

The Promising Marriage of Wireless and GPS Technologies

**Convergence leads to new breed of
location based services**

white paper by:

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Executive Summary

As both mobile service providers and GPS device manufacturers struggle to find new profitable services to offer their customers, the convergence of GSM and GPS technologies is starting to bear fruit. By equipping global positioning terminals with a parallel wireless back-channel, a whole new realm of application possibilities emerge that would have been impossible with either technology alone. This whitepaper describes some recent deployments of converged wireless/GPS applications, and gives a hint as to what exciting possibilities lie in the near future.

The Promising Marriage of Wireless and GPS Technologies

We stand at an interesting crossroads in the telecommunications industry. Service Providers are experiencing continued commoditization of their bread-and-butter fixed and mobile voice and Internet services. At the same time, they are under attack from cable operators who have broadband access directly into most households, while disruptive online providers such as Skype, Google Talk and Yahoo/MS messenger are providing VoIP and video services practically for free. This trend in the telecoms industry is really proving the old saying that "Talk is cheap".

In a parallel industry, the Global Positioning sector, a similar search for revenues is taking place. While GPS has become a mature and globally adopted technology, makers of consumer positioning devices are seeing their revenues stagnate as the market for personal and automotive navigation saturates. The problem is that beyond helping consumers find their way from point A to point B, today's GPS industry is still looking for a way to provide compelling mass-market consumer services.



Taipei e-bus web portal:
enabled by GPS/GPRS
combination

While Service Providers are searching for the next generation of profitable revenue, the answer may be right under their feet: new billable location based services based on the convergence of wireless and GPS technologies. The resulting services are new and attractive, and can provide new revenue streams for service providers ...so long as a few technical hurdles are overcome and an ecosystem involving service providers, content providers and consumers is established.

Early Adopters: Fleet Management

The convergence of Wireless communications and GPS has already produced fruit at a very practical level: the converged technologies enable devices, vehicles and machines to determine their physical location and transmit the information anywhere in the world.

Fleet management is a good example of how quickly a converged GSM/GPS application has spread across the world. One recent example is the [Taipei e-bus system](#) where Taiwan-based e-platform specialist and u-blox fleet-management solution partner [Advantech](#) has deployed a fleet management system that keeps track of the exact location of over 4000 buses on 300 routes in the Taipei metropolitan area (www.e-bus.taipei.gov.tw). The solution is based on the u-blox [LEA-5S GPS receiver module](#) combined with GSM connectivity to providing real time information to riders via the Internet or fixed-line and mobile phones including bus position and arrival time.

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Additional services such as accident logging and anti-vandalism video surveillance can report exact details about when and where an incident occurred, who was involved, and automatically summon assistance.



*Location Based Technologies'
PocketFinder based on u-blox'
software GPS + GSM solution*

Personal Locators

Consumer applications combining GSM and GPS have also started to appear on the market. A recent example is [Location Based Technologies](#), an Anaheim, California-based company that markets real-time, pocket sized locators named "Pocketfinder" and "Petfinder" for tracking of humans and pets (www.pocketfinder.com). The technology behind the Pocketfinder is based on u-blox' unique software assisted-GPS solution "Capture & Process" to enable low-power GPS operation (7-day battery life) together with GSM/GPRS connectivity to provide real-time tracking of the devices anywhere in the world there is mobile phone coverage. You can see where the devices are in real-time by viewing a simple Internet "dashboard". The palm-sized devices can not only report where your children and pets are on-demand, but even how fast your teenagers are driving your car (velocity information is also available via GPS!).

The business model for telcos for these types of consumer devices is very similar to traditional mobile phone services – they can bill for:

- Individual location "lookups" (pay-per-use)
- Flat rate (as many lookups as you want)
- Pre-paid (pay-in-advance for specific number of lookups)
- Areas covered (similar to local vs. roaming billing)
- Location-based alerts (e.g. warn me when my dog has escaped the backyard, also called "Geofencing")

The cost of the devices, currently below 130 US dollars, can easily be subsidized or even offered for free along with the locator service bundling.

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McMurdo's FastFind Personal Location Beacon



The European eCall system for automated accident assistance is planned for deployment across the EU by 2014



Location-based services will soon be a standard option on portable devices

Emergency Services

GPS converged with other wireless networks such as Satellite enables high-end emergency locator services that can operate in remote locations. These devices have the ability to transmit emergency information combined with a user's location at the touch of a button and send an emergency text message, regardless of mobile phone coverage.

