Mitigation of Possible GPS Brownouts

Professor Bradford Parkinson
Chief Architect of GPS
Original GPS Program Manager
Stanford University
Department of Aeronautics and Astronautics

Background

- GPS now has over 50 Million Civil Users and up to 100,000 DOD users
  - Vital to infrastructure – especially FAA's NextGen
  - Essential to virtually every DOD Weapon System
- Current "Requirement" is for 24 sats, but level of service is 29 to 30
  - Independent review teams repeatedly advocated requirement be raised to 30
    - Defense Science Board, GPS Independent Review Team, PNT Advisory Board say 30
    - European and Chinese competitors both set at 30 Sats

GPS Brownouts -

Satellite numbers fall to less than current service

- Risk of Brownouts repeatedly pointed out by independent review teams
  - IIF Replacements greatly delayed
    - Congenital Defects due to bad procurement practices imposed on the Developers in late 90s
    - Design now quite old – many parts no longer available
  - IIIA now underway (finally)
    - Delayed by DOD for at least 3 years
    - Independent reviewers believe it is potentially a model procurement/development
    - Main impediment is multilayered approval process above the Program Office

GAO Report Omission

44 months Award-to-Launch Demonstrated by GPS I

- List of historic development times omitted the most significant one – GPS I (June 74 to Launch Feb 78)
  - Brand new design – no prototype
- Keys included:
  - Streamlined Approvals
  - Only one small change to contract
  - Integrated Product team – heavy USAF involvement at contractor

It can be done – goal was 36 months!

GPS Constellation Size

(Currently 31 sats – could be down to 24 or less in 2018)

- *Constraints* on Brown-out Mitigations
  - Only *current GPS* signals will help (Civ and Mil)
    - User equipment for new signals will not be fielded
  - Brand New Foreign Satellite Developments of no help
- *Options*– in order of value

1. Use **previously retired GPS satellites** still available
2. **Speed up GPS IIIA** (expedite milestone approvals)
3. Develop a **simplified GPS IIIA satellite (IIIS)** in parallel with IIIA (no extra payloads)

X. Restart /Extend IIF line (would be risky, expensive, and late)

•Desired: about 6 more Satellites by 2016 to help insure a constellation of 24 to 30

1. Reactivate Previously Retired GPS satellites still available (in operational orbits)

- Pros
  - USAF has already prepared for this (~5 sats available)
  - Procedures well established – low operational risk
  - More older satellites will probably qualify to do this
  - Option is virtually free
- Cons
  - Old satellites – will only give a few years each & ***will not completely resolve problem***
  - Will not activate non-GPS functions

2. Speed up GPS IIIA
(expedite milestone approvals)

- Pros
  - Already on contract
  - Design underway and going well
  - Includes new International signal
  - Almost ten times more military power
- Cons
  - Speedup constrained by funding and budgeting process
  - Earlier DoD level management impediments
    - Confusing chain of command
    - Many can say no – no one can say yes
    - Considerable unnecessary delay

3. Develop simplified GPS IIIA satellite (IIIS) in parallel with IIIA (no extra payloads)

- Pros
  - All essential boxes already at PDR for IIIA
  - Has modernized signals and additional power
  - Also would need streamlined decision making
  - Could be dual launch – savings about $75M/ sat
  - Could be accommodated with current contract
- Cons
  - Additional Payloads not included
  - Not budgeted
  - Strain on contractor and Program Office

X. Restart /Extend IIF line

- Pros
  - Already designed
- Cons
  - Design and Parts obsolete – must be redesigned
  - Still untried – may have further congenital defects
  - Lacks Powerful Military signal (Hostile Jammers have seven times more effective area with IIF signal than GPS IIIA)
  - Does not have new International Signal (L1C)
  - Probably would have to be recompeted (a “new” design)
  - Major near term budget hit – IIF is still overrunning

Conclusions

options can be done in parallel, where reasonable

- Option #1 (Reactivating retired satellites) should be continued and expanded where feasible
- Option #2 (speeding up IIIA schedule) should be encouraged and supported
- Option #3 (IIIA derived spartan satllite – IIIS) should be seriously explored and used if possible
- Option X is a non-start, IIF design is dead end – an old design against old requirements

Above all, the senior decision chain has to become a part of the solution with appropriate urgency
A risk mitigation plan is needed, using options 1, 2, and 3