Government of Canada | Gouvernement du Canada

700TAG – Technical Advisory Note #2

LightSquared LTE and the potential impact on GPS

700 MHz Mobile Broadband for Public Safety - Technology Advisory Group

Public Security Science and Technology

August 30, 2011

Partners: The Technology Advisory Group for 700 MHz Public Safety Spectrum (700TAG) is composed of a collaborative group of technical experts led by Centre for Security Science and includes scientific authorities from Communications Research Center, and technical experts from Federal/Provincial-Territorial/Municipal agencies.

Objectives:

The objective of this Technical Advisory Note is to inform the Canadian public safety community of the status of the controversy concerning the services proposed by LightSquared in the US and the potential impact on GPS receivers. Although LightSquared has not indicated it will apply for a license to operate a terrestrial L-Band network in Canada, there is the potential for interference in border regions from LightSquared's US-based transmitters if the FCC grants it a license. As such the Canadian public safety community may be impacted by this issue.

The results of tests, which were mandated by the FCC, to assess potential interference of LightSquared's proposed terrestrial service on GPS receivers are examined and interpreted.

Background

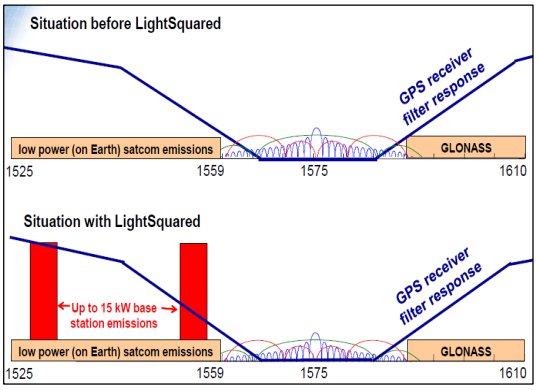
LightSquared (www.lightsquared.com), previously known as SkyTerra Communications, is a privately-held US corporation which has a license to operate satellite-based mobile services in the L-band (downlink: 1525 – 1559 MHz; uplink: 1626.5 – 1660.5 MHz) via MSAT-1 and MSAT-2 satellites. LightSquared launched the SkyTerra-1 satellite in 2010 and will launch SkyTerra-2 in 2011, which will replace MSAT-1 and MSAT-2. LightSquared provides voice and data connectivity to first responders in remote areas using MSAT terminals. SkyTerra-1 and -2 have more sophisticated interference control and adaptive capabilities such that the terminals working off these satellites can be smaller and lighter and have the form-factor of a cell-phone.

GPS receivers operate at two frequencies. L1 is at 1575.45 MHz. L2 is at 1227.60 MHz. The military uses both L1 and L2. Commercial receivers can only decode L1.

On Nov.18, 2010 LightSquared submitted an application to the FCC requesting authorization to offer dual-mode satellite and terrestrial services in 2@10MHz segments of the L-band. Users that would be out of range of terrestrial coverage could be connected automatically, if desired, to one of the satellites. The service would provide ubiquitous 4G broadband coverage for 92% of the US territory using LTE. LightSquared intends to offer wholesale carrier services to retail service providers, which is essentially a carriers' carrier model. The FCC viewed LightSquared's proposal as being in line with the National Broadband Plan to extend broadband access to rural and under-served areas.

The application attracted significant attention from a broad base of GPS users, citing the potential for over-load and desensitization of GPS receivers. On Jan.26, 2011 the FCC approved LightSquared's application, but attached a condition for LightSquared to demonstrate that its terrestrial network would not interfere with GPS receivers. LightSquared assembled a working group composed of members of its staff, the GPS community, and National Telecommunications and Information Administration (NTIA) to study the potential for interference with GPS receivers for various applications. One sub-team was formed for each application tested. On June 30, 2011, LightSquared submitted the final test report (Report) to the FCC.

Figure 1 illustrates the receiver selectivity of GPS receivers and the proximity of the frequency band where LightSquared intends to operate.



Source: Chris Hegarty, MITRE Corporation, March 2, 2011.

Figure 1: GPS receiver selectivity and proximity to LightSquared's proposed base station transmitters.

Test Results:

Five types of GPS applications were tested:

- Aviation
- Cellular
- General Location and Navigation
- High precision, Timing and Networks
- Space-based receivers

The National Public Safety Telecommunications Commission (NPSTC) submitted comments on 3 applications: Cellular, General Location and Navigation, and Timing. In summary, NPSTC's position is that no degradation to GPS-based applications can be tolerated. In this Note the test results of the 3 applications that were of interest to NPSTC are reviewed.

a) Cellular

GPS receivers in cellular devices were significantly affected by interference in the upper L-band (1545.2 to 1555.2 MHz). The same GPS receivers were not affected by LightSquared's transmissions in the lower L-band (1526 to 1536 MHz).

b) General Location and Navigation

The executive summary of this section of the Report is prefaced with a statement that LightSquared and the sub-team could not reach agreement on the interpretation of the tests. So, there are two contributions to the executive summary – one from LightSquared and one from the other sub-team members.

