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

<table>
<thead>
<tr>
<th></th>
<th>AUTO</th>
<th>HANDSET</th>
<th>CONSUMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 Units</td>
<td>~60M</td>
<td>200M+</td>
<td>&lt;4M</td>
</tr>
<tr>
<td>2010 TAM</td>
<td>150M+</td>
<td>~1.5B</td>
<td>500M+</td>
</tr>
<tr>
<td>2010 Units</td>
<td>~70M</td>
<td>300M+</td>
<td>&gt;6M</td>
</tr>
<tr>
<td>Penetration</td>
<td>45%</td>
<td>20%</td>
<td>1%</td>
</tr>
<tr>
<td>Y on Y Growth</td>
<td>&gt;15%</td>
<td>&gt;50%</td>
<td>&gt;60%</td>
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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
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
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
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.