One recent example of such an emergency application is UK-based McMurdo (www.mcmurdo.co.uk) who have recently launched a handheld emergency location beacon they call "FastFind Personal Location Beacon" based on the u-blox' [LEA-5A GPS receiver module](#) that can transmit location data to anyone from virtually anywhere in the world via the global COSPAS SARSAT 406MHz search and rescue satellite communication system. This satellite locator solution operates virtually anywhere in the world, and satellite service providers can charge a premium for the service.

Another initiative to combine GSM and GPS for vehicle emergency services is [eCall](#), a project by the European Commission to provide rapid assistance to motorists involved in a collision anywhere in the European Union. The service, which is planned for implementation in 2014, is backed by numerous car, truck and bus manufacturers and the [European Automobile Manufacturers Association \(ACEA\)](#). The system will monitor in-vehicle sensors for such events as airbag deployment to automatically transmit location details and summon assistance via GSM. Such a system has further applicability such as logging of vehicle location and velocity information (via GPS log) just before and after an accident for liability and insurance purposes.

Location-Based Services for Portable Devices

Converged Wireless/GPS services are already being made available on mobile phones, Netbooks and personal navigation devices, and location-awareness capability is even being built into Microsoft's upcoming Windows 7 operating system through a specially developed "[Sensor and Location Platform](#)" launched on October 22, 2009 and supported by u-blox. With a wireless Internet connection and large display, these devices can provide interesting services relevant to one's location such as:

- **What services are available around me?** (i.e. shopping, restaurants, ATMs, public transportation, tourist information, police), including:
 - o How do I get there? Turn by turn directions for vehicles and pedestrians.
 - o Photos, menus, and advertising of special offers or sales ("hungry? Stop by Gino's pizzeria for a 2-for one pizza special... only 50 meters to your left!").
- **Who is around me?**
 - o Are any of my friends or family nearby? How do I find them?
 - o New social-networking services such as "Proximity Dating": the ability for a handheld device to alert the user of a nearby "date" who matches a pre-programmed profile ("30 year old male looking for 25-35 year old woman, non-smoker, interested in classical music, hiking, and photography, please contact me if you are interested, I am 200 meters away.").

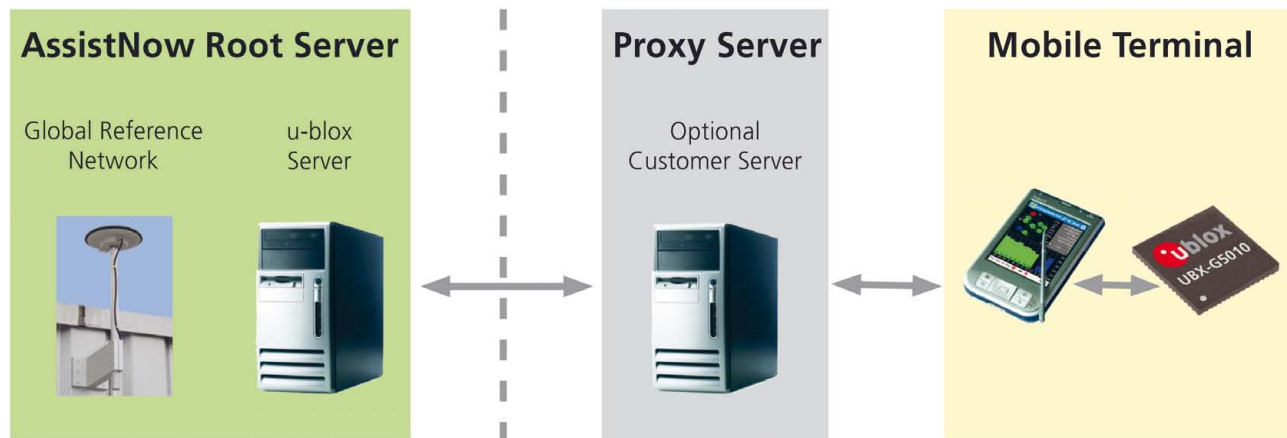
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Location-based services such as these can easily be supported via various service-provider business models: subscription, pre-paid, per-fix, content-hosting, proximity (100 meter radius, 500 meter radius, etc), zone-based (i.e. local, regional, national), user-specified alerts, and intelligent advertising services that push location-relevant ads to end-users.

With a little ingenuity, the location-based content that supports the service can be user-generated: information and photos about points of interest and services can be entered into the device by thousands of end-users, as well as by business /service owners, and uploaded to an online service such as Google Earth. End-users can even be incentivized via service "bonus points" in exchange for entering new content.

