Multi-GNSS Constellation Technology SyncServer S600 Series

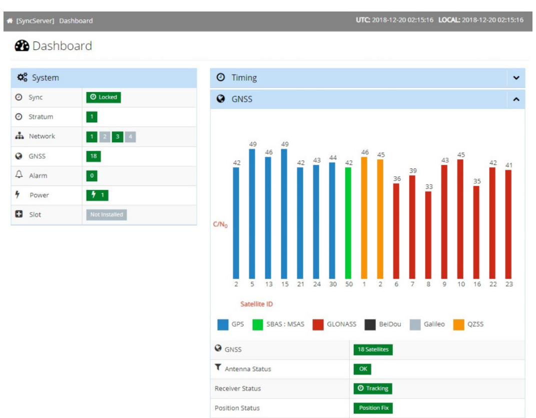
Summary

Global positioning system (GPS) was once used to describe the satellite-based positioning, navigation, and timing system most widely used for civil applications. Over time, as more satellite-based systems were placed in orbit, global navigation satellite system (GNSS) more broadly described the systems available today. Tracking multiple GNSS satellites is now commonplace in the age of smartphones and vehicle navigation systems. As people and vehicles move about, rapidly updated positions in a variety of sky-view scenarios can be critical. Although precise time and frequency receivers are generally stationary, they also benefit from tracking multiple GNSS satellites to significantly improve the timing accuracy in limited sky-view applications.

The Urban Canyon Advantage

The urban canyon environment found in large cities can sometimes mean that the GNSS antenna must be mounted with only a partial view of the sky. GNSS timing receivers require tracking at least four satellites to lock the time. GNSS satellites are medium earth orbit satellites (not geostationary) and are thus always in motion relative to the antenna on the ground. Given the greater number of GNSS satellites in orbit than any single satellite system like GPS, there is a higher likelihood that enough satellites will be in view at any point in time to accurately derive the time in a limited sky-view scenario.

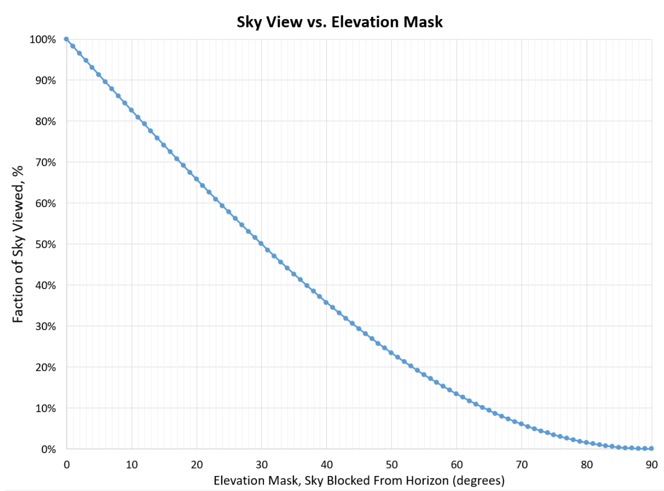
The following dashboard screen snap shows the SyncServer S600 series tracking both GPS and GLONASS satellites from an unobstructed sky-view position. In this case, there are far more satellites in view than are needed to derive the accurate time.



Tracking multiple constellations significantly improves the overall number of visible satellites available to continuously derive the time.

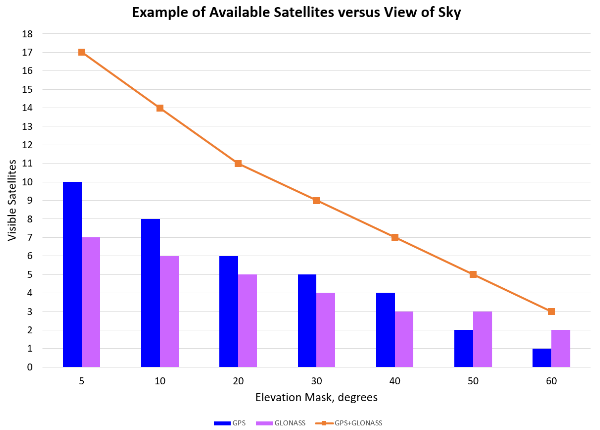
However, the surrounding buildings in an urban canyon tend to obscure the lower-elevation satellites from view. Low-elevation satellites are often a source of unwanted signal reflections, or multipath, in a GNSS receiver. Thus, receivers can often be configured to ignore satellites below a given elevation angle above the horizon. This so-called elevation mask effectively reduces the area of the sky that will be used to track GNSS satellites. Urban canyons can result in very high elevation masks depending on how high the surrounding buildings are relative to the GNSS antenna.

