March 18, 2011

VIA ELECTRONIC FILING

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

Re:  Notice of Ex Parte Presentation in LightSquared Subsidiary LLC  
   Request for Modification of its Authority for an Ancillary  
   Terrestrial Component, IBFS File No. SAT-MOD-20101118-00239

Dear Ms. Dortch:

On March 17th, 2011, Deere & Company (“Deere”) met with Julius Knapp, Geraldine Matise, Mark Settle, Walter Johnston, Robert Weller, Brett Greenwalt and Brian Butler of the Commission’s Office of Engineering and Technology, with Gene Fullano and Clifford Gonsalves of the Public Safety and Homeland Security Bureau, and with Robert Nelson and Sankar Persaud of the International Bureau to discuss the above-referenced application. Attending this meeting on behalf of Deere were Barry Schaffter, Senior Vice President, Intelligent Solutions Group and Chief Information Officer, Patricia Harris, Assistant General Counsel, Paul Galyean, Director, System Engineering and IME/Robotics, and Mark Rentz, Senior Systems Engineer, along with Catherine Wang and Tim Bransford of Bingham McCutchen LLP, outside counsel to Deere.

During this meeting Deere expressed its support for a cooperative and constructive process that through technical analysis and other means, including testing, enables the Commission and all interested parties to understand the challenging interference issues presented by LightSquared’s plan for operating terrestrial cellular base stations in L-band mobile satellite service (“MSS”) frequencies. We provided a presentation describing high-precision, augmented Global Positioning Systems (“GPS”), including Deere’s StarFire service, that use GPS and MSS signals to guide agricultural and construction equipment with accuracy as precise as two (2) inches. We explained the major role high-precision and augmented GPS technology plays in the agricultural and construction industries, and emphasized that all modern growing activities rely on this technology, which has become so ubiquitous that it is now a standard feature on Deere agricultural products.

During this meeting we discussed the three potential types of interference that LightSquared’s plan may create for GPS and augmented GPS systems. Specifically, we discussed out-of-band emissions (“OOBE”), GPS receiver overload, and co-channel
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interference to licensed augmentation MSS signals. We also reviewed a number of issues raised in Deere’s Petition for Reconsideration, including the need for an improved and strengthened process for technical evaluation of LightSquared interference into GPS and augmented GPS receivers, adequate time to analyze and test complex and varied interference issues, development of a comprehensive test plan and open and transparent test procedures, and the need for the Commission to articulate the standards it will use to evaluate work product and data generated through the technical working group.

The attached presentation was circulated to staff in attendance. If you have any questions regarding this meeting, please do not hesitate to contact the undersigned.

Very truly yours,

/s/

Catherine Wang
Tim Bransford

CC: Julius Knapp
Geraldine Matisse
Mark Settle
Walter Johnston
Robert Weller
Brett Greenwalt
Brian Butler
Gene Fullano
Clifford Gonsalves
Robert Nelson
Sankar Persaud
LightSquared Interference to GPS and StarFire

17 March 2011
Agenda

• Executive Summary
• John Deere – Who We Are
• What we do with GPS and Satellite Navigation
• Major Issues
• High Precision Receivers
• Analysis
• Testing
• Additional Concerns
• Plans
Executive Summary

Deere GPS receivers will be very adversely affected in and near areas served by LightSquared
• Degradation starts at 11 - 85 miles, severe at 4 - 21 miles

StarFire differential GPS will be very adversely affected in and near areas served by LightSquared
• Degradation starts at 6 - 85 miles, severe at 4-21 miles

Deere customers in agriculture, construction, and other applications will lose high accuracy navigation in and near areas served by LightSquared

There are major economic consequences (not just for Deere)

We do not know any feasible mitigations at this time
Deere & Company: Quick Facts

• Founded in 1837

• Operations in 35 countries

• Headquartered in Moline, IL

• FY2010 Annual Net Sales and Revenues: $26.0 billion

• Number of Employees: more than 50,000 worldwide
Committed to Those Linked to the Land

John Deere is committed to the success of its customers, those linked to the land. We are helping our customers - who cultivate, harvest, transform, and build upon the land - meet the world's dramatically increasing need for food, fuel, fiber, and infrastructure.

The world faces major challenges in coming decades. World yields must increase in size and efficiency and, at the same time, new infrastructure is needed to deliver the food, fiber, and fuel needed for the future.

John Deere is taking a leadership position to help our customers meet these new challenges by providing premier equipment solutions. In doing so, we are supporting a higher quality of life around the world.

In fulfilling our commitment to those linked to the land, we will partner with companies, universities, governments, and others to develop and deliver long-lasting, intelligent equipment solutions.

