RTT TECHNOLOGY TOPIC
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Positioning

In our last Hot Topic (Packet Shaping/Traffic Shaping Protocols Part 2), we highlighted the value of time domain dependency - milliseconds, microseconds, nanoseconds, picoseconds - pico second accuracy costs more in terms of power budget and clock accuracy overhead then millisecond accuracy and (generally) is worth more - the time/value margin metric.

A similar metric applies to positioning - millimeter accuracy is worth more than centimetre accuracy is worth more than metre accuracy is worth more than kilometre accuracy.

There are eight prime location standards competing for the positioning market.

The least accurate lowest cost is cell ID. The network knows which cell your are being served from and therefore knows your approximate position. Cell ID can actually be very accurate, for example in a picocell environment it can pinpoint a user to within a few metres. However it lacks consistency - its accuracy depends on whether the user is served by a picocell, microcell or macrocell. Given that perceived quality is as much about consistency as absolute performance, cell ID scores low in terms of (a consistent) user experience.

Next is Time Difference Of Arrival. Here, location is judged by the signal strength measurement and synchronisation off-sets received by three base stations from the target mobile. TDOA requires a network upgrade but no changes to the handset and delivers fix accuracy of between 300 and 1100 metres. Commercial examples include Cell Loc and True Position.

Next is Time Difference Of Arrival/Angle of Arrival. Here, accuracy is increased by the addition of phase array antennas at the base station to give 40 to 400 metre accuracy - no change to the handsets, but additional base station complexity and cost - commercial examples include the Sigma One/Plextek proposition.

Next is Enhanced Observed Time Difference - EOTD relies on the relative time of arrival of base station signals at the **handset** and at specific location measurement points. Accuracy is 40 to 400 metres, but with the disadvantage of needing a handset software/hardware upgrade - commercial examples include Cambridge Positioning Systems.

Other options include existing and future satellite based systems. GPS provides accuracy of 5 to 100 metres (better in rural areas, less good in urban), with a second generation constellation with better positioning planned for 2008. Commercial products using GPS include SiRF, Trimble, Conexant, Parthus and Garmin. The Russian Glonass system (same accuracy but 21 rather than 24 satellites and slightly better European coverage) provides a presently available alternative and in the longer term (by 2008) there will be the additional possibility of a European system, Galileo.

Satellite based location/positioning systems have to be compared on the basis of accuracy, reliability (how often the signal is usable, the interoperabality with other systems), latency (time to fix - not a GPS strong point), and directional capability (can the system tell where the user is headed and how fast - an ability of all systems except Cell ID).

For more details see the recent Shosteck Report on Location and Positioning systems (www.shosteck.com).

To overcome the limitations of satellite based systems, a number of hybrid assisted GPS solutions have been proposed, the most commercial of which is the Qualcomm/Snaptrack system (10 - 20 metre accuracy in rural **and** urban conditions).

Practical hybrid products emerging include Benefon's GPS Cellphone and the Garmin GPS/Aircell product (usable in airplanes!).

GPS receivers have some commonality with wideband CDMA/IMT2000. The 50 bit per second data rate (almanac and ephemeric information) is modulated with a PR code unique to each satellite at 1.023 Mchips per second. Received signal energy is typically -130 dBm spread over a 2 MHz bandwidth with most of the signal energy concentrated in the centre 1 MHz. The received signal is 16 to 18 dB below the noise floor, very similar to W-CDMA. This provides some interesting correlation commonalities and has resulted in some hybrid GPS/IMT2000DS receiver designs being propositioned to the European 3G design community. However, although the signal to noise ratios are similar, the received signal levels for GPS are much lower (typically 70 nano volts versus 1 microvolt for IMT2000, ie 143 times smaller).

This demands significant design attention if GPS and IMT2000DS signals are to be received simultaneously in the presence of IMT2000 transmit energy. An alternative is to suppress IMT2000 transmission but this in turn places a premium on GPS acquisition performance (usually achieved by using off chip FPGA hardware accelerators).

Initial practical hybrid designs may not match initial user expectations but in the longer term, positioning/location functionality, integrated 'for free' into an IMT2000DS/IMT2000MC handset should offer a seductive proposition for realising position/location based added value.

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RTT, the Shosteck Group and The Mobile World are presently working on a number of research and forecasting projects in the cellular, two way radio, satellite and broadcasting industry.

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