Accelerating position fix via Wireless Assistance Data

A disadvantage of current GPS technology, as anyone with a car navigation system knows very well, is the 30 second to several minute wait when first turning on the system (known as "cold start"). The delay is influenced by many factors including obstructions such as buildings, foliage or snow covered antenna which all block or reflect satellite GPS signals, but is primarily a symptom of the baud rate of the GPS signals themselves: only 50 bits per second, with a complete 1500-bit frame (or "page") containing satellite positional data requiring a full 30 seconds to be received. Add to that the requirement to read frames from 4 different satellites to obtain a fix, as well as to determine which 4 of the total of 30+ GPS satellites are even visible to begin with, and the challenges of obtaining a near-instantaneous position fix during cold-start conditions are impossible to overcome based on GPS receiver technology alone.



u-blox' AssistNow A-GPS solution capitalizes on wireless connectivity to accelerate positioning

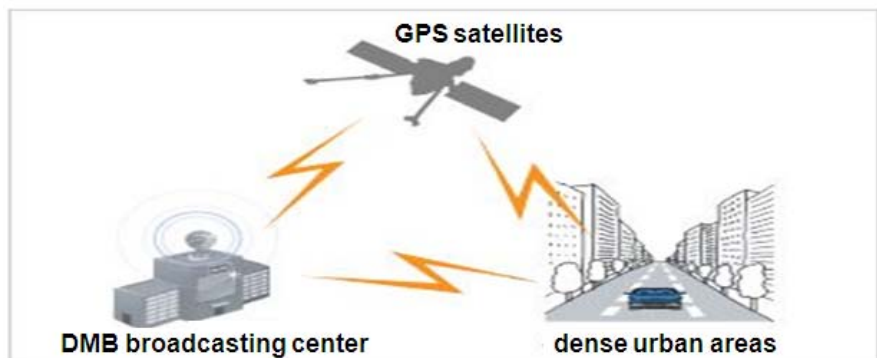
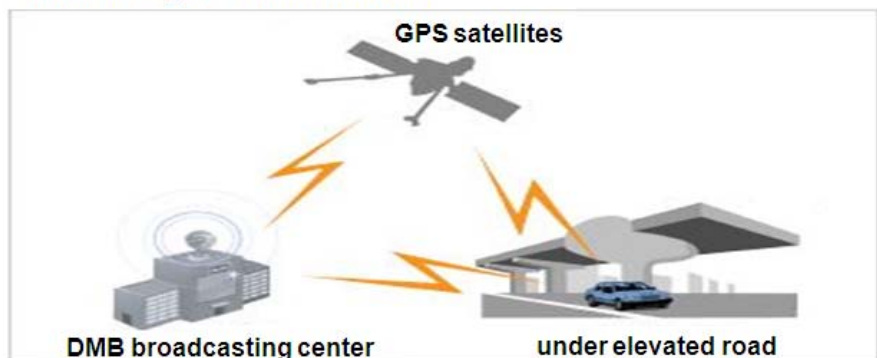
This is where wireless services such as GSM/GPRS or digital terrestrial broadcast services play an important role. By providing a parallel wireless communications channel with access to GPS assistance data, the question of "which satellites are visible and where are they?" can be answered instantly via wireless link and quickly provided to the GPS receiver.

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Indeed, services such as u-blox' "AssistNow" assisted GPS service (A-GPS) provide precisely this functionality: a global network of satellite tracking stations keep a central server updated with positional information of all GPS satellites in orbit. So, instead of a GPS receiver trying to determine satellite positions on its own via very slow satellite signals, the data can be quickly accessed via wireless link. Given that the distance from the GPS receiver to the GPS satellites can be instantly calculated by the receiver via delay measurement of each satellite's unique pseudo-random spreading code (called "Gold Codes") used in the spread-spectrum modulation technique, with A-GPS a position fix can be reduced to seconds even under cold-start conditions.

Assisted GPS systems such as these can operate in online mode where (wireless) network connectivity is required in real-time, or in offline mode where correctional data to satellite positions is downloaded to the GPS device in advance and used for a period up to 2 weeks later to extrapolate satellite positions while offline.

Accelerating GPS with TurboGPS



Fine Digital's DMB Broadcast Server delivers GPS aiding data throughout South Korea

An example of this technology in use can be illustrated by the recent launch of "TurboGPS" assisted-GPS service covering South Korea. Using South Korea's Terrestrial Digital Multimedia Broadcasting (T-DMB) network, a wireless technology operating on radio frequency band III (VHF) and L (UHF), datacasting service carrying GPS aiding data is provided to portable devices in addition to digital terrestrial TV and radio. u-blox' AssistNow service is thus made available to GPS devices throughout the country. The service is a result of a partnership between u-blox and FINEDIGITAL Inc., a leading Korean vendor of telecommunications, networking and GPS products and systems. The service significantly reduces the time required for portable GPS devices to establish a position fix, typically less than 15 seconds, even in dense urban environments such as Seoul.

