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Ultra wideband geolocation soon a commodity among machines

By Julien Happich

AEROSCOUT is in the business of assets tracking. It provides its customers with battery-powered wireless tags that use triangulation techniques in standard Wi-Fi networks.

The company claims a geolocation to within 3 to 5 meters indoor. Some of its most sophisticated tags feature bi-directional communication or even integrate a GPS unit capable of tracking the tag's physical location to within 5 to 10 meters in remote outdoor locations that would not be reached by Wi-Fi. Applications are plentiful, ranging from ID badges for patient or staff monitoring in large hospitals, to car tracking on parking lots, or logistics in shipping yards and manufacturing facilities.

This unique form of Wi-Fi RFID and geolocation has also entered consumer electronics in the form of Skyhook's Core Engine, a software-only location system based on Wi-Fi positioning, GPS and cell tower triangulation, leveraging the position databases of millions of Wi-Fi access points throughout populated areas (claimed accuracy range from 10 to 20 meters). After a mobile device has collected raw data from nearby emitters, the Skyhook client sends this data to a location server and a single location estimate is returned.

In emergency situations or in law enforcement, a few meters of accuracy indoors can only be interpreted as any adjacent room or corridor, unless you are standing in the middle of a large warehouse. Now what if you could narrow down this geolocation to a few centimeters instead of a few meters? You could pinpoint hundreds of tag within the most complex industrial maze. And what if all these tags could communicate with each other and mesh into a network of their own, in the pure ZigBee fashion?

Dublin-based DecaWave has been brewing such a solution for real time location since its foundation in 2004. In the process, Decawave's President and CTO Michael McLaughlin largely contributed to the ZigBee's 802.15.4a amendment (ratified in 2007), which added two additional physical interface (PHY) standards to the original 802.15.4 standard, one of them based on Ultra Wideband.

The standard supports four different data rates 110kbps, 850kbps, 6.8Mbps and 27Mbps, over 15 different frequency bands, and it includes specific support for ranging.

The Irish company has just received sample silicon for a chip it has dubbed "ScenSor1" designed on a 90nm CMOS process from TSMC, and AeroScout is developing its first ultra-precision asset-tracking prototypes based on the Ultra Wideband device.

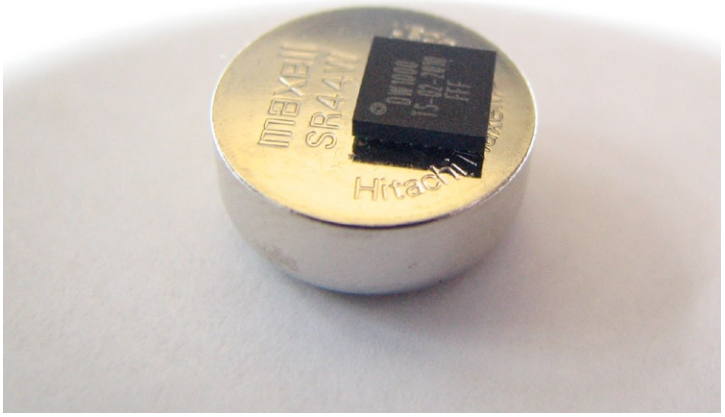
The ScenSor single chip wireless transceiver which will be commercialized as part number DW1000 is named after its main functions, Seek, Control, Execute, Network / Sense, Obey, Respond. Thanks to it use of Ultra Wideband radio technology, the chip communicates much more reliably in highly reflective RF environments such as manufacturing plants where multipath fading is usually an issue for competing narrowband devices. Geolocation accuracy is down to ±10cm, nearly two orders of magnitude compared to competing solutions, and according to DecaWave's CEO Ciaran Connell, the transceiver also cuts down the power budget by enabling sensors to use about 50 times less power in transmit-mode and 10 times less power in receive-mode than the best 2.4GHz narrowband devices. Yet, they support data rates of 110kbit/s, 850kbit/s or even 6.8Mbit/s. The chip can be used as either a Scen or Sor device.

Microstrain is another early adopter of DecaWave's ScenSor technology and is currently prototyping a new breed of stress-monitoring sensors that would take advantage of DecaWave's low power Ultra Wideband solution. "Just looking at power consumption which is often a limiting factor for battery-based sensor networks, our next-generation of devices based on the ScenSor radio could operate for ten times longer than with the current ZigBee solutions we use at the moment" said Chris Townsend

