Low-Energy Wireless: Just what the doctor ordered

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The medical market, while on the frontier of human sciences, has always been conservative and cautious when it comes to analyzing the market's technology adoption rate. While the rest of the industrial and consumer markets were immersed in the potential of wireless connectivity, networking and the Internet, the medical market continued to build devices with tried and tested technology. However, we are now witnessing a technology revolution in the medical market. This is in part due to a perfect storm of events: an aging population, increasingly costly health care and rapidly developing technology trends.

A global aging population combined with rising health care costs is straining the world's health care infrastructure. For instance, baby boomers are entering an age bracket where they will be affected by chronic diseases. As the burden of illness increases, the health care system will not have enough professionals to care for the ill.[1] We are at a point where yesterday's technology, adapted to today's medical market, can solve critical unmet needs in medicine, such as

improved health care coverage and quality, and lower health care costs. One such technology is wireless.

Wireless technology can be used in a variety of medical applications—in the hospital, in the home, on the body and, lastly, implanted within the body. Although the focus of this article is low-energy wireless in the home and on the body, it is worthwhile to briefly mention the wireless standard for implantable devices—Medical Implant Communication Service (MICS). MICS was established by the US Federal Communications Commission (FCC) in 1999 in the 402 MHz to 405 MHz frequency band (the same band as for weather balloons). While MICS is not the primary allocation of this frequency band, it is used in the US, EU, New Zealand, Japan and Canada to provide a communication medium between an implanted “can,” such as a pacemaker, and an external programmer. The range is typically two meters with a power limitation of 25 mW.

Wireless telehealth overview

Telehealth is one of the primary applications for low-energy wireless connectivity in medicine. Telehealth is a broad term used to describe telemedicine, telemonitoring and telecare. Wireless technology is making a huge impact in telemonitoring by enabling remote patient monitoring for the healthy (preventative medicine) and for those that require management of chronic diseases. Wireless technology will allow doctors to improve quality of care by providing a new method to collect more relevant data, more frequently and at a lower cost.

We’ve seen this story unfold before, however, where a game changing technology comes along, only to be derailed by the lack of interoperability. Fortunately, because the medical market

has been slow to adopt new technology, this problem has already been solved and similar applications have proven successful in other markets. The answer for the medical market is standards. Standards will allow medical devices to talk to each other and deliver the promise of telehealth. There are two associations driving standards for low-energy wireless technology in the health care industry: Continua Health Alliance and IEEE® 802.15.6 wireless body area network (WBAN).

Standardizing wireless telehealth

Continua's mission is to establish a standard for medical devices and systems within the personal health care (which includes telehealth) and fitness monitoring application space. One of Continua's key criteria is to choose a technology or technologies that are globally applicable. Therefore, technologies that operate in the 868 MHz and/or 915 MHz bands are automatically locked out of the greater world market, including Japan, Korea and China.

Freescale, with its broad portfolio of microcontrollers, sensors and analog devices, can enable Continua's mission by providing solutions for satellite devices that collect the data and the infrastructure devices that analyze and manage the data. No other company of similar size and pedigree can approach this space in such a one-stop-shop way.

