Trimble Maxwell™ 7 Technology - Protection Against GNSS Spoofing

INTRODUCTION

With the introduction of Maxwell™ 7 Technology, Trimble has added several technical innovations that improve the performance of its receivers. This technical bulletin provides an overview of how Trimble receivers provide protection from the increasing threat of false GNSS signals. These false or spoofed signals could potentially result in a receiver calculating positions in error by many kilometers. This is not to be confused with jamming, which also disrupts positioning by transmitting strong undesired signals that overload the GNSS receiver's RF or signal processing. However in the jamming scenario, while the receiver has difficulty calculating a position, it will generally not be in the wrong location. A separate technical bulletin will describe how Trimble Maxwell™ 7 technology helps overcome GNSS jamming signals.

WHAT IS GNSS SPOOFING?

GNSS receivers track low-power signals transmitted from satellites. With the availability of low- cost programmable radios it is now possible to develop a transmitter that will broadcast a spoofing signal that a receiver will use instead of the true signal. Depending on the sophistication of the spoofer, this can cause various positioning and timing errors. Although Trimble is not seeing spoofing in its high-precision applications today, such activities may increase in the coming years.

WHAT IS TRIMBLE DOING ABOUT GNSS SPOOFING?

Trimble receivers that incorporate Maxwell™ 7 Technology include a number of features to protect from spoofing. Maxwell™ 7 Technology is based around Trimble's next-generation ASIC, RF and processor developments. The technology provides robust precision positioning by fusing all GNSS constellation signals with additional sensor data. The defense against spoofing is currently handled at the following levels:

- **Rejection of Spoofed Signals in the Digital Signal Processing (DSP)**

  Advanced tracking algorithms detect if multiple signals are received for each satellite and ensure only the true signal is tracked. The spoofed signal generally shows as a stronger secondary correlation peak, which the tracking channel isolates and rejects from reaching the positioning algorithm.

- **Satellite Data Checking**

  By keeping a historical record of the orbital parameters transmitted by each satellite, Trimble can detect if these change unexpectedly or fall outside reasonable bounds.

Trimble Maxwell™ 7 Technology can also cross-check orbital data from multiple sources (e.g for GPS L1 LNAV is compared to L2C and L5 CNAV).

- **Receiver Autonomous Integrity Monitoring (RAIM)**

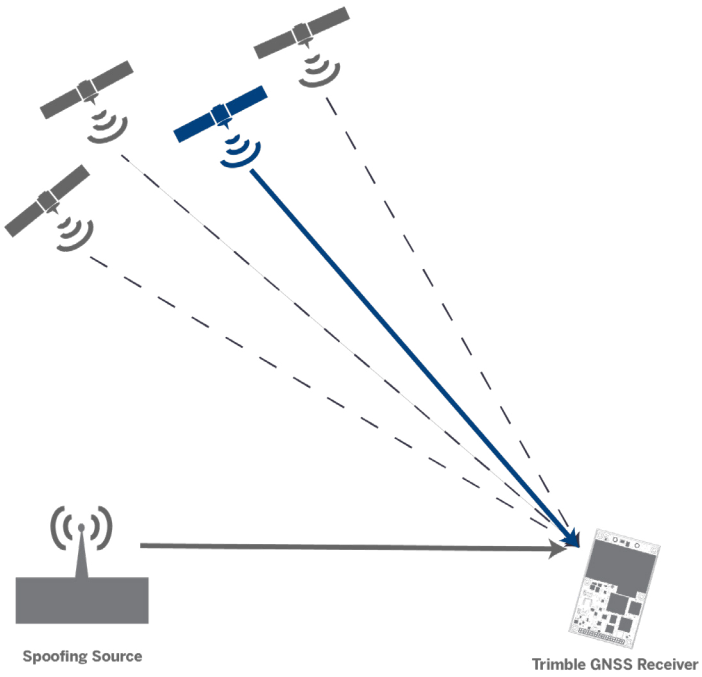
  With more measurements than unknowns, the receiver has the ability to detect measurements that do not fit into the positioning solution. Newly tracked satellites that fail this test are put through additional tests before inclusion while existing satellites are immediately removed from the solution. RAIM is also calculated between GNSS constellations with complete systems being rejected, if necessary. This assumes a simplistic spoofing event where a subset of constellations are affected. For example, if only GPS is spoofed then by calculating multiple position solutions from subsets of measurements from GLONASS, BeiDou, Galileo, QZSS, NavIC, and SBAS the GNSS receiver can determine confidence that the GPS measurements need to be removed.

- **Position Sanity Checks**

  If the receiver detects positions have jumped by an unrealistic amount since the last computed position this is also a valuable indicator of spoofing.

- **Limiting Satellite Search Window**

  Utilizing recent tracking information, the GNSS receiver will limit the search window for reacquiring satellites that are temporarily lost and prevent a spoofing attack.



CONCLUSIONS

Trimble expects the occurrence of spoofing to increase in the future. These have the potential to disrupt critical applications. To prepare for this Trimble's precision receivers include Maxwell™ 7 Technology to identify and remove unwanted signals. As spoofing becomes more sophisticated, Trimble technology will continue to evolve to mitigate these challenges. Users can feel confident with advanced protection and the accuracy of their high-precision positioning solution from Trimble.

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