

Aviation Impacts from the Loss of GPS due to Space Weather Events

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Why is GPS important for aviation?

- GPS will allow more aircraft in our airspace:
 - Guarantee of a full operability will reduce en-route and terminal spacing
- GPS will reduce fuel burn and greenhouse gas emissions:
 - More direct, time-based routings
- GPS Timing – better precision operations
- GPS will enable safer operations due to position awareness:
 - Reduce runway incursions
 - Provides greater situational awareness
- NextGen is highly dependent on GPS!

NextGen –GPS dependency:

- Navigation – *GPS*
 - RNAV/RNP
 - GBAS/LAAS
 - SBAS/WAAS
 - Curved Path Approaches
- Surveillance – *GPS*
 - ADS-B
 - CDTI
- Surface Traffic Safety Applications - *GPS*
 - ASDE-X
 - RAAS
 - Surface Moving Map Display

Space Weather interference with GPS

- Radio interference
 - Travels at the speed of light, no advanced notice possible (rare events)
 - 6-10 minute GPS outage caused by solar radio interference on Dec. 13, 2006
- Ionospheric turbulence
 - Strong magnetic storms caused by Coronal Mass Ejection (CME)
 - Usually takes 20 hours to 3-4 days to reach earth
 - Can be forecast and planned for
 - Twenty-five hour degradation of WAAS caused by CME on Oct. 29-30, 2003

Effect of loss of GPS

- Aircraft have back-up navigation systems
 - Inertial Reference Units don't need radio signals to function
 - FAA working on Alternate PNT service to back-up GPS



Loss of GPS in a NextGen environment

- NextGen navigation and separation standards are based on quality of navigation service. Critical application by domain:
 - Terminal: Required Navigation Performance (RNP) approach
 - Enroute: Possible 3nm separation standard based on ADS-B
 - Oceanic: 30/30 separation standard based on ADS
- A sudden and unplanned loss of GPS will have the effect of aircraft suddenly not being capable of maintaining Actual Navigation Performance (ANP) or remaining in a reduced separation environment
 - Missed approach likely on an RNP approach
 - “Minor chaos” likely as ATC executes contingency procedures to reestablish traffic within larger separation standards
 - Minor reduction in safety until larger separations are achieved
 - Reroutes with delays and diversions likely

Conclusions

- NextGen initiatives must take into account potential GPS loss of signal for many reasons
 - FAA needs to continue to define and develop a NextGen Alternate PNT (APNT) service
- Improvements in space weather forecasting need to be pursued:
 - Advanced warning and a regionalized assessment of the impact of a CME event and it's effect on:
 - GPS
 - Other aviation safety systems

Thank You!

