Benefits of Using Multi-GNSS for Mobile/Cellular Platforms

Pros & Cons of Performance to the User and Market Access

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Agenda

- Brief history of GLONASS in cell phones
- Sample results of Multiconstellation impact
- Pros and Cons of Multi-GNSS

History: How did GLONASS become standard?

- GPS for E9-1-1 began appearing in cell phones in 2002
- Standards were developed to provide assistance data (A-GPS) to improve availability and accuracy
- Dominant phone supplier at the time (Nokia) started pushing for Assisted GLONASS support in standards as the higher orbital inclination angle provided improved coverage and geometry at high latitudes
- Uptake was initially low due to cost of additional RF and issues with GLONASS constellation reliability
- As the GLONASS constellation was replenished, RF costs dropped and performance improvements were clear
  - Primary tests implemented by handset manufacturers were urban canyon drive tests as this was key use case: replacing PNDs

Increasing Performance

Example of driving through central Seattle

= GPS = GNSS

- Every handset manufacturer had their favorite test drive
- Demanded fixes for every small deviation
- GLONASS helped immensely and allowed advanced receiver manufacturers to differentiate against cheaper suppliers
- More satellites also allows lower quality signals (low SNR or excessive multipath) to be excluded from position computation

"GPS vs. GNSS" Performance Statistics

Constellations In Use, versus cumulative percentage horizontal position accuracy		50%	67%	95%	99%
GPS (mixed environments)		5.75 m	8.75 m	35.25 m	63.75 m
GNSS (mixed environments)		5.75 m	7.75 m	23.25 m	34.25 m
GPS (dense urban environment)		11.75 m	18.25 m	49.25 m	88.75 m
GNSS (dense urban environment)		8.25 m	13.75 m	29.25 m	38.75 m

- Most dramatic benefit in "removing outliers"

Ubiquity of Multi-GNSS

- All Intel chipsets shipped since 2011 have included GLONASS as standard
  - Newest chipsets support all 4 constellations
- All handset customers REQUIRE GPS+GLONASS as a minimum
  - Trend is heading towards support for all 4 constellations
  - Difficult to meet urban canyon performance requirements on any single constellation
- Unlikely that MultiGNSS will ever be removed from hardware support
  - Always possible to disable in software
- Related issue around single constellation KPIs
  - Beidou only cold start

Interaction and Mitigation

- GPS/GLONASS designs for phone use a single antenna
  - Very wide bandwidth, very poor performance, but very small and cheap
    - Think bent paper clip
- RF selectivity achieved using external filters
  - Narrow is always better as UNITENTIONAL interference (e.g. backlight) is the biggest problem
- Further IF selectivity using on-chip digital filters
  - Helps with self jamming (cell phone transmitters) and noise issues
- False signals are much better handled when there are more GOOD signals
  - RAIM (Autonomous Receiver Integrity Monitoring)
    - Kalman Filters and Overdetermined solutions
  - Assistance data is nearly impossible to spoof

Pros and Cons

	Single Constellation	Multi-GNSS
Urban Canyon Performance	No longer sufficient	Required
TTFF	Significantly compromised	Optimal
Cost	Marginally lower (Less RF area)	In Baseline
Power	Marginally lower (dynamic management)	In Baseline
Size	Marginally smaller (fewer SAW filters)	

Conclusion

- Current plan is to continue supporting Multi-GNSS in all products
- Working to attempt to harmonize (minimize) global certifications
  - Single constellation KPI (key performance indicators)
  - Legal requirements for operational modes
- User experience is best when
  - Hardware is capable of using all satellites in the sky
  - Software decides optimal search/tracking strategies in real time
    - application and context dependent
  - Network connectivity provides assistance and integrity
- Maintain support to turn off constellations when requested
  - By user, network or other agency