Abbreviated History

• 2003 (“Eight Years Ago”)—ATC first authorized as LSQ advertises in press releases
  – Does not resemble current proposed network
  – Placed responsibility for resolving harmful interference on ATC operator

• 2005 Reconsideration of ATC order
  – Removed limit on number of base stations
  – Upped allowable power to 1.5 KW
  – Reiterated satellite “gating” criteria and promised, in very strong terms, no stand-alone terrestrial service

• 2010 “Harbinger” Order
  – Transfer order to allow LightSquared ATC authority
  – Power increased to 15 KW
    • GPS Community assumed “no stand-alone terrestrial service ever” still applied
2011 Conditional Waiver

- Granted waiver of requirement for dual-mode handsets
- *Granted permission for terrestrial stand-alone service conditioned on resolution of GPS overload interference problem*
- LightSquared proposed up to 40,000 transmitters – all could be 15 KW
- FCC stated “no limit to number of transmitters”
Spectrum
Current matrix of alternatives to be considered - *All still on the plate*

<table>
<thead>
<tr>
<th></th>
<th>Lower Power 1.5 Kilowatts</th>
<th>Higher Power 15 Kilowatts</th>
<th>Multiple Transmitters</th>
<th>Handheld Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower LSQ Band</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Upper LSQ Band (Closer to GPS)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>
Initial Testing

- DOD and Other Agencies, Manufacturers, and Users expressed strong concerns.
- Began a series of tests of all types of receivers.

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<th>Higher Power 15 Kilowatts</th>
<th>Multiple Transmitters</th>
<th>Handheld Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower LSQ Band</td>
<td>Partially Tested</td>
<td>Analysis Only</td>
<td>Not Tested</td>
<td></td>
</tr>
<tr>
<td>Upper LSQ Band</td>
<td>Tested</td>
<td>Analysis Only</td>
<td>Not Tested</td>
<td>Not Available for Testing</td>
</tr>
</tbody>
</table>
First Phase Test Results
Reported by All Agencies Concerned
(Testing April/May 2011 –Results Reported Late June 2011)

- Many **Military, Precision-Civil, Public Safety, Aviation** Receivers and others were severely affected **at the lower power levels**

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<th>Higher Power 15 Kilowatts</th>
<th>Multiple Transmitters</th>
<th>Multiple Handheld Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower LSQ Band</td>
<td>Many receivers failed (30/32 Hi-Precision)</td>
<td>Analysis Only</td>
<td>No Live Tests</td>
<td>Not Available for Testing</td>
</tr>
<tr>
<td>Upper LSQ Band (Closer to GPS)</td>
<td>Most Sets Failed</td>
<td>Analysis Only</td>
<td>No Live Tests</td>
<td></td>
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</tbody>
</table>
Low band, Low power initially
- **LSQ Has not abandoned the higher power and upper band**

Number of Transmitters unchanged but increased density

<table>
<thead>
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<th>Lower Power 1.5 Kilowatts</th>
<th>Higher Power 15 Kilowatts</th>
<th>Handheld Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower LSQ Band</td>
<td><strong>Current Testing</strong></td>
<td>Later ?</td>
<td></td>
</tr>
<tr>
<td>Upper LSQ Band</td>
<td>Later ?</td>
<td>Later ?</td>
<td>?</td>
</tr>
<tr>
<td>(Closer to GPS)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Another Round of Testing has begun – two phases –
- First: General Location and Navigation Receivers and cellular devices
- Second: Exploring Potential of further Filtering with high precision Rcvr’s
<table>
<thead>
<tr>
<th></th>
<th>High Precision</th>
<th>Aviation</th>
<th>Military</th>
<th>Emergency Services</th>
<th>Space Corrected Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower LSQ Band</strong></td>
<td>Several Manufacturers Pursuing - One Demoed, No Independent Tests</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td><strong>Upper LSQ Band (Closer to GPS)</strong></td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>
Complications

• New Signals
  – Lm
  – L1C
  – Compass etc

• International Agreements
  – ITU
  – Emergency Beacons
  – Defense Communications Applications
Many GNSS Signals
Options to mitigate interference

• Simplest: FCC Rescind the waiver
• Less burden: on the Government: Move LSQ to a more compatible band
• Alternative: Help LightSquared find a solution that will not interfere with GPS
• Several manufacturers are working to determine if there is a technical solution, but none have been independently verified
  – Solutions to be verified in the later portions of second round of testing
    • Upper band is much more difficult
  – Must consider the newer GPS signals (i.e. Military, and International)
  – Must particularly explore performance issues: Sensitivity, Multipath rejection and timing uncertainty This relates to sharpness of correlation peak...

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</thead>
<tbody>
<tr>
<td>Lower LSQ Band</td>
<td>Technical Feasible for new equip*</td>
<td>Filter <strong>may</strong> be feasible</td>
<td>Difficult to “Analyze” – Major Issue for Aviation</td>
<td>Unknown, no hardware to test</td>
</tr>
<tr>
<td>Upper LSQ Band (Closer to GPS)</td>
<td>Feasible Technical Solution not known</td>
<td>No known technical solution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Issues - Lower Band Only

• Unknown extent of all GPS uses and probable unknown and unintended impacts

• *Retro-fitting* current receivers is not a realistic option
  – Cost (New Front-end?)
  – Sequencing
  – Duration of transition

New Receivers would probably be Required
Verification Issues

• Are there **verified** Technical Solutions that do not affect current or future GPS performance and are affordable (what band and power level)?

• **If so:**
  – What is the phase-in timing *and*
  – Who will pay for what?

• **If not**, the best alternative **may be** to find another operating band for LSQ

---

**The Right Process:** The USAF conducted an extensive fact finding with all users for time to abandon support of “Codeless” receivers.

**Decision reached** - allow 12 years (2020) – this satisfied all stakeholders.

**Principal Rationale** – Allow the high-precision GPS users time to phase in a solution *that was already understood and accepted*. 
Overarching Issue

• No known solution for Hi Performance GPS if High LSQ band is Activated
• Hi-Band is still in the LSQ plan
• No real point in seeking or implementing a Low LSQ band Solution
  – GPS users would have to retrofit a second time in 5 (?) years
Bottom Line

• If FCC allows “waiver” to proceed
  – Effects will be immediate and disastrous
    • Aviation
    • Precision Agriculture
    • Survey
    • Machine Control
    • Public Safety Providers (helicopters)
  – Transition time should be at least 8 to 10 years for Lower Band

• Upper Band must be Immediately Prohibited

• Whole MSS Band should be reserved for Satellite to Ground