Wireless Options for Medical Applications

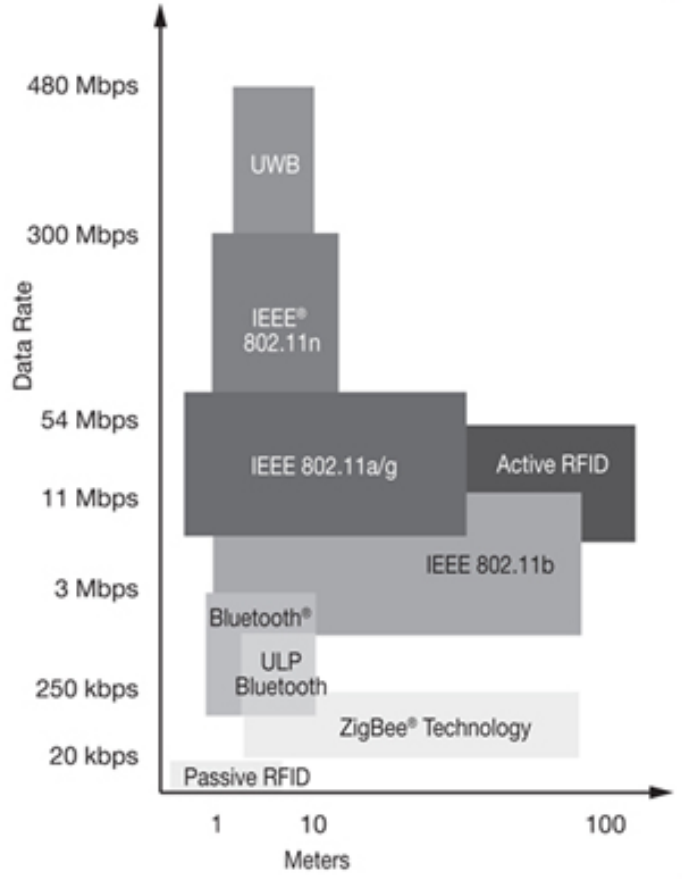

Figure 1

Telehealth System Concept

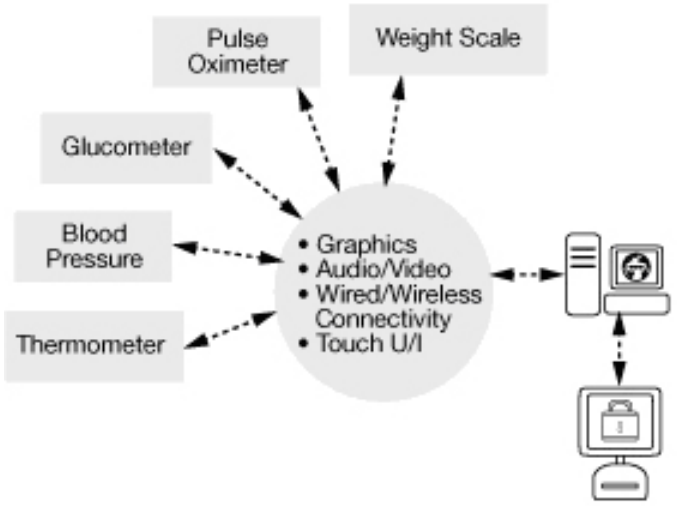

Figure 2

Continua recently published version 1 (VI) of its guidelines for wireless connectivity for portable medical/telehealth

applications. In this initial version, Continua selected Bluetooth® technology as the wireless standard (USB was selected for wired connectivity) and we will soon see interoperable medical devices from leading device manufacturers that will be certified by Continua.

Bluetooth® Wireless Technology and BTLE Technical Merits		
	Bluetooth	BTLE
Frequency Band	2.4 GHz	2.4 GHz
Data Rate	1-3 Mbps	1 Mbps
Range (meters)	5–10	5–10
Max Power	+20 dbm	+10 dbm
Modulation	GFSK, PSK	GFSK
Low-Power Capability	Not ideal	Sleep modes to conserve power. Designed for battery operation.

Table 1

Bluetooth wireless technology certainly meets the needs of the medical market from a risk mitigation point of view. According to market analysts, over one billion Bluetooth chipsets were shipped in each of the last two years. With these numbers, there is no doubt that Bluetooth technology is tried and tested. However, many argue that Bluetooth technology is not ideal for the intended medical use cases where low data rate, low power and short range are key requirements. As a result, Bluetooth Low Energy (BTLE) is being promoted for the second version (V2) of the Continua guidelines.

