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 its effect on:
    - GPS
    - Other aviation safety systems
Thank You!