The following illustration shows what percent of the sky is available as a function of the elevation mask. As illustrated, even a relatively low elevation angle of 30% reduces the available sky area by 50%.



An elevation mask, much like urban canyon environments, eliminates multipath-prone low-elevation satellites, but also limits the amount of sky that can be seen to track remaining satellites.

However, tracking multiple GNSS constellations in such limited-sky scenarios significantly improves timing accuracy. Consider the following chart showing a real example of how the elevation mask can increase to 50 degrees (23% of the sky is visible) and still have at least four satellites in view to derive the time.



Tracking multiple GNSS constellations provides more satellites in view at higher elevations, as is the case in limited sky-view urban canyon installations.

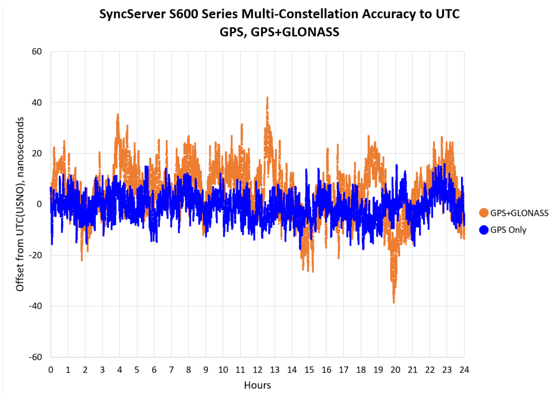
Tracking multiple GNSS satellites provides signal continuity/availability with improved time accuracy, as there is a higher likelihood at least four or more satellites will be in view all the time.

Time Accuracy Versus Satellite Quantity

One might assume that GNSS reference clock time accuracy improves with the number of satellites being tracked. In practice, this is not the case. The different constellations use different reference clocks as an ultimate source of time with each GNSS operator working to assure some level of time accuracy that translates into acceptable positioning accuracy for their system. As a manufacturer of precise time and frequency systems, Microchip further refines the received GNSS data to provide as stable, accurate, and precise timing outputs as possible.

The following graph shows the typical time accuracy of the SyncServer S600 tracking GPS (blue) and the time accuracy simultaneously tracking GPS and GLONASS (orange). It is apparent that tracking GPS alone is more accurate and precise than tracking the combined GPS+GLONASS constellations.

Parameter	GPS Only	GPS+GLONASS
Mean UTC Offset	1 ns	5 ns
Max Offset	17 ns	42 ns
RMS to UTC	5.4 ns	11.7 ns



SBAS Satellites for Improved Reliability and Accuracy

Calibrated, ground-based measurements of GPS satellite signals are made in real-time to measure small variations in the GPS signals themselves to create correction information. This correction information is broadcast from a satellite-based augmentation system (SBAS) that GPS receivers use to correct the received signals for improved accuracy and reliability. The SyncServer S600 series uses this SBAS information from the WAAS, EGNOS, and MSAS geostationary satellites situated above the United States, Europe, and Japan, respectively. If one of these SBAS satellites is in view, the green bar displays to indicate the SBAS correction information is being used, as seen in the previous chart.

Multi-GNSS for Backup Constellation Peace-of-Mind

In an uncertain world of GNSS jamming, spoofing, and geo-political unrest, the ability to track multiple GNSS constellations that use different technologies can provide one more bit of operational peace-of-mind. While there are no guarantees, multi-GNSS tracking is a way of diversifying the risk of depending entirely on one GNSS constellation alone.

Multi-GNSS in the SyncServer S600/S650 Series

All SyncServer S600/S650 series devices are equipped with a GNSS receiver capable of simultaneously tracking more than one GNSS constellation. The primary constellations include GPS, Galileo, GLONASS, and BeiDou. In addition, the regional GPS satellite-based augmentation satellites (WAAS, EGNOS, MSAS and QZSS) are automatically used if the SBAS satellite is in view and GPS tracking is enabled. GPS is enabled by default; additional tracking of the other constellations (including SBAS/QZSS) requires the GNSS Multi-Constellation Software License. The Multi-GNSS License option adds the ability to simultaneously track one or two of the three frequency plans (GPS/Galileo/QZSS, GLONASS, and/or BeiDou).

Note: SyncServers shipping approximately from the start of 2019 are capable of tracking Galileo satellites if version 3.1 software is loaded and the Multi-GNSS Constellation option is installed.