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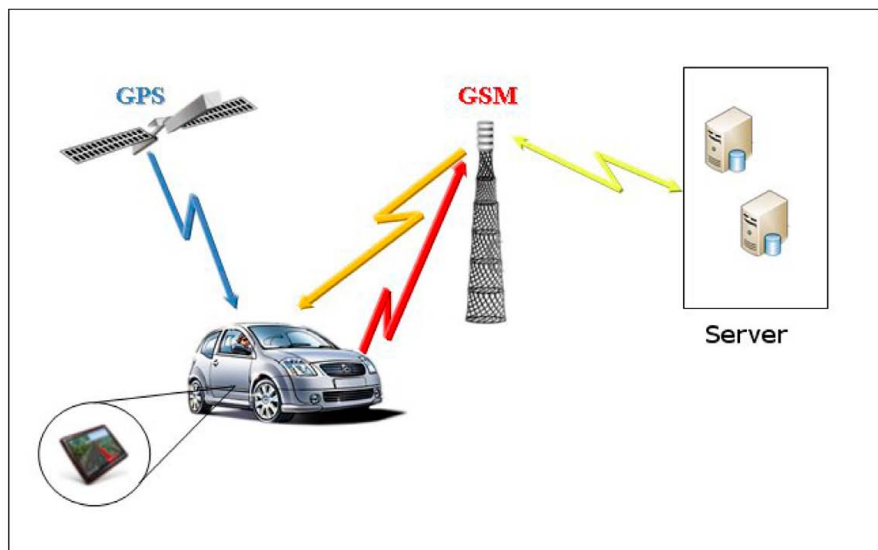
Road Pricing Applications

A new opportunity for converged GPS/GSM applications has appeared with the news that the European Commission has made a decision in October 2009 to establish the essential technical specifications and requirements to launch a European Electronic Toll Service (EETS) which will enable road users to easily pay tolls throughout the whole European Union (EU) based on road usage.

The subscription-based service makes use of an onboard box containing both GPS and GSM technologies that communicate road usage information to a service provider for billing purposes. EETS is planned to be available on all infrastructures in the entire European Community such as motorways, tunnels and bridges where toll can be paid using on-board equipment.

The aim of EETS is to reduce cash transactions at toll stations, thereby improving traffic flow and reducing congestion. European Commission Vice-President Antonio Tajani, Vice-President for EU transport policy, considers this decision to be the most important improvement for drivers in Europe since the abolition of EU border controls.

EETS will be available within three years for all road vehicles above 3.5 tons or for vehicles allowed to carry more than nine passengers (including the driver). The service will be available for all other vehicles within five years.



GPS/GSM technology used for road-pricing

GSM/GPS applications are becoming increasingly popular because the infrastructure that is required to support the devices is easy to implement. Apart from the terminal device, companies that would like to participate in this market have only to put a server in place for collecting the information sent from the devices. There is no need to build up a new network infrastructure because the devices use existing GSM worldwide networks in combination with globally available GPS satellite signals.

In the case of applications for fleet-management and personal tracking, devices send only a very small amount of data (typically just latitude/longitude) through the GSM network to the server, where the information is processed and graphically shown on a map so that users can see where the device is located.

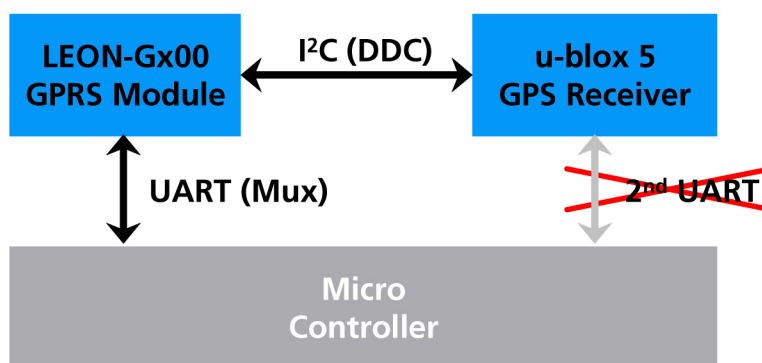
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For PND's and devices for electronic toll collection, the amount of exchanged information can be larger; devices can exchange information on traffic jams, accidents, road closures and also information on services that are on the planned route. In the case of the electronic toll collection, the device has only to calculate distances (using GPS) and invoice the motorist via the GSM network.

