WHITEPAPER

locate, communicate, accelerate

The rise and challenges of M2M applications

12 practical considerations for connected designs

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Executive Summary

2013 could be the year when machine-to-machine (M2M) communications exceed human-to-human communications for the first time in history, with even more machines connected to the Internet than people. Equipping devices with M2M communications has special requirements, however, depending on the application. It is important to consider these features when thinking not only of the initial design, but also about product longevity - how long the device should operate before needing replacement, geographical coverage, and compatibility with wireless network upgrades, 2G to 3G to 4G.

This article discusses 12 specific issues that should be considered when designing devices for M2M applications.

The year of the connected machines

Considering the ease of wirelessly connecting to the Internet, the decreasing price of connection, and the increasing speed and data gathering capabilities of even the most modest, mass-produced computing devices, it is no surprise that conversations between machines will soon exceed conversations between humans.

This is occurring at the same time that we are running out of IP addresses. IP version 4 addresses, all 4 billion+ of them, have now been allocated. Does this mean machines have missed the party? No, because the future of the Internet relies on IP version 6, which supports 2 to the power of 128 addresses, more than enough for every grain of sand on Earth to have its very own address. It is thus no surprise that LTE, the fourth generation of mobile networks (4G), is designed to deliver services such as data, voice, and video all over IP version 6.

The motivation for this networking revolution is simple – all devices and applications that can profit from being connected to the Internet eventually will be connected. It is the reason that our phones, notebooks, tablets, cars and gaming devices have all acquired networking capabilities. Although these are the most visible applications of mobile connectivity, humans aren't the only ones using the internet. It is the invisible applications that are growing the fastest…the silent conversations between millions of machines exchanging data 24 hours a day, 7 days a week, with no human intervention.

All that's needed to join the network is to embed any device with a small, low-cost (wireless) modem. Applications reporting on location, speed or navigation information, also require a GPS or GNSS (Global Navigation Satellite System) receiver. Both components, with an antenna, can fit easily in a device much smaller than a mobile phone.

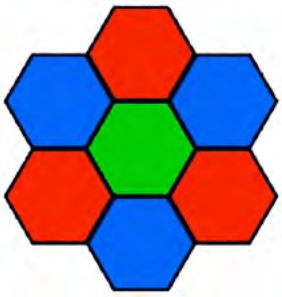
This is happening across all sectors of the electronics industry at this very moment.

Equipping devices with M2M communications capability, however, has special requirements, depending on the application. It is important to consider these requirements when thinking not only of the initial design, but also about product longevity (how long the device should operate before needing replacement), geographical coverage (it was initially designed to work in only one region, but now needs to work in another one), or compatibility with unavoidable wireless network upgrades, 2G to 3G to 4G.

Below are some important technical features to consider when designing M2M applications, and how they can affect the design of specific types of devices.

1) **Power consumption**
For portable tracking, security or personal safety devices, time between battery charging is one of the most important features. For example, a container-mounted tracking device that has to recharge once a day is too frequent, as a typical trip could take several days by air or road, and up to several weeks if shipped by sea.

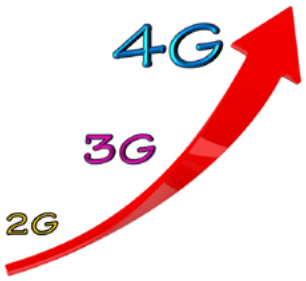
For consumer devices such as personal tracking or health monitoring devices, mobile phones have set the standard for expectations – battery life should last a minimum of 3 days. When comparing modem and GNSS receiver specifications of such applications, not only operating and standby current consumption are relevant, but also power saving modes such as auto-wakeup features and intelligent power-saving modes such as the ability to log data autonomously without waking up the host processor. Ideally these components should be in a minimum-power mode most of the time, waking up only when absolutely necessary.



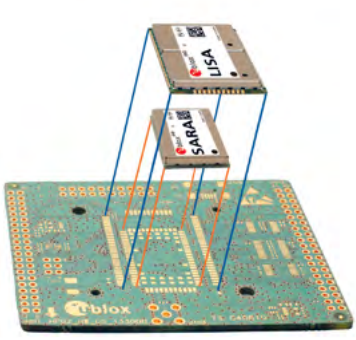
2) **Cellular network compliance**
In which regions should the device work? With global mobility increasing for both people and goods, it is important to consider that a modem that works in one region, may not work in another (GSM is supported by 2 main frequency bands worldwide, UMTS by 6 and LTE over 30.) For these types of applications it is important to identify where the device should work geographically, and to anticipate that this area could expand in the future. When you have identified this requirement, choose the wireless modem best suited to the task.

