

Space Service Volume (SSV) Approach

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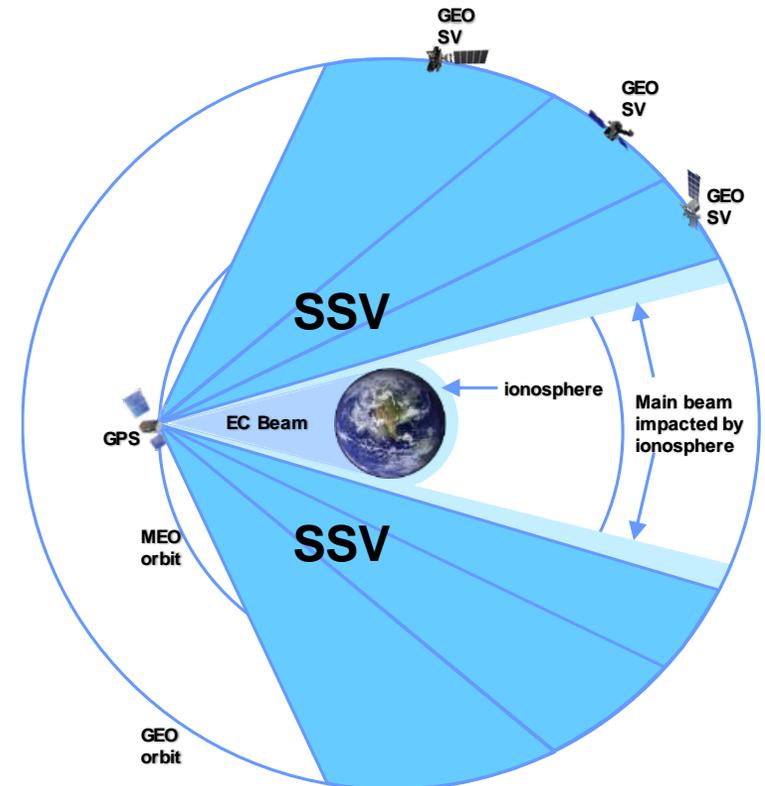
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Agenda

- GPS III and SSV Status
- SSV Requirements
- SSV Requirements Considered
- Constellation Modeling
- GPS III SSV Plan

GPS III

- GPS III Space Vehicle (SV) 01 launched 12/18
- GPS III SV 02 launch planned for 7/19
- GPS IIIF SV 11 & 12 on contract
- Space Service Volume (SSV) following IS-GPS-200
- Special Study initiated to explore SSV improvements
- Potential insertion on SV 13



SSV Importance

- Missions in Highly Elliptical and Geo-stationary Earth Orbits (HEO/GEO) using GPS signal to improve Space Vehicle PNT performance
 - Performance has been greater than requirement
- Improves satellite real-time navigation performance
- Reduces complexity and cost of satellite on-board clock

GSP SSV SIGNALS SUPPORT HEO/GEO SATELLITE MISSIONS

Current SSV Requirements

- IS-GPS-200
 - User-Received Signal Levels

Table 3-Vc. Space Service Volume (SSV) Received Minimum RF Signal Strength for GPS III and Subsequent Satellites over the Bandwidth Specified in 3.3.1.1 – GEO Based Antennas				
SV Blocks	Channel	Off Axis Angle Relative To Nadir	Signal	
			P(Y)	C/A or L2 C
III and Subsequent	L1	23.5 deg	-187.0 dBW*	-184.0 dBW*
	L2	26.0 deg	-186.0 dBW	-183.0 dBW

