Use Case Scenarios – Space Based Receiver Assessment

GPS Adjacent Band Compatibility Assessment Workshop VI

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Space Based Receiver Applications

• Space vehicle navigation / Precise Orbit Determination (POD)
  – Position
  – Velocity
  – Time
  – Attitude
  – Associated scientific missions:
    • Ocean and ice altimetry
    • Synthetic Aperture Radar (SAR)
    • Interferometric SAR
    • POD and time transfer for gravity field
• Science measurements:
  – Radio occultation (GNSS-RO)
    • NOAA Operational Weather Forecasting
    • Climate change science
    • Space weather phenomenona
  – Reflectometry (GNSS-R)
    • Weather forecasting
    • Tidal surges
    • Flood plain monitoring
NASA Developed Receivers

• Goddard Space Flight Center (GSFC)
  – Navigator GPS Receiver
• Jet Propulsion Laboratory (JPL)
  – Flight TurboRogue
  – BlackJack GPS Receiver
    • IGOR
    • IGOR+
  – TriG Receiver
Focus on TRIG

• Applications:
  – Navigation/POD/sub-nanosecond time transfer
  – Radio Occultation

• Upcoming Missions:
  – Deep Space Atomic Clock (DSAC)
  – COSMIC-2 Equatorial (6 satellites)
  – COSMIC-2 Polar (6 satellites)
  – GRACE-Follow-On
  – Sentinel-6
  – Surface Water and Ocean Topography (SWOT)
  – NASA-ISRO Synthetic Aperture Radar (NISAR)
  – Other missions in development
On-Orbit Assessment Parameters

- Assessment based on the aggregate received interference from terrestrial interferer network
- Computation Method:
  - MATLAB time simulation
    - 10-day orbit simulation period @ 1-sec time steps
- System on-orbit specifications:
  - Altitude
  - Inclination angle
- Receiver specifications:
  - Antenna type
  - Antenna pointing azimuth
  - Antenna pattern
  - Polarization
  - Interference threshold*
- Propagation Loss
- Cross-polar antenna loss

* Obtained from results of DOT ABC Radiated Chamber Testing (April-2016)
TRIG GNSS-RO Antenna Gain Pattern

12-Element Array Antenna (Main beam pointing toward Earth limb)

[NOTE: A 2\textsuperscript{nd} 12-element array antenna exists on the reverse side of the satellite. The 2\textsuperscript{nd} array antenna has been omitted from this pictorial for graphical simplicity.]
GNSS-RO Antenna Beam Earth Grazing Coverage Area

TRIG RO Antenna -3dB Beamwidth earth grazing coverage

Antenna Downtilt Angle
From Satellite velocity vector : 26.2°

Coverage Area > 200,000 sq km (red contour)

Antenna -3dB Beamwidth Coverage Area Contour
On-Orbit View of US Major Cities
Assessment Challenges

• Unknowns of interferer network deployment
  – User target basis
    • Broadband mobile, IoT, Public Service Utility, etc.
  – Mixture of macro-/micro-cells* in a given environment
    • Urban vs rural
    • City-by-city
  – Maximum EiRP per sector per channel

• Any combination of the unknowns may affect:
  – Antenna orientation
  – Antenna vertical down-tilt/up-tilt angles
  – Density of base-stations (urban vs rural)

* Macro-/micro-cell specifications defined in ITU-R M.2292
Next Steps

• Continuation of collaboration with DOT
  – Ensure succinct assumptions for base-station macro-/micro-cell specifications
• Methodology of analysis
  – Development of generic terrestrial network deployment scenario(s)
• Documentation of assumptions
• Modeling and simulation analysis
• Provide results to DOT within a timeframe correlated with DOT’s other use-case scenario assessments
POC Information

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