For example, a resource management system that must monitor shipments in all regions of the world should have either a quad-band GSM modem, or 6-band UMTS modem. For a device that you don't expect to move, for example a residential electricity meter, only a single frequency band is necessary. Other applications may need some additional consideration. For example, a vending machine whose location is often forgotten, can always "phone-home", but it must then be equipped with a modem that operates in regions where it is, or could be located.

3) **Operator approval**
Any wireless device that communicates via GSM, UMTS or LTE will require operator certification before it is allowed to access their network. To significantly ease the certification process, the modem embedded in the device should also be operator certified. Check the list of modem certifications against the regions where the tracking device should operate, and select your modem accordingly. Most modem venders provide a list of operator-certifications on their websites.

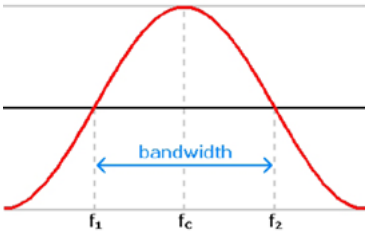


4) **Wireless modem upgradeability**
Although it is tempting to rely on GSM/GPRS for remote metering applications where only small amounts of data are communicated, the frequency bands for GSM are already being considered for re-allocation to 3G and 4G services. In the case of Automatic Meter Reading systems, retro-fitting hundreds of thousands of remote utility meters is expensive. It may therefore be wise to design with the technology of the future in mind. This means either already designing with UMTS/HSPA or LTE modems, or at least future-proof your hardware design such that modem upgrade is as cost-effective as possible. This leads to the next point…



5) **Nested modem design**
Your M2M device today may need to adapt to a new mobile or GNSS standard tomorrow, or address a new customer demand coming from a region that uses a different frequency band or satellite receiver standard. Ideally, you can react to this market requirement by simply updating the firmware, antenna and modem or GNSS receiver of your existing design. In reality, this is a nightmare unless nested design is an inherent property of your vendor's products. In particular, PCB layout issues can generate a long list of expensive design and logistics problems.

The best way to avoid this issue is simply to use components that have layout compatibility across the entire range of wireless modem (GSM, UMTS, CDMA and LTE) modules or GNSS receiver (GPS, GLONASS, Galileo, and BeiDou) modules. With this solution, a single PCB layout can be designed for use by all end-product variations. This issue can be addressed with these questions: Does your component vendor support a nested design philosophy? Does their next generation modem fit comfortably on the same PCB footprint of their current modem product? Do they provide documented technical support to help you make a successful nested design?

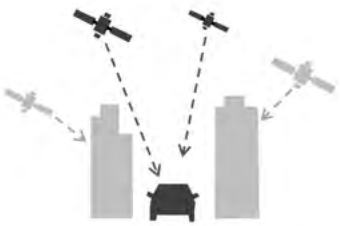


6) **Bandwidth requirements**
For many of today's tracking applications, only a low bandwidth connection is required to support tracking and text messaging. If only data is needed,then simple GPRS is sufficient. If a voice-channel option is required, then at least GSM/GPRS. If a video stream to support visual surveillance is desired, then UMTS/HSPA is the better choice. For applications requiring high-definition video with minimal latency such as telehealth terminals, LTE will be the technology of choice. One thing that is certain is that the tracking applications of tomorrow will always require increasing bandwidth. Select your modem based not only on the requirements of today, but also 3-5 years from now, or make a selection where modem upgradeability comes with minimal costs (refer to nested design above).

7) **Automotive requirements**
Especially for vehicle mounted systems where temperature, humidity and vibration conditions can be extreme, look for components that are automotive qualified, conforming to AEC-Q100 and manufactured in ISO/TS 16949 certified sites. Qualification tests for each component should conform to the ISO16750 standard: "Road vehicles – Environmental conditions and testing for electrical and electronic equipment". This is important not only for vehicle mounted devices, but also for industrial devices that must operate outside, in ships or railcars.

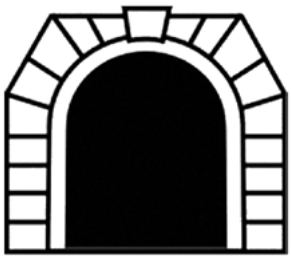
8) **Support of emergency call systems**
There is a global trend to equip new cars with automated systems that can automatically report an accident, as well as aid recovery in the case of theft. The US, Europe, Russia and Brazil have all established nationwide initiatives supporting these systems and that will increasingly be required by government mandate. For these systems, a specific modem feature, the "In-band modem", is often required. It enables data to be sent over the modem voice channel, similar to how a fax machine sends data over the telephone lines. This is required due to the higher prioritization of the voice channel over data in mobile networks. In an accident scenario, voice channel availability is higher than data channels such as GPRS or HSPA which may not even be available in remote areas. The voice channel is therefore a crucial link for transmitting data to an emergency response center.

Questions to ask your modem vendor concerning emergency call support: Do your modems support in-band modem? Is it supported on both 2G and 3G modems? Are your modems suitable for automotive applications? Do your satellite receivers support Dead Reckoning? Do you provide both GPS and GLONASS receivers? (See related points above.)



9) **Assisted positioning**
For M2M applications requiring reliable position information in urban environments, the availability of an assisted positioning system should be considered. Especially in cities where satellite visibility is often blocked by tall buildings, drop-out of positional overview can be overcome by calling up a remote A-GPS server. This is a simple process of downloading a few bytes of satellite orbital data from the Internet using a wireless modem. With this aiding data, visible satellites need only be visible for a few seconds to calculate a position, and not the full 30 seconds it takes to receive an entire 1500 bit satellite frame.

For certain applications, such as low-end navigation systems, a momentary lapse of position can be tolerated. For other applications such as vehicle emergency call or road-pricing systems, even temporary loss of position can have unacceptable consequences, making assisted positioning an attractive feature. What to look for when considering assisted positioning: Does the positioning (GPS) receiver vendor support an online assistance service? How reliable is the service, for example, does it provide guaranteed availability? Which regions of the earth does the service support? Does the vendor include client software that supports the service transparently? Do the positioning receiver and the wireless modem have an interface to support the service? Is the service available for GPS and GLONASS?



10) **Dead reckoning support**

For vehicle-based telematics systems, such as insurance tracking systems, the ability to accurately record position, heading and velocity information is crucial. In tunnels, however, the absence of satellite signals means this information must be temporarily generated by a parallel system. An important technology to supplement satellite signals is Dead Reckoning, which extrapolates location and speed based on input from vehicle sensors.

Questions to ask about your positioning receiver: Does it support Dead Reckoning? Can it be plugged directly into the vehicle CAN bus to acquire the data? Can it directly interface to vehicle sensors such as Gyro and odometer? Does the vendor offer a complete, proven system with evaluation environment? Are the components automotive grade (see point below)?

11) **Indoor positioning**

Unfortunately, GPS does not work indoors, nor do any other satellite-based navigation systems. The extremely weak signals are easily blocked by walls, metal, or even a thin sheet of water. Does this mean that M2M applications that rely on positional overview of assets without a sky-view are doomed to fail? The answer is no. For applications where an approximate position indoors is required, combining a satellite receiver with a wireless modem can overcome this problem via a hybrid solution that exploits the visibility of 2G or 3G cells.

As GSM or UMTS signals easily penetrate walls, if the boundaries of visible mobile cells are known, an approximate position can be calculated based on where the cells overlap. This solution requires wireless connection to an external service, similar to the assisted positioning solution mentioned above. Questions to ask about your source of positioning receiver and wireless modems: Do they support such a solution? Is it proven or only in theory? Do they provide an online service, and is it in operation? Can your chosen satellite receiver and wireless modem support the service? How accurate is it?

12) **Positioning system compatibility**

Until recently, GPS was the only system you needed to consider. Now, with Russia's GLONASS and Japan's QZSS systems online, plus China's BeiDou and Europe's Galileo on the horizon, compatibility with GPS plus at least one other satellite system will be required to increase system reliability and accuracy as well as fulfill regional government mandates for compatibility with their own systems.

Often, parallel operation that uses two systems simultaneously will be part of the specification. An example is Russia's new ERA-GLONASS vehicle emergency call system that requires GLONASS compatibility. Questions to ask about your GPS/GNSS receiver: Does it provide multi-GNSS support? Does it provide parallel GPS/GLONASS or GPS/BeiDou?

These are just some of the considerations you may want to think about when designing your M2M products. Remember that many new standards, both wireless and positioning, are in transition. It is important to consider the long term anticipated lifetime of your product on the market, and which markets your products will serve. Also consider whether it is important to include in the design support for next-generation performance and network coverage, or instead to design for easy upgradeability of your products in the field.

About u-blox

Swiss-based u-blox (SIX:UBXN) is a global leader in positioning and wireless semiconductors for the consumer, industrial and automotive markets. Our solutions enable people, vehicles and machines to locate their exact position and wirelessly communicate via voice, text or video.

With a broad portfolio of chips, modules and software solutions, u-blox is uniquely positioned to enable OEMs to develop innovative personal, professional and M2M solutions quickly and cost-effectively. With headquarters in Thalwil, Switzerland, u-blox is globally present with offices in Europe, Asia and the USA. (www.u-blox.com)

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