High-accuracy positioning for the mass market

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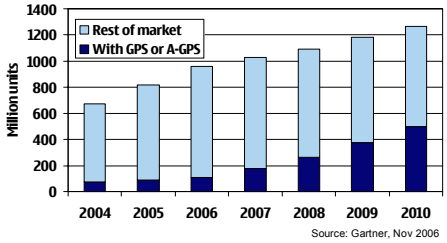
Introduction and market background

- Mass-market for GPS devices currently dominated by unconnected navigation devices
  - Standalone positioning
  - No access to assisting information improving accuracy and availability
- Handsets having Assisted GPS (AGPS) with an access to assistance information becoming more commonplace
- Michael Halbherr (Vice President, Nokia Location Based Services):
  - Nokia will sell 35M AGPS-enabled handsets in 2008
  - Up to 50% of Nokia's handsets could be equipped with AGPS in 2010 to 2012



Source: Gartner, Nov 2006

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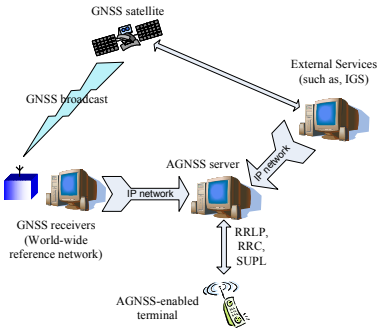
AGNSS (Assisted GNSS) architecture

- AGNSS server either in
  - Public internet
  - Cellular network
- Server distributes data originating from
  - GNSS receivers
  - External services (extended ephemeredes etc.)
- Methods of distribution
  - Control channel of the cellular network
  - User plane (IP-network)
- Examples of assistance elements
  - Ephemeredes
  - Ionosphere model
  - Reference location and time
- AGNSS standardized in 3GPP, 3GPP2 and OMA
- **The architecture opens the way for advanced assistance data and positioning methods**



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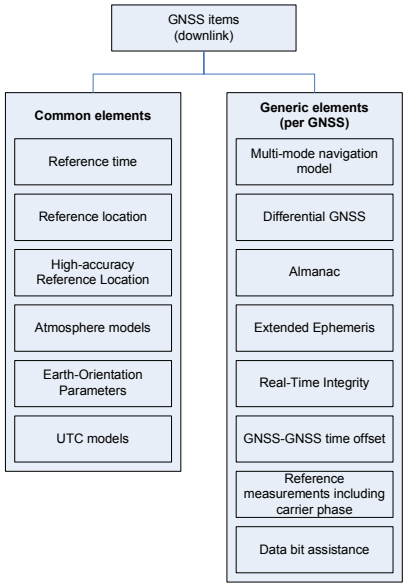
Assisted GNSS evolution

oma Open Mobile Alliance

- Current standards include basic assistance data including broadcast ephemeredes for GPS and Galileo
- Work towards more advanced assistance standards commencing in Open Mobile Alliance
- Single, unique interface for providing handsets with assistance information over IP-networks

- Common Elements are GNSS-independent
  - Reference Location, Atmosphere models
- Generic Elements are GNSS and/or Signal-dependent
  - Navigation models, Differential GNSS



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Improvements to conventional GNSS positioning

- Assisted GNSS techniques can improve user experience in terms of speed of position fix and accuracy
- Assisted GNSS obtains position fix typically in 10-20 seconds
  - Reference location, accurate time and navigation models contribute
- High-accuracy navigation model can improve accuracy by several meters. The same can be achieved by DGNSS.
- Assistance may include troposphere delays obtained either from a reference receiver network or weather forecasts
- Ionosphere models (regional maps etc) have the greatest impact
- Extended Ephemeris refers to giving handset navigation models several days ahead – potential user experience improvement due not needing to connect to the assistance server
- Real-Time Kinematics and Precise Point Positioning

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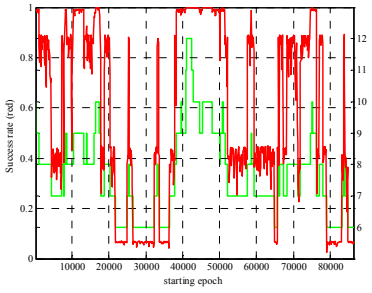
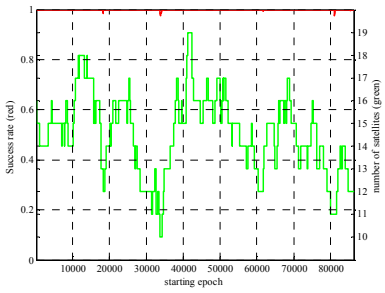
Real-Time Kinematics in mobile landscape

- Proposed standards enable high-accuracy relative positioning in two manners: between two handsets **OR** between a handset and an assistance server
- Bulk of handsets will remain in L1 band for years to come due to high delta cost of dual-frequency receiver – challenge for ambiguity resolution
- Introduction of GLONASS and Galileo in the L1 (E1) band will improve the situation



Galileo E1



GPS L1 + Galileo E1

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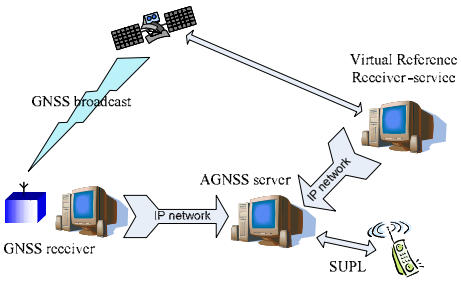
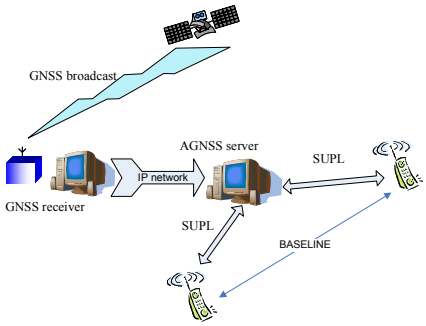
mobile-RTK : Two options



- Assistance data server has an interface to regional Virtual Reference Receiver - service



- Assistance data server works as a router
  - Establishes data connection between the two terminals

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mobile-RTK : Key points

- Carrier Phase measurements readily available in AGNSS handsets
  - Not utilized to full extent yet
- AGNSS is the key enabler
  - Protocols, assistance and infrastructure are already there – data exchange relatively easy to implement on top of the existing items
  - Multiple receivers may also be used (network-approach)
  - Virtual Reference Receiver –services play a major role
- No surveying grade requirements – float solution is already an improvement
- Technology, algorithms etc are there
  - AGNSS provides the way to the mass market applications

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mobile-RTK : Use cases

- Accurate navigation
  - Parking
  - Lane guidance
- Friend finder
- Games
  - Geo-caching

- Low-cost solution : possibility to extend professional use cases

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Precise Point Positioning in mobile landscape

- The next generation assistance standards will include various items required in PPP
  - Real-time ionosphere and troposphere maps, Earth-Orientation Parameters, precise orbits and clocks...
- Goal: PPP-light
  - Use precise orbit predictions, ionospheric maps
    - →These provide the greatest performance improvements in the short term

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Conclusions

- Market for AGNSS terminals growing fast
- AGNSS is a very powerful technology in terms of user experience improvement
- Architecture also enables providing terminals with highly advanced assistance data
- The current work in the standardization fora (mainly OMA) aims at gradually bringing the tools currently in professional use to wider audience
  - Enabling new LBS

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Thank you!

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