



Multi GNSS Receiver Trends

Consumer Market

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Consumer Market Overview

- We divide the market into 3 main sectors
 - Handsets : anything with a modem
 - Automotive : In-dash and PND
 - Consumer : Computers, Cameras and other mobile electronics

	AUTO	HANDSET	CONSUMER
2009 Units	~60M	200M+	<4M
2010 TAM	150M+	~1.5B	500M+
2010 Units	~70M	300M+	>6M
Penetration	45%	20%	1%
Y on Y Growth	>15%	>50%	>60%

End User Platforms Drive Technology Requirements

- PND platform in early 2000
 - Fast start-up and robust urban canyon and foliage performance without benefit of additional sensors
 - SiRFstarIII architecture with 300K correlators and -152 dBm sensitivity enabled mass market acceptance
- E911 mandate in early 2000
 - Low power fast start-up and high sensitivity
 - SiRFstarII/III + AGPS and Qualcomm AGPS helped meet the mandate
- Navigation Services on handsets
 - Low power “Always On” capability
 - SiRFstarIV + -160dBm Sensitivity provided necessary user experience
- Broad range of Location Enabled Services on handsets
 - High availability/low accuracy for social networking
 - High availability/high accuracy for “Pinpoint Mobile Promotions”
 - Requires extension into indoor environments
- Collision Avoidance and “Self Driven Cars” in automotive
 - High availability sub-meter accuracy

Trends in Requirements

- For the past few years, the key performance requirement from customers was **SENSITIVITY**
 - Keyed by the development of AGPS techniques
 - Once you don't need data, signal processing takes over
 - Drove receiver architectures to accommodate large memories for long integration times at lower powers
 - SiRFstarII on 130nm, III on 90nm, IV on 65nm
 - New satellite signals (pilots) will continue to help
- The new upcoming performance requirement is now **AVAILABILITY**
 - Customers expect to receive location information anywhere, all the time
 - Additional GNSS systems are necessary, but not sufficient
 - GLONASS provides urban canyon improvement
 - Regional systems like QZSS provide clear improvement
 - They do not solve the indoor problem very well
 - Many applications require positioning where GNSS will never work
- Increasing availability will drive the continued penetration of GNSS into consumer products

Improving availability

- To improve availability, receiver architectures are moving to hybrid location methodologies
- Radio hybrids: Using signals of opportunity or dedicated infrastructure to augment GNSS
 - Platform level integration keeps incremental costs low
 - Reuse of existing radios
 - Cellular, WiFi, BT
 - Software integration of additional measurements
- Sensor hybrids: Bringing motion sensor technology into personal electronics
 - Proven on automotive platforms with fixed reference frames
 - Far more challenging in handheld environment
 - Advances in MEMS technology opening new doors
- Initial accuracy of solutions likely to be significantly worse than outdoor GNSS

Impact on GNSS architecture

- Very low cost GNSS receivers likely to remain L1 only
 - Driven by the need for large volumes of “good enough” location
 - Key factors are price, cost, size, power and price
- High performance location determination receivers moving to multi-frequency
 - Adding GLONASS bands provides immediate benefit
 - GLONASS requirements in Russia and in 3GPP
 - Radio hybrids require additional frequency support
 - 2.4 GHz worldwide band has strong attraction
 - Extension of Multiband RF/digital CMOS from WiFi/cellular
 - Multi-frequency is more immune to jamming
- Dual-band moderate bandwidth (6MHz) front ends will become the norm
 - L1 will always be the anchor with a second tunable radio for hybrid
 - Silicon can handle the tunability
 - Software can handle the flexible coding schemes
 - Antenna and filter will be the main hurdle at product level

Future architectures

- With SENSITIVITY at maximum and AVAILABILITY at 100%, market focus will shift to ACCURACY
 - Probably 3-5 years out
 - Desire for 1-3m in all conditions will grow
 - GNSS architectures will become multi-band, wide bandwidth for maximum performance

Summary

- Today's L1 only receivers will continue to gain market share but mostly at the low end
- Focus for next 1-3 years is on creating platforms that provide location everywhere
 - Hardware and software integration of all available information
 - Receivers will support more than one relatively narrow frequency bands and one of them will always be L1
- Future will see highly flexible, wide bandwidth GNSS receivers for maximum accuracy