The sub-team reported that there was widespread interference of GPS receivers in the upper L-band, and that 20 out of 29 receivers experienced harmful interference in the lower L-band. The sub-team concludes that the only solution is for LightSquared to operate in a different frequency band. However, that solution presents two technical issues, aside from the significant business issues; (i) LightSquared would need to find a frequency band that can be used for this service, and (ii) the service must not interfere with adjacent incumbents of that band.

LightSquared states that the lack of consensus centers on a disagreement over what level would constitute harmful interference. The sub-team considered harmful interference as one that degrades the carrier to noise ratio (C/N_0) by 1dB. This means that a GPS signal would have to be received with 1dB higher power for that receiver to perform in same manner as without the interferer. National and international standards bodies such as American National Standards Institute (ANSI) and European Telecommunications Standards Institute (ETSI) use 1dB and 3dB degradation as being the reference points for performance specifications of radio receivers. Radio manufacturers typically state their adjacent channel and co-channel interference rejection performance for 1dB degradation in C/N_0.

LightSquared's perspective is that harmful interference occurs with 6dB degradation in C/N_0. At this level of interference, LightSquared shows that only 1.2% of the service area would be negatively impacted in the lower-L band.

c) High Precision, Timing and Networks

This application includes critical timing for P25 LMR networks. The transmitters of simulcast systems must be precisely synchronized so as to not interfere with each other. As with the General Location and Navigation tests, the sub-team and LightSquared did not agree on the interpretation of the results for this application. Two separate contributions are part of the Report.

The sub-team states that there is no feasible solution to make LightSquared's proposed system compatible with this application. All receivers of this class experienced harmful interference in lower and upper L-band. This application uses wideband receivers and is therefore, more susceptible to interference.

LightSquared acknowledges that there are interference issues but claims that the issues are due to the poor design of the GPS receivers' RF filters. In the executive summary they focused on potential mitigation actions. Such actions include limiting the range of operating frequencies of GPS augmentation signals, which are used to enhance the precision of commercial GPS receivers, and to add better filters to the GPS receivers. The cost and feasibility of adding better filters to GPS receivers in current use was not addressed in the Report.

On June 15, 2011 NPSTC submitted a note to the FCC expressing a number of concerns about the potential for interference on public safety systems. NPSTC stated that some tests needed to be re-done because:

i) The tests were conducted on a sample size of 30 user subscriber terminals. NPSTC stated that this sample size is too small.

ii) Many of the tests were conducted with an RF anechoic chamber. This does not represent real life conditions where reflections and terrain effects are de-rigueur.

LightSquared's revised proposal

In a submission to the FCC, concurrent with the Report, LightSquared has acknowledged that operating in upper L-band will adversely affect a significant number of GPS receivers. It lays the blame on the GPS industry for having inadequate filters in their receivers. LightSquared has offered to modify its application to use only the lower L-band and to cooperate with the GPS industry to find a solution for the GPS receivers that use augmentation signals, for example, precision agriculture, surveys, mining, and science. It has also offered to contribute financially to implementing the solution(s).

LightSquared claims that the FCC encouraged it to rationalize the L-band spectrum at a cost of $500M in order to make it usable for a dual satellite-terrestrial network. It further argues that since 2001 the NTIA and GPS industry were aware of its intentions to operate an L-band terrestrial network, and yet continued to deploy GPS receivers that would be susceptible to interference. LightSquared's investors have already invested $4 billion in developing its business and are prepared to invest an additional $22 billion over the next 7 years. It adds, "…the LightSquared network will provide a boost to the economy, jobs at a time of need and competition and innovation that would not otherwise exist— an estimated $120 billion in benefits to consumers that would be lost."

The FAA released a report on July 12, 2011 which states that upper and lower L-band terrestrial operation, even at reduced power, would deny GPS capability for aircraft navigation. LightSquared's response is that the source of the problem is with the GPS inadequate filters.

Outcomes:

There are indications that LightSqaured's proposed service would have adverse consequences for critical GPS applications. LightSquared alledges that the GPS receivers' filters are inadequate and need to be improved. That solution would require retro-fitting a large number of GPS devices currrently in service. But the industry will need to first demonstrate that the improved filters eliminate the interference susceptibility of the GPS receivers. .

Mode detailed information can be found in the documents referenced below.

References:

(i) *Test Working Group final report, June 30, 2011*

http://licensing.fcc.gov/myibfs/download.do?attachment_key=900848

(ii) *FAA Test Report, July 12, 2011*

http://www.govexec.com/pdfs/072711bb1.pdf

(iii) *NPSTC comments on the test report, June 15, 2011.*

http://licensing.fcc.gov/myibfs/download.do?attachment_key=904779

Authors: Claudio Lucente

Scientific Authority:

Approved for Release By:

Dr. Andrew Vallerand, DRDC Centre for Security Science, DSTPS