BTLE is specified for short-range, low-energy applications where only short bursts of data are required (i.e. non-streaming data). Low latency and available sleep modes allow BTLE to boast low power consumption characteristics. Furthermore, based on the simple BTLE framework, processor memory and performance requirements are low. Although BTLE is now a part of the Bluetooth Special Interest Group (SIG), there are significant differences between the two standards. The key difference between Bluetooth wireless

technology and BTLE is that BTLE is designed for low-power, battery-powered applications. This will effectively serve the portable medical market since 18 months of battery life for portable medical monitors is a requirement from various manufacturers. However, it is important to note that Bluetooth technology and BTLE are not inherently interoperable. The Bluetooth device must be new enough to understand BTLE. For many devices already in the field, that may be difficult. Therefore, interoperability may really only begin with the next generation of Bluetooth devices beyond the ones available today.

Wireless Protocols Contending for Continua's V2 Guidelines

Wireless Standard	Data Rate	Range	Nodes	Battery Life	Frequency Band
ANT	1000 Kbps		65,000 + 1	~4 years	2.4 GHz
Sensium	50 Kbps	3m	8 + 1	> 1 year	862–870 MHz 902–928 MHz
Z-Wave	9,600 Kpbs	30–100m	232	> 1 year	900 MHz
BodyLAN	1000 Kbps				2.4 GHz
BTLE	1000 Kbps	5–10m	7 + 1	1 year	2.4 GHz
ZigBee®	250 Kbps	1–100m	65,524	> 3 years	868 MHz 915 MHZ 2.5 GHz

Table 2

BTLE is the leading contender for Continua's V2 guidelines, however, ZigBee® technology is also a strong and viable candidate. Besides BTLE, there are five other wireless protocols that are in contention for V2 guidelines:

• ANT: Proprietary 2.4 GHz technology developed by Dynastream. ANT is currently used in some health and fitness products, using a version of the Nordic nRF24 transmitter. Total volume to date is a few million units, and an alliance has been created to promote an ecosystem.
• Sensium: Proprietary 868/915 MHz technology developed by Toumaz.
• Z-Wave: Proprietary technology developed by Zensys. Total volume to date is a few million units and an alliance exists to promote an ecosystem.
• BodyLAN: Proprietary 2.4 GHz technology developed by Fitsense. This is part of a larger effort that includes fitness equipment and fitness centers. Total

volume is unknown, but appears to be less than a million units.
• ZigBee: The only technology based on an international standards body (IEEE). The ZigBee Alliance, an open organization, has the personal, home and hospital care (PHHC) profile that caters to the Continua-defined use cases. IEEE 802.15.4 total volume to date is around 25 million units and growing rapidly.

While Continua would like to accept only one additional wireless technology in its V2 guidelines, it is not mandatory that only one is selected. Companies such as Philips, Motorola and Freescale are working together to promote ZigBee as one of the standards approved by Continua.

IEEE is also focusing on establishing a wireless standard for medical applications. IEEE 802.15.6, or WBAN, is strictly focused on wirelessly connecting sensors worn on the body. In comparison, Continua is creating use cases for both WBAN and personal area networks (PAN). PAN use cases include wirelessly connecting portable medical monitors to telemonitoring gateways (see Figure 2).

A task group for IEEE 802.15.6 has recently been formed to develop the WBAN standard encompassing a physical layer (PHY) and media access control (MAC) layers. Although this group is in its infancy, the high-level technical requirements include low power consumption, security, multi-node networking, interference protection and coexistence.

Wireless applications in the medical market are on the cusp of a breakthrough. Imagine a system that uses a sensor embedded in your clothing to monitor your heart rate, then transmits the data to a telemonitoring gateway and alerts your physician, all wirelessly,

without intervention. The only way for this to become a reality is to establish standards so various sensors and portable medical monitors can speak to each other. This is exactly what Continua and IEEE are doing with the support of technology drivers like Freescale. The vision is set, standards are being defined, and a technology revolution for the medical market is underway.

References

[1] “Tele-What?: It’s Time to Re-Think the Industry’s Terms,” Wuorenma, Jan K, TeleHealth World, