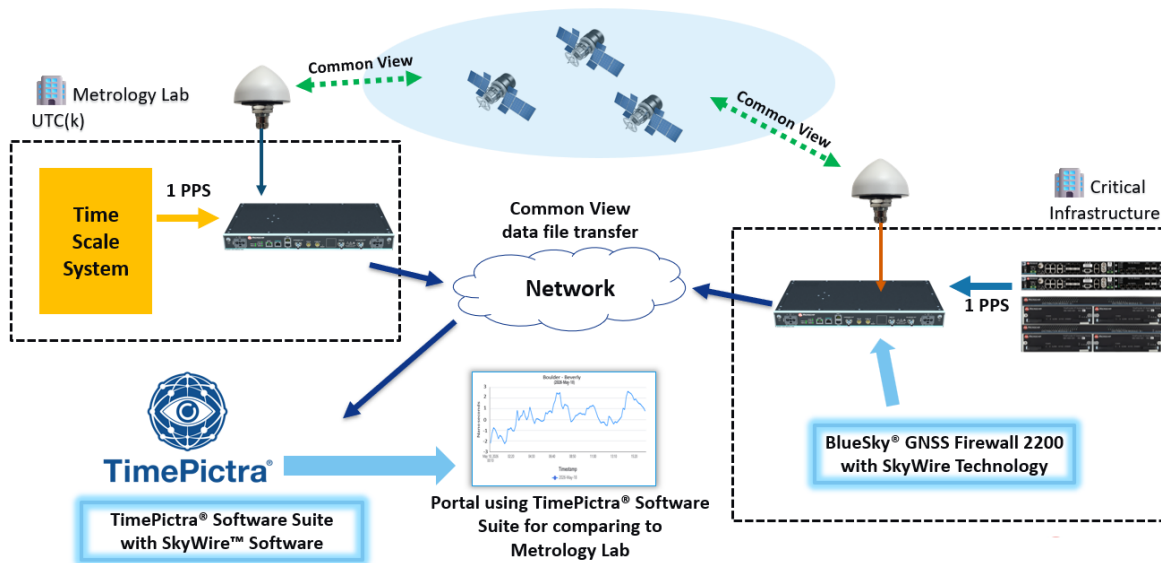
integrated SkyWire technology, each firewall performs precise time of arrival measurements of GNSS signals and generates common view measurement data. These measurement files are securely transmitted to TimePictra, where the data from both locations is aggregated and processed. TimePictra computes the relative clock offset between Clock A and Clock B and presents the results through intuitive graphical plots, enabling operators to visualize clock alignment and verify timing performance across distributed sites.



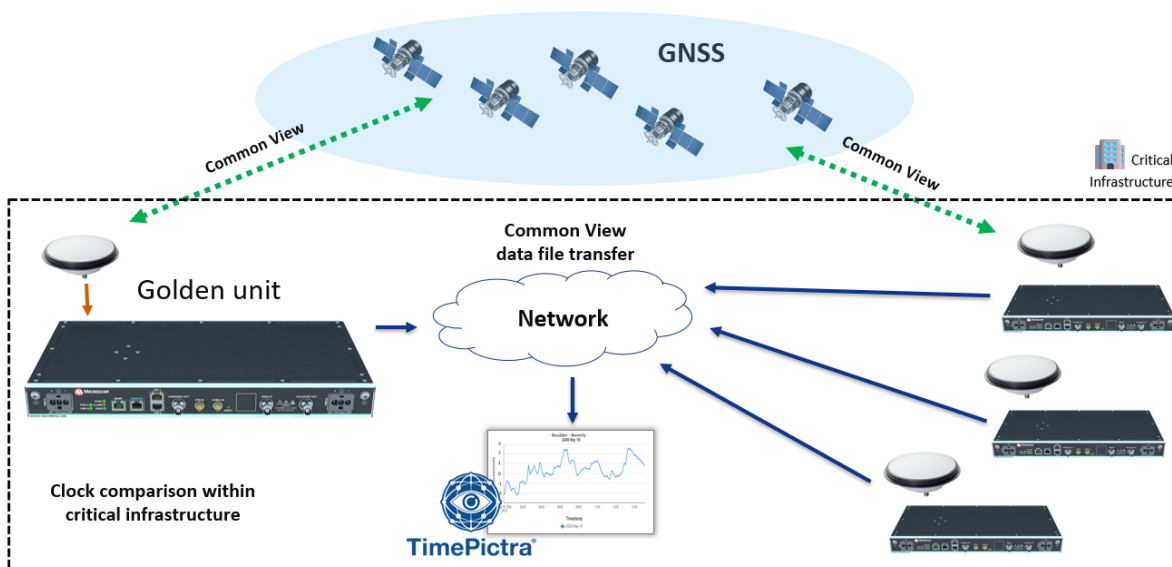
The TimePictra software platform can be installed and deployed within a wide range of IT infrastructure environments running supported operating systems, including Red Hat®, Oracle Linux® or AlmaLinux® versions 9.x or 10.x. Once deployed, customers can access the platform through standard web based browsers, including Mozilla Firefox®, Google Chrome™, Microsoft Edge® and Apple Safari®, without the need for specialized client software. BlueSky GNSS Firewalls periodically transmit time of arrival measurement data in Time Measurement and Analysis Service (TMAS) files at 10 minute intervals. The TimePictra platform ingests these SkyWire files and performs the required common view clock offset calculations using SkyWire technology. When any two firewalls are selected within the TimePictra interface, the calculated clock offset results are presented graphically, enabling intuitive visualization of clock offsets between geographically separated locations.



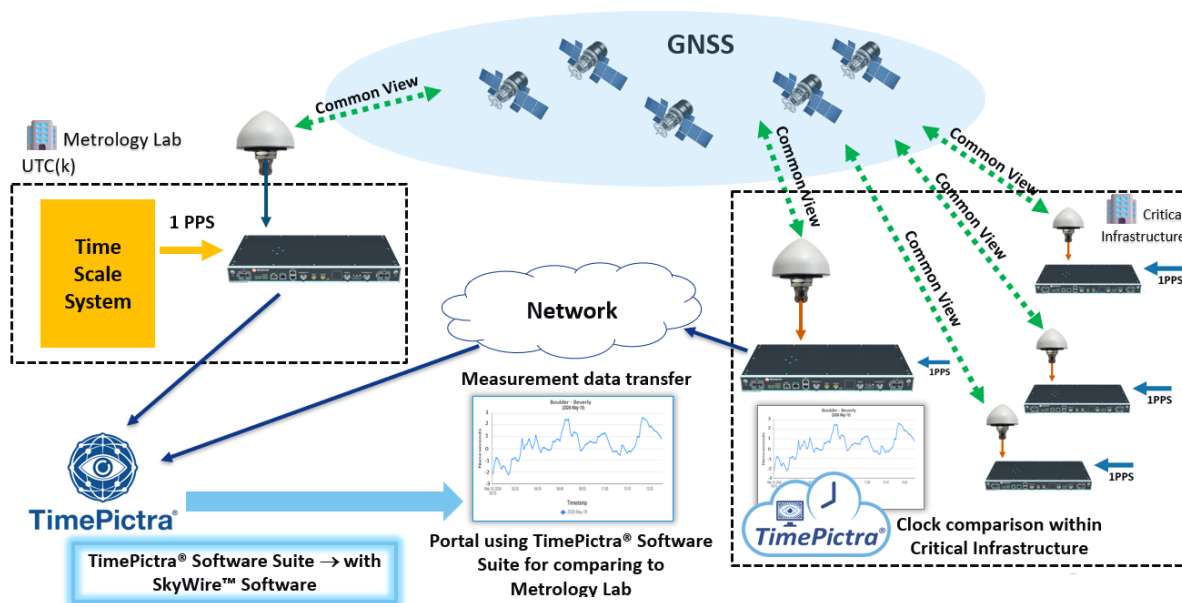
The figure above shows an example of the SkyWire technology user interface within the TimePictra software platform. Under the Performance tab, a dedicated SkyWire view provides visibility into all managed BlueSky GNSS Firewall units within the network, listed along the left hand side of the display. Operators can select any two firewall units for a specific day and, by scrolling to the SkyWire analysis section, initiate clock comparison by selecting the Plot function. Common view measurement files generated by each firewall are collected and processed within TimePictra, which performs the SkyWire calculations and displays the resulting clock offset between the two locations. In the example shown, a BlueSky GNSS Firewall deployed in Daventry, United Kingdom, is compared against a unit in Tuscaloosa, United States, with the plot clearly illustrating the relative timing offset between the clocks at these geographically separated sites.



In this first use case, SkyWire technology is used to enable direct clock comparison between a national timing laboratory and a critical infrastructure site. On the left hand side of the diagram, the National Institute of Standards and Technology (NIST) operates its official time scale and provides a 1 PPS reference signal that is connected to a BlueSky GNSS Firewall. On the right hand side, a second BlueSky GNSS Firewall is deployed at a critical infrastructure facility and is connected to the local clock that the operator wishes to measure and validate. Both firewalls perform common view time of arrival measurements using shared GNSS satellites, and the resulting common view data is transmitted over the network to the NIST Time Measurement and Analysis Service (TMAS). Using the TMAS data service and visualization portal, customers can calculate and display the clock offset between their local clock and NIST, enabling direct verification of timing performance and traceability to UTC as maintained by the national timing laboratory.



In this second use case, the BlueSky GNSS Firewall with integrated SkyWire technology is used to compare clocks across widely dispersed geographic locations without the need for dedicated point to point timing links. Multiple firewall equipped sites simultaneously measure signals from the same GNSS satellite or satellites that are commonly visible, enabling precise common view time of arrival measurements across the network. The resulting measurement data from all locations is aggregated, processed and analyzed by the TimePictra software suite, which computes the relative time differences between any selected clocks and presents the results through intuitive visual plots. This scalable, multi site clock comparison capability is well-suited for critical infrastructure operators such as data centers and hyperscale operators, where precise time alignment across distributed locations is required to support applications including distributed database access, transaction ordering and synchronized operations.



In this third use case, the BlueSky GNSS Firewall with SkyWire technology enables clock comparison with national metrology laboratories that do not operate a dedicated common view portal infrastructure such as NIST's TMAS service. On the right hand side of the deployment, a BlueSky GNSS Firewall is installed at the end user or critical infrastructure site and is connected to the local clock to be measured. On the left hand side, NIST is replaced by another national or regional metrology laboratory anywhere in the world, with a BlueSky GNSS Firewall connected to the laboratory's reference time scale. Instead of relying on a laboratory hosted portal, common view measurement data generated by both firewalls is aggregated and analyzed within the TimePictra software platform. TimePictra provides the same core capabilities as a metrology portal, including clock offset calculation, visualization and historical analysis. This architecture allows customers to directly compare their local clocks to their country's metrology laboratory, even when no native common view service is available, extending traceability to national time standards through a cost effective and scalable BlueSky based solution.