For the electronic toll collection application, in particular, a very important function for the GPS system to implement is "dead reckoning", the ability of the system to extrapolate vehicle position in tunnels based on last known position together with wheel speed sensors or gyroscope/odometer readings. A [dead reckoning solution](#) for both methods is available with u-blox' [LEA-4R](#) GPS receiver module and [UBX-G5010](#) automotive GPS receiver chip.

u-blox' GSM/GPS solution

Because of the exciting and numerous applications for converged GSM/GPS technology running on portable devices, u-blox has implemented special features in its new family of GSM/GPRS modem modules [LEON](#) to ease the design effort required for the integration of GSM with GPS.

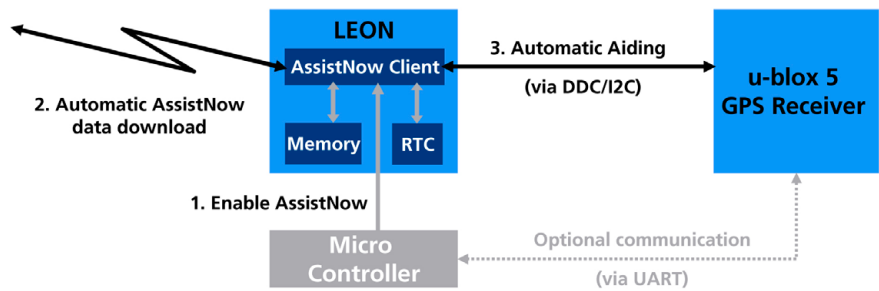


Combining a LEON GSM/GPRS module with a u-blox GPS receiver allows you to have full access to the GPS directly via LEON. LEON relays the control messages to the GPS receiver via a simple 2-wire I²C interface. This means you don't need a 2nd interface, because you can fully control the GPS receiver through AT commands via the GSM modem.

Even power management of the GPS receiver as well as UBX and NMEA messages are routed through LEON. The result is simple and cost effective GSM/GPS integration, making optimal use of PCB space.

Another key advantage of the u-blox GSM/GPS solution is that LEON contains an embedded AssistNow client supporting both online and offline Assisted GPS (refer to pages 7–8 of this paper, "**Accelerating position fix via Wireless Assistance Data**").

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The combined u-blox GSM/GPS solution with AssistNow client results in:

- Better GPS performance in weak GPS signal environments
- Faster Time-to-First-Fix (seconds, not minutes)
- No resources required from the application’s microcontroller
- No software integration effort on microcontroller required.



u-blox’ C16 GSM/GPS reference design

GSM/GPS Reference design

To help OEM developers of converged GSM/GPS applications to evaluate and design new telematics terminals, u-blox has prepared a reference design which combines both wireless and GPS technologies.

The [C16 GSM/GPS reference design](#) is an SMD solution that incorporates LEON GSM/GPRS and NEO GPS receiver modules with Taoglas SMD antennas and all passives. A pre-activated SIM chip with telephone number and M2M control/provisioning platform with mobile service provider subscription is also available.

The off-the-shelf design is a complete end-to-end reference design for developers of M2M applications such as fleet management, asset tracking, navigation, road pricing, and even security/surveillance systems.

Conclusion

The marriage of wireless technologies such as GSM with GPS has an exciting future, enabling new and compelling mass-market services for businesses, shopping, tourism, public and private transportation, social networking and entertainment, as well as for logistics, fleet management and emergency services.

Most importantly, these converged services offer clear value propositions and revenue models to allow all players in the ecosystem, end-users, device and end-product manufacturers and service providers, to benefit.

About the Authors



Carl Fenger

Carl Fenger

Carl has 25 years of international experience working in the semiconductor, software, telecoms, and GPS industries based in the USA and Switzerland. Carl is a published author of numerous technical articles and conference papers in the areas of embedded computing, telecom services billing, and broadband multimedia distribution. Carl holds a Bachelors of Science degree in Electrical and Computer Engineering from the University of California. Carl is a classical pianist and avid chess player.



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Tomaz Petaros

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About u-blox

u-blox is a leading fabless semiconductor provider of embedded positioning and wireless communication solutions for the consumer, industrial and automotive markets. Our solutions enable people, devices, vehicles and machines to locate their exact position and wirelessly communicate via voice, text or video.

With a broad portfolio of GPS modules, cards, chips, and software solutions together with wireless modules and solutions, u-blox is uniquely positioned to enable OEMs to develop innovative solutions quickly and cost-effectively. Headquartered in Switzerland and with global presence in Europe, Asia and the Americas, u-blox employs 180 people. Founded in 1997, u-blox is listed on the SIX Swiss Exchange.

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