Solution Brief

Ways to meet next-generation PRTC timing accuracy with multi-band GNSS receivers

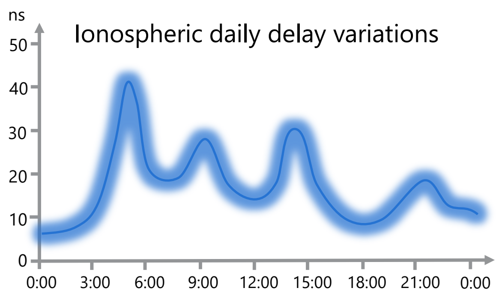
Networks need to deliver better synchronization

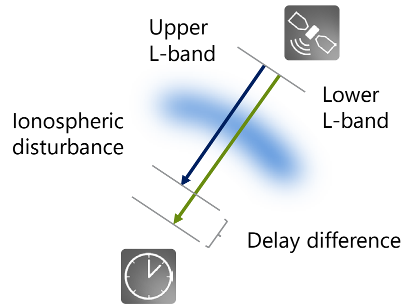
Highlights

- **Multi-band transmission of timing information enables ionospheric delay variations to be compensated automatically by the receiver in real time**
- **Very precise timing signals from superior receivers eliminate the cost of high-performance rubidium oscillators**
- **Quality degradation from obscured satellites is mitigated by accessing multiple constellations**
- **Multi-band GNSS receiver technology offers better resilience to jamming and spoofing**

Ever increasing precision in timing is essential for critical infrastructures such as energy, communication, finance and transportation. The ITU responded to this need by tightening the requirements of their primary reference time clock (PRTC) specification by releasing a PRTC-B specification. However, there is concern that higher timing precision is creating additional cost. This is certainly true when expensive oscillators such as rubidium clocks are used in order to achieve the additional boost in performance. Fortunately, there are innovative alternatives that come at significant lower cost and are supported by all technical experts in the market.

Meeting next-generation PRTC timing accuracy with multi-band GNSS receivers





Compensation of ionospheric delay variations by measuring delay difference from multiple L-band signals

Limitations of current GNSS-based timing

Today, timing based on Global Navigation Satellite Systems (GNSS) is widely used but, with existing single-band GNSS receivers, its accuracy is limited. Delay between satellites and receivers can easily be affected by space weather, which creates time errors at the receiver. These delay variations are caused by ionospheric disturbances affected by day/night cycle or sun activities with very low change rates in order of hours, days or even years. At the receiver, those variations may cause inaccurate time information in the order of several tens of nanoseconds, exceeding the most stringent PRTC-B specifications, which target time error within 40nsec from UTC. Those changes can be partly averaged out with a filter implemented by a high-quality oscillator. As this oscillator needs to smooth out variations happening over many hours, it needs to have a very high stability such as a rubidium oscillator. But this adds considerable cost and might not even be enough when these variations happen at a very low frequency or if the environmental temperature changes significantly.

Eliminating cause of inaccuracy with multi-band GNSS receivers

Now, there's a much more efficient and accurate way to handle ionospheric influences. GNSS-satellites transmit time information in several frequency bands. The delay difference between signals at different frequencies provides information about ionospheric impact on the absolute delay. This enables multi-band GNSS receivers to compensate for delay variations of radio signals transmitted from the satellite to the receiver. With a much smaller time error, there's no need for extensive filtering.

Applying multi-band GNSS receivers in ePRTC

In addition to PRTC-B a multi-band GNSS receiver can also be used in enhanced primary reference time clocks (ePRTCs). The ePRTC combines two key functions. An enhanced primary reference clock (ePRC) realized with a cesium atomic clock can be combined with a GNSS receiver to provide highly accurate UTC-traceable time information and extraordinary holdover capabilities. As ITU is considering a new class of ePRTC, there emerges a need for higher stability of the ePRC as well as higher accuracy of the timing signal provided by the GNSS receiver. This improved accuracy and stability of the multiband receiver will also result in faster locking times.

Single-band or multi-band GNSS receivers?

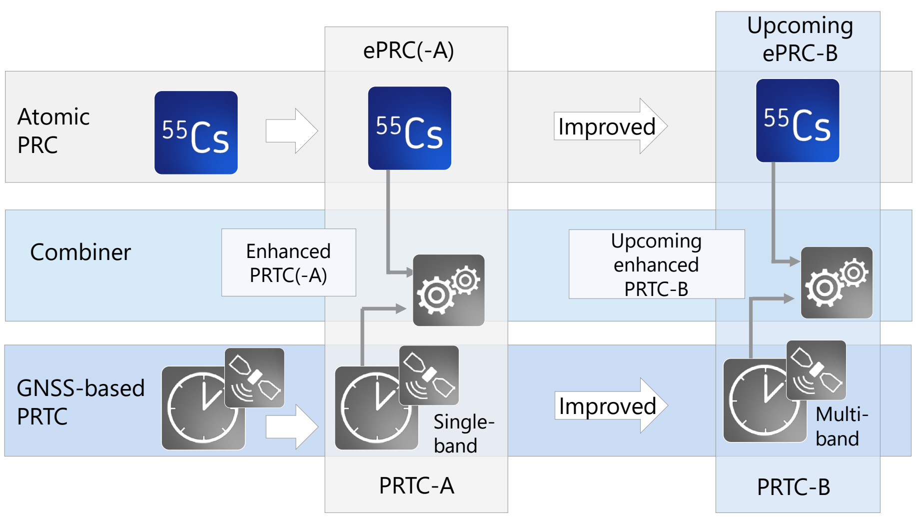
Service providers have different preferences over how they implement their PRTC-B. There is however one common objective: They need to meet their performance targets in all operational scenarios while minimizing cost. As rubidium clocks add significant cost, Oscilloquartz has invested in the development of a superior PRTC-B algorithm using a high-performance double-oven crystal oscillator combined with a multi-band GNSS receiver. Such a robust solution can provide the required accuracy even under significant ionospheric disturbances while a single-band GNSS receiver might fail to provide the required performance in these harsh conditions. In addition, this solution can work in locations with significant temperature variations.

Applying modular, multi-band GNSS receivers

- A cost-efficient way to achieve latest PRTC-B specifications
- Do not require high-cost rubidium oscillator
- Field upgradable – can be added to existing devices in the field as expansion card
- Can be used to boost ePRTC performance
- Improving precision with unique Syncjack™ timing assurance solution

Clocks for any purpose rather than a single multi-purpose clock

Network failure and GNSS outages impact the quality of the timing signal. To make synchronization networks robust against a variety of disturbances, clocks with very different characteristics are required. In some cases, there's a need for highest accuracy in steady-state operation, while in other cases ultra-high stability in hold-over mode is required. While the latter is provided by ultra-stable oscillators, the first is achieved with an innovative multi-band GNSS receiver concept. Our Oscilloquartz synchronization solutions can combine high-quality quartz, rubidium or cesium clocks with single-band or multi-band GNSS receivers. This type of modular approach is needed to meet tight timing requirements in the most cost-efficient way.



Multi-band GNSS receivers are ideal for PRTC-B and ePRTC applications