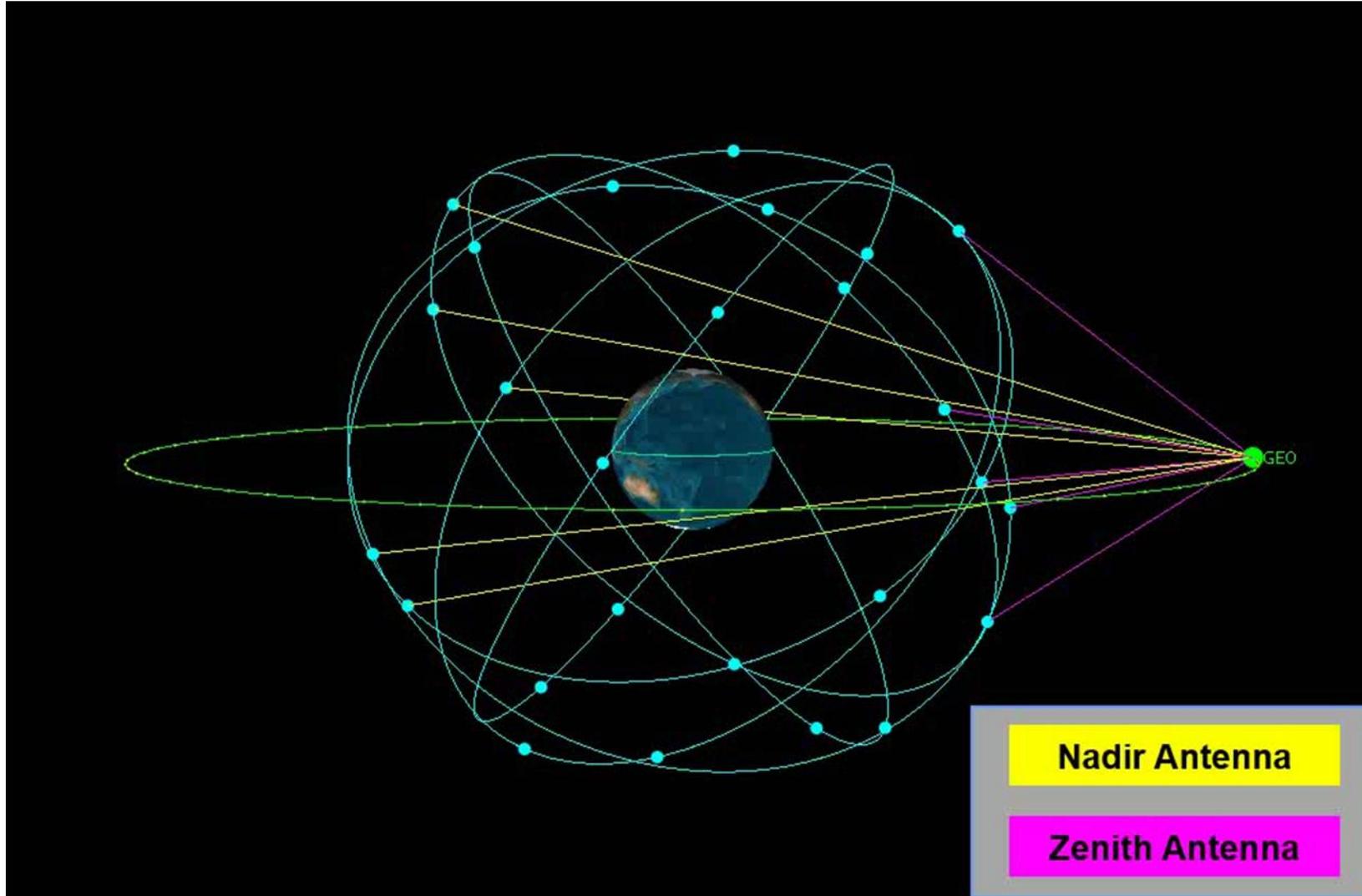
* Over 99.5% of the solid angle inside a cone with its apex at the SV and measured from 0 degrees at the center of the Earth

MANY HEO/GEO SATELLITES UTILIZE SIGNALS BEYOND IS-GPS-200 REQUIREMENTS

SSV GEO Requirements Considered

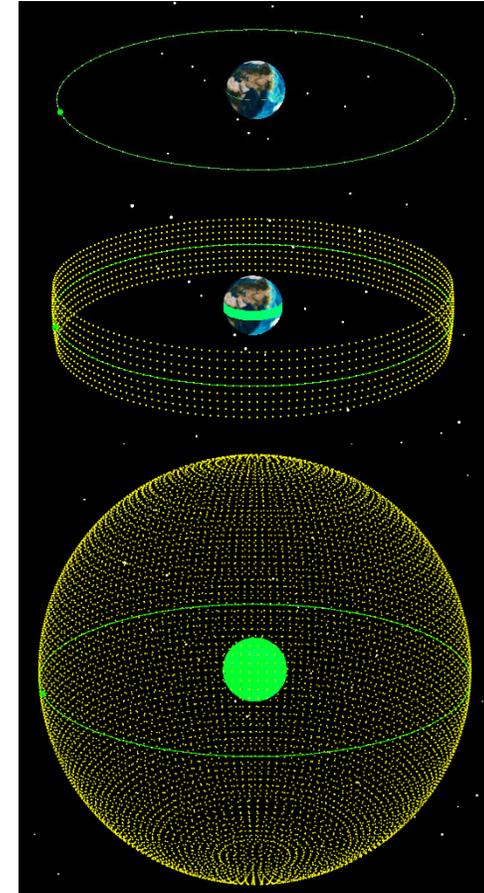
- SSV Received Signal Strength
- 4 SV Availability
- Maximum outage time
- SIS URE accuracy
- Geometric Dilution of Precision (GDOP)
- Civil and/or Military signals
- Other Considerations
 - Spurious Transmissions (in-band at or below -40 dBc over respective bands (IS-GPS-200))
 - L1 & L2 C/A off axis relative power shall not decrease by more than 2 dB (edge of earth to nadir) (IS-GPS-200)

Nadir (30°) and Zenith (85°) Access to GEO User



Constellation Modeling

- Nadir antennas (half angles > 26 degrees)
- Coverage Areas:
 - Receivers with a minimum requirement of RSS
 - Along Equator
 - Over an Equator ± 10 degrees Latitude area
 - Over a Global area
- Figures of Merit Considered:
 - Worst-case 50th Percentile GDOP
 - Avg # in view GPS SVs over all users
 - Min # in view GPS SVs over all users
 - 4 SV Outage time [min] (< 30 min req)
 - % users with 4 in view % of time



Overall Plan

- Update constellation models
- Assess system requirements and lower level requirements (e.g. antenna beam width)
- Review antenna alternative possibilities (Nadir and Zenith)
- Recommend requirements and designs
- Down select recommended design
- Prototype antenna
- Complete insertion plan and SV design

COORDINATED EFFORT BETWEEN GPS DIRECTORATE AND USER COMMUNITY

LOCKHEED MARTIN