We aspire to achieve sustainable SVA (Shareholder Value Added) growth through global expansion - to be the partner of choice for both existing and prospective customers throughout the world in this regard, our aspiration is to become the world's premier agricultural equipment solutions provider and a globally recognized construction equipment solutions provider with a meaningful presence in China.

We aspire, at the end of the cycle, to achieve enterprise net sales of at least $110 billion (USD) and asset turns of 2-3 times by 2018, and to deliver operating margins of at least 12 percent by 2018.

Our Purpose

Our Aspirations
Agriculture

A world leader in providing advanced products and services for agriculture
Construction

A leading equipment producer for a wide range of construction projects
Global Navigation Satellite Systems (GNSS)

Deere has been using satellite navigation on its platforms for 15 years – pioneer in precision agriculture.

Deere designs and manufactures its own GPS receivers

Many Deere applications require accuracies of a few inches

GPS alone can’t provide the necessary accuracy – differential GPS augmentation is needed:

• StarFire – global network – 4-10 inch accuracy
• RTK (Real Time Kinematic) – dealer and customer networks - 1-2 inch accuracy
GPS Receivers

We are delivering our 4th generation GPS receiver: SF-3000

Deere receivers are specifically designed for our customers:
- Very high accuracy (precision measurement quality)
- StarFire and RTK are integral capabilities
- Extremely rugged/reliable (required for Ag and Construction)
- Uses GPS and GLONASS (Russian GNSS), will use Galileo (EU GNSS) and COMPASS (China) when they are available
**Deere StarFire™ Network**

Distributes differential GPS corrections via six Inmarsat L-band satellites to Deere customers worldwide

- Owned and operated by Deere
- Corrections derived from real time data collected at over 50 worldwide GPS reference stations
- Computations at two Deere Processing Centers are sent to Uplink sites for the satellites
- Deere GPS receivers use the corrections to achieve high accuracy real time navigation

All six satellite downlinks are in the MSS band (1525-1559 MHz)
RTK

RTK is a form of differential GPS
A stationary GPS receiver sends corrections to local mobile GPS receivers
- Accuracies of two inches over ranges of 15 miles are normal
- Deere dealers operate many RTK networks in the US
Major Issues

There are three issues:

• LightSquared Out of Band Emissions

• GPS receiver overload

• LightSquared MSS co-channel interference with Deere StarFire network
Out of Band Emissions – Issue 1

LightSquared base stations will operate in the MSS band (1525 MHz–1559 MHz) just below the GPS band (1559 MHz-1591 MHz)

OOBE is not a problem in the GPS band if LightSquared filters their signals as they have committed

• -100 dBW/MHz is below the thermal noise floor; no GPS impact
GPS Receiver Overload – Issue 2

Very serious problem affecting all GPS receivers near a LightSquared base station, not just Deere receivers
• All GPS receivers assume MSS contains low powered signals
• All GPS receivers use filters that overlap in the MSS band
• GPS filters are overwhelmed by LightSquared base station power
• It is not feasible to use filters that could eliminate the high powered LightSquared signals
  • >45 dB attenuation required from GNSS band at 1559 MHz and LightSquared LTE at 1555 MHz
  • Cost, power, size, weight, degraded performance

Overload may also be a problem for GPS receivers near LightSquared handsets
MSS Co-Channel Interference – Issue 3

StarFire (and Omnistar, other major augmentation provider) signals are broadcast from satellites in the MSS band to be used by LightSquared

- Many agriculture, machine control, survey, and high precision GPS receivers receive these augmentation signals

LightSquared signal is >90 dB stronger than StarFire signal near base stations

- Exceeds the capability of the filters to reject LightSquared power at considerable distances from the base stations
- Augmentation signal cannot be received when near a base station
High Precision Receivers are More Affected

High precision receivers are more affected than are consumer grade receivers

- Modern high precision receivers use filters that cover MSS, GPS, and GLONASS bands
- Wideband filters are required for higher rate, precision codes

![Diagram showing signal power for different systems and frequencies](image)
GNSS Code Structures

2+ MHz is sufficient for consumer receivers using C/A Code

High precision GPS receivers need 20+ MHz for GPS P(Y) code

- Legacy GPS satellite signals are 24 MHz bandwidth
- GPS is being modernized with new signals and satellites
- Future GPS satellite signals will be 32 MHz bandwidth
- Other GNSS signals are also wideband
- In the future, many more GNSS receivers will be wideband
Analysis

We have analyzed the response of some of our receivers to LightSquared signals

- GPS and StarFire reception considered
- LightSquared power mask and signal structure used
- Particularized to the architecture of our receivers

- Considers propagation models:
  - The $1/d^2$ model is for free space, does not account for horizon effects, and overestimates ranges in the Deere environment
  - The HATA Open model is for urban environments ($1/d^{4.5}$), drops off very rapidly at the horizon, and underestimates ranges in the Deere environment
  - These two estimates bound the range of the interference effects
# LightSquared Terrestrial Service

