SPIRENT Communications

541 Industrial Way West | Eatontown, NJ 07724 USA | Tel +1 732-544-8700
www.spirent.com

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: IBFS File No. SATMOD2010111800239

Dear Ms. Dortch:

On September 2nd, 2011, at the request of Michael Ha, I met with Bob Weller, Ron Repasi, Chip Fleming, and Michael Ha of the FCC by phone to provide information about GPS simulation and test methodology utilized during the test effort leading up to the FCC LightSquared Technical Working Group (TWG) final report[1]. Brock Butler and John Pottle, also from Spirent, joined the meeting with me.

Spirent is the leading supplier of test and measurement equipment to the GPS and mobile device location technology industry. Spirent offers GPS simulators, GPS record and playback devices, and A-GPS automated test systems, many of which were used during the FCC LightSquared TWG test campaign to provide an accurate and repeatable test environment for assessing the impact of LightSquared L-Band interference. In the High Precision and Cellular working groups, Spirent was contracted by LightSquared to provide customized test automation of the working group test plans. I also served as an advisor to the Cellular working group.

The purpose of this meeting was to provide the FCC with specifics of the GPS simulation and test methodology used during the Cellular, High Precision, and General Navigation working group testing, with the intention of making the results more meaningful.

Three types of Spirent GPS simulators were used during the FCC LightSquared TWG test campaign:

- GSS6700, GSS6560, GSS5060[2] – These three instruments are functionally equivalent for the purposes of this testing. All offer GPS L1 C/A-code 12-channel simulation. Spirent SimGEN software is used to create test scenarios which can be standards-based or generated in real time to mimic real world characteristics.
- GSS7790 – This is a high-end GPS simulator capable of simulating GPS signals at L1 and L2, and it used for testing high precision and military grade receivers. The GSS7790 has combined output and multi-output modes. In single output mode, it shares many characteristics with Spirent's current high-end offering for GNSS simulation, the GSS8000[3].
- GSS6400[4] – This instrument uses a GPS antenna to sample RF signals in the live environment, storing them to a hard drive, and allowing them to be replayed in a laboratory environment. This instrument uses a 2MHz bandwidth to capture signals. All RF signals in this band will be captured and replayed.

These simulators were used in both radiated and conducted environments:

---

[1] Federal Communications Commission, LightSquared Technical Working Group final report, Washington, D.C., June 30, 2011

[2] GSS6700 Information on Spirent Web Site: http://www.spirent.com/Solutions-Directory/GSS6700

[3] GSS8000 Information on Spirent Web Site: http://www.spirent.com/Solutions-Directory/GSS8000

[4] GSS6400 Information on Spirent Web Site: http://www.spirent.com/Solutions-Directory/GSS6400

- Radiated – The Cellular, General Navigation, and High Precision working groups utilized anechoic chambers to provide a controlled RF environment for GPS, interference, and augmentation signals to be transmitted over-the-air.
- Conducted – The Cellular working group also tested some devices with RF signals fed directly into devices through coaxial cable and RF connectors, bypassing the GPS antenna and associated circuitry.

Cellular working group overview: Spirent helped the Cellular working group create a test plan and perform tests that were based on industry standards, while also adapting them as needed to provide meaningful results in a realistic timeframe. Spirent's GSS6700, GSS6560, and GSS5060—all equivalent GPS Simulators—were used for the testing. These instruments were part of Spirent's LTS[5] and PLTS[6] automated test systems for UMTS and CDMA A-GPS, respectively. The UMTS device tests were based off of the 3GPP 34.171 A-GPS tests and the CDMA device tests were based off of TIA-916 A-GPS tests. UMTS devices were predominantly tested radiated because most were missing RF connectors. CDMA devices were predominantly tested conducted because all were provided with appropriate RF connectors and cables. To make sure the results were analogous, the UMTS device testing included a procedure for calibrating the GPS antenna loss. This calibration factor was derived by presenting devices with a range of known signals and evaluating the measured GPS C/No. Each device had a unique calibration factor that was accounted for in the test automation software. This allows the results from conducted and radiated testing to be comparable.