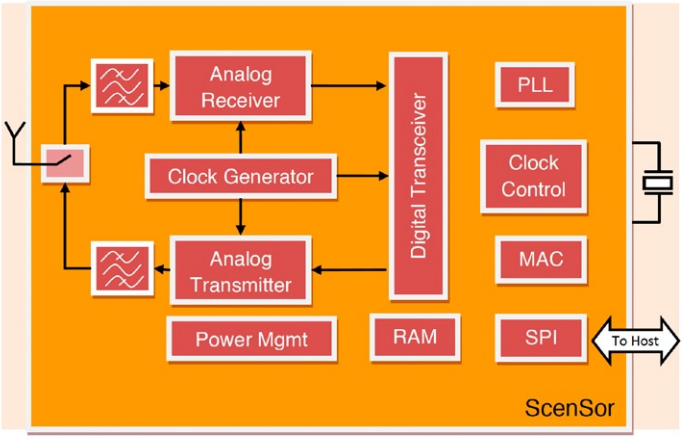
vice president of MicroStrain. "That's partly because their data rate is three times faster than ZigBee, hence we cut both transmission times and power consumption drastically", he added. Alternatively, Microstrain could perform measurements more frequently to gather more data on the structures it monitors.

DecaWave has made a number of key innovations in the implementation of the 802.15.4a standard. The first is in using a coherent receiver that allows more energy to be extracted from the received signal than would be the case in a non-coherent implementation. This increases the operating range in non-line-of-sight conditions up to 40m (and about 400m in line-of-sight). The DW1000 supports two-way ranging as well as one-way ranging, using time-of-flight and time-difference-of-arrival methods.

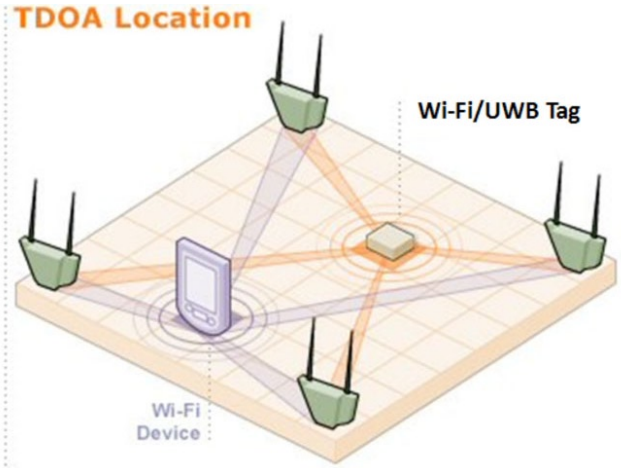
The second innovation is proprietary to DecaWave and is the subject of patent ap-



DecaWave's ScenSor chip (the DW1000) enables geolocation with a ±10cm accuracy. It comes in a 4.5x4.5mm 64-pin BGA package.



The ScenSor's functional block diagram.



The concept of geolocation based on the tag signal's time difference of arrival (TDOA) as it is received by ScenSor-enabled Wi-Fi antennas at well known positions in the network infrastructure.

plications on the modulation and encoding schemes. "Our strong IP portfolio enabled us to design a new architecture and a new set of algorithms, it made it possible to pack all the geolocation and communication functionalities into a 7mm² die whereas competing solutions would be prohibitively expensive at around 20x this size" commented Connell. "With this sort of die area and at a $1 price point in high volume, we could target mass markets including mobile phones, tablet PCs and WLAN access points. You could locate any one carrying a mobile with a ±10cm accuracy in buildings equipped with ScenSor-enabled Wi-Fi" he added.

The location accuracy is maintained even for tagged objects moving at up to 5m/s. Theoretically, more than 11,000 tags could be located in a 20m radius non-line-of-sight. Other specifications of the DW1000 which operates from a single 2.5 to 3.6V supply voltage include a transmit power of -14dBm or -10dBm with a current consumption as low as 16mA, a transmit power density less than -41.3dBm / MHz and a receive mode consumption as low as 33mA.

The ScenSor1 will be in full volume production in Q3 2012 but the company has already positioned two variants on its roadmap. A Scen-specific part (Seek, Control, Execute, Network) could be designed in WLAN access points, bearing most of the geolocation routines for accuracy, while a Sor part (Sense, Obey, Respond) would be optimised for low power consumption and easy integration into sensor units.

In the future, DecaWave's goal would be to ship as many Scen chips as possible to run alongside Wi-Fi chips in public installations, or the company could license the Scen as embedded IP to Wi-Fi chip manufacturers in order to enable the geolocation of all mobile devices bearing a Sor chip. "Splitting the ScenSor would make two very cost-competitive chips, something in the range of $50 cents in high volume", estimates Connell.

Currently the company is engaging with Wi-Fi access point vendors to have its ScenSor technology included as standard. Depending on its success, any building equipped with a WiFi network would also automatically be enabled for high-precision real time location systems.

"All our IP is in the digital domain", concluded Connell, "and as we speak, we already have the algorithmic solution for a chip that could offer a ±1cm accuracy, relying on a periodic autocorrelation function for each message sent out". No doubt that the internet of things is evolving towards geolocation, soon machines and objects could not only have an IP address, but also their real time location tagging along. ■