## LightSquared and Inmarsat Channels

<table>
<thead>
<tr>
<th>StarFire Channels</th>
<th>LSQ Phase 0</th>
<th>LSQ Phase 1A</th>
<th>LSQ Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1535 1537</td>
<td>1545</td>
<td>1550 1555</td>
</tr>
<tr>
<td></td>
<td>1526 1531</td>
<td></td>
<td>1550 1555</td>
</tr>
<tr>
<td></td>
<td>1526 1536</td>
<td>1545</td>
<td>1555</td>
</tr>
</tbody>
</table>

1525 MHz - 1559 MHz
GNSS Receiver Architecture

TYPICAL GNSS RECEIVER WITH MSS-BAND AUGMENTATION
LightSquared GPS Interference Effects

**Red Zone**: No satellites are tracked (A)
- LTE\(^{(1)}\) causes significant compression in the antenna/LNA

**Orange Zone**: Some satellites lost, all measurements degraded (B)
- LTE weaker than antenna/LNA maximum, but stronger than 1 dB compression point of GPS mixer

**Yellow Zone**: Only weakest satellites lost, minor to significant measurement degradation (D)
- LTE signals do not cause mixer compression, but stronger than filtered thermal noise, affects A/D

**Green Zone**: No satellites lost, little loss of measurement accuracy
- LTE signals weaker than thermal noise floor

\(^{(1)}\) Long Term Evolution, the standard 4G signal structure used by LightSquared
LTE Interference in Wide Band GNSS Receivers

**LTE POWER and RECEIVER INTERFERENCE**

- A/D and Baseband Degraded
- Limit of LTE Impact

- $d^2$ model = 85 miles,
- Hata = 11 miles

**MHz**
- 1450 to 1675

**dBm**
- -160 to -30
LTE Interference in Wide Band GNSS Receivers

LTE POWER and RECEIVER INTERFERENCE

d^2 model = 21 miles
Hata = 3.6 miles

Receiver Mixer Compression
A/D and Baseband Degraded
LTE Causes Mixer Saturation
Limit of LTE Impact
LTE Interference in Wide Band GNSS Receivers

![Diagram of LTE POWER and RECEIVER INTERFERENCE with markers for various interference levels and distances.]

- d^2 model = 1.2 miles
- Hata = 0.9 miles

- Antenna LNA Overload
- Receiver Mixer Compression
- A/D and Baseband Degraded
- LTE Causes Ant Saturation
- LTE Causes Mixer Saturation
- Limit of LTE Impact
LightSquared StarFire Interference Effects

**Red Zone:** No StarFire signal tracked (A)
- LTE\(^{(1)}\) causes significant compression in the antenna/LNA

**Orange Zone:** Strongly degraded StarFire tracking, very high bit error rates (C)
- LTE weaker than antenna/LNA maximum, but stronger than 1 dB compression point of StarFire mixer

**Yellow Zone:** Degraded StarFire tracking, minor to significant bit error rates (E)
- LTE signals do not cause mixer compression, but stronger than filtered thermal noise, affects A/D

**Green Zone:** StarFire tracking OK
- LTE signals weaker than thermal noise floor

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\(^{(1)}\) Long Term Evolution, the standard 4G signal structure used by LightSquared
LTE Interference in StarFire Receivers

LTE POWER and RECEIVER INTERFERENCE

Limit of LTE Impact

d^2 model = 85 miles
Hata = 11 miles

- Limit of LTE Impact
- A/D and Baseband Degraded
LTE Interference in StarFire Receivers

LTE POWER and RECEIVER INTERFERENCE
LTE Stronger than StarFire

\[ d^2 \text{ model} = 36 \text{ miles} \]
\[ \text{Hata} = 6 \text{ miles} \]

-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
dBm

1450 1475 1500 1525 1550 1575 1600 1625 1650 1675 MHz

LTE Stronger than StarFire
A/D and Baseband Degraded
Limit of LTE Impact
LTE Interference in StarFire Receivers

LTE POWER and RECEIVER INTERFERENCE
Mixer Saturation

LTE Causes Mixer Saturation
Receiver Mixer Compression
A/D and Baseband Degraded
Limit of LTE Impact
LTE Stronger than StarFire

\(d^2\) model = 21 miles
Hata = 3.6 miles
LTE Interference in StarFire Receivers

LTE Causes Ant Saturation
Antenna LNA Overload
Receiver Mixer Compression
A/D and Baseband Degraded
LTE Causes Mixer Saturation
Limit of LTE Impact
LTE Stronger than StarFire

d^2 model = 1.2 miles
Hata = 0.9 miles
### LightSquared Interference Analysis Results