Why are satellite signal power levels so much lower in cellular working group when compared to other working groups? Cellular devices are made to work in difficult environments like urban canyons and indoors and they benefit from assistance data sent over the cellular network. The industry-standard sensitivity test specifications account for this and set the requirement for devices to work well in an environment where the satellite signal levels are 10 to 20 dB below nominal levels. A 0 dBi antenna is assumed when determining the level to be applied to the device. This may not be an easy scenario for autonomous GPS devices to operate in. As a result, the General Navigation and High Precision working groups used power levels quite a bit higher than this.

Were tests based on FCC E911 requirements? Yes, industry standards A-GPS tests for cellular devices are based on E911 requirements and are reflected in the LightSquared test plan and results.

High Precision working group overview: Spirent helped the High Precision working group by automating test execution for the multi-day test plan in which 57 devices had to be tested simultaneously. Spirent created the GPS scenario with L1 C/A code, L1 Pseudo Y code, and L2 Pseudo Y code using the GSS7790 simulator. Precautions were taken to ensure that devices did not interfere with each other. The simulation had the following characteristics

- L1 had C/A + Pseudo Y code simulated and L2 just Pseudo Y code (the AS flag in the Nav Data was set to show this)
- A typical choke ring antenna pattern was used; 0dB's loss at the zenith rising to 10dB's at 0 degrees elevation
- The elevation mask was set to 5 degrees
- Signal strength set so that the receivers reported similar levels as in real life

---

[5] Spirent's Location Technology System (LTS) for UMTS A-GPS: http://www.spirent.com/Solutions-Directory/8100_Location_Technology

[6] Spirent's Position Location Test System (PLTS) for CDMA A-GPS: http://www.spirent.com/Solutions-Directory/C2K-ATS/C2K_LBS

- The number of channels being simulated varied with time as SV's rose and set in the constellation; typically 8 or 9 SV's in view. Log files were provided for a complete set of signal data.

How were 24 satellites simulated with a 12-channel simulator? A full GPS satellite constellation is setup in Spirent's SimGEN software, but only 8-9 satellites are ever visible at one time in the test set up used here. The scenario was setup to simulate latitude and longitude at NavAir facility, which is as representative a United States GPS environment as any other for the purposes of this testing.

Explanation of simulated antenna pattern: A choke ring antenna pattern was used in the simulation to vary attenuation between 0 and 10 dB, with more attenuation as satellites go closer to the horizon. This antenna pattern is simulated in the software and used to make the GPS scenario more realistic. The software was set up such that signals from satellites that are less than 5 degrees above the horizon are not transmitted. The antenna pattern of actual devices will vary from device-to-device, but this model is representative.

Why does the SV signal level vary from working group to working group? The Satellite Vehicle satellite strength differs between High Precision, General Navigation, and Cellular working group test plans. In Spirent's view this is a result of there being no accepted industry standards for GPS performance generally (cellular being a notable exception), and the variation form working group to working group illustrates this fact. Without a clear reference, different groups of industry experts will define different GPS test scenarios based on their particular application. This would appear to be what happened here.

General Navigation working group overview: Spirent did not participate in the General Navigation working group, but Spirent GSS6700 and GSS6400 GPS simulators were used for the testing. This working group defined both Static and Dynamic tests. The Static tests were executed with the GSS6700 and a basic simulated GPS scenario. The Dynamic tests were executed with the GSS6400 and a record and playback GPS scenario. The main advantage of a record and playback approach is the ability to capture and replay exact field conditions. Unlike field testing, a recorded data set can be repeatedly and precisely replayed in a laboratory. This is a test approach employed by many GPS chipset manufacturers because it is overly challenging to exactly replicate challenging and chaotic field conditions synthetically. The General Navigation working group captured several field scenarios that appear to be representative of common use cases, and all sample devices were tested against these scenarios with varying levels of a simulated LightSquared interferer. All tests were performed radiated.

Are the record and playback scenarios used representative? The record and playback approach is widely used in the industry, but the specific scenarios used are effectively proprietary to each manufacturer rather than being set in a standard. The recordings and resulting data sets used here appear to be carefully selected and executed.

Respectfully Submitted,

Ronald W. Borsato

Ronald Borsato
Solutions Architect
Spirent Communications
541 Industrial Way West
Eatontown, NJ 07724
732.544.8700