<table>
<thead>
<tr>
<th></th>
<th>dBm</th>
<th>Effect</th>
<th>Range $1/D^2$ Model (miles)</th>
<th>Affected Area (sq miles)</th>
<th>Range Hata Open Model (miles)</th>
<th>Affected Area (sq miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GPS L1 Signals Processing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturation of Antenna LNA</td>
<td>-40</td>
<td>Inoperative</td>
<td>1.2</td>
<td>4.5</td>
<td>0.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Saturation of Mixer</td>
<td>-65</td>
<td>Heavily degraded sensitivity</td>
<td>21</td>
<td>&gt;1200</td>
<td>3.6</td>
<td>40</td>
</tr>
<tr>
<td>Degraded A/D and Baseband</td>
<td>-80</td>
<td>Reduced accuracy, weak satellites lost</td>
<td>&gt;85</td>
<td>&gt;20,000</td>
<td>11</td>
<td>&gt;375</td>
</tr>
<tr>
<td><strong>StarFire Signals Processing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>21</td>
<td>&gt;1200</td>
<td>3.6</td>
<td>40</td>
</tr>
<tr>
<td>LTE OOBE power equals StarFire power</td>
<td>-70</td>
<td>3 dB degraded tracking, minor to significant BER</td>
<td>36</td>
<td>&gt;4000</td>
<td>6</td>
<td>110</td>
</tr>
<tr>
<td>Degraded A/D and Baseband</td>
<td>-80</td>
<td>Degraded tracking, minor to significant BER (depending on channel)</td>
<td>&gt;85</td>
<td>&gt;20,000</td>
<td>11</td>
<td>&gt;375</td>
</tr>
</tbody>
</table>
Laboratory Testing

GPS testing conducted March 2011, StarFire testing pending

- Filtering consistent with LightSquared power mask
  - Used 10-pole cavity filter which kept LTE OOBE in L1 below thermal noise floor
- Particularized to the architecture of our receivers
LTE Jamming Test – GPS

Test 1 Setup
• NavLabs GPS simulator
• Agilent E4438C-OPTS34 LTE source
• Signal combiner and attenuators
• UUT: SF-3000 GNSS Receiver with hard line LNA input

Test 1
• With LTE source off, set GNSS level and C/N$_0$ to GPS ICD nominal at LNA input.
• Add LTE signal in increments of 10 dBm to LNA input.
• For each increment measure:
  • Acquisition time
  • Received C/N$_0$ for all channels
Test 1 Setup Diagram

- **Spirent GNSS Simulator**
- **Agilent E4438C Signal Generator**
- **1559 to 1610 MHz Blocking Filter**
- **Receiver Under Test**
- **Spectrum Analyzer**
- **PC**

- **Step Attenuator**
- **Cable moved from Receiver to Spectrum Analyzer for Calibration**
Test 1 Setup in Lab

GPS Simulator
PC
LTE Generator
Power Supply
Receiver Under Test
Combiner and Filter
Spectrum Analyzer

Test 1 Setup in Lab

GPS Simulator
PC
LTE Generator
Power Supply
Receiver Under Test
Combiner and Filter
Spectrum Analyzer
**LTE Jamming Test – StarFire**

Test 2 Setup
- NavLabs GPS simulator
- Deere L-band Simulator with Agilent ESG RF Signal Generator
- Signal combiner and attenuators
- UUT: SF-3000 GNSS Receiver with hard line LNA input

Test 2 Procedure
- With LTE source off, set L-band power at LNA input such that $E_b/N_0=10$ dB (data rate = 600 BPS)
- Add LTE signal in increments of 5 dBm to LNA input.
- For each increment measure:
  - Acquisition time
  - Receiver Reported $E_b/N_0$
  - Bad Packet ratio
Test 2 Setup Diagram

- Agilent E4438C Signal Generator
- Deere L-band Simulator
- Agilent ESG RF Signal Generator
- Step Attenuator
- Receiver Under Test
- PC
Additional Concerns

May not be possible to receive StarFire signal in MSS band with remaining Inmarsat bandwidth and LightSquared OOB power level in this band (-40 dBW/MHz)

While LightSquared intends to operate at 32 dBW, they are licensed to 42 dBW

• Higher powered operations would increase the range of degradation

LightSquared operations closer to GPS than 1555 MHz could be done with reduced power

• Even more difficult to address closer frequency

Handsets may be a problem when operated close to GNSS receivers
**Plans**

Conduct further Deere tests, measure more parameters to determine the impact on receiver performance: C/N₀, code noise, carrier noise, cycle slips, bit errors, etc.

Continue to fully participate in LightSquared – USGIC Technical Working Group

Work with FCC on any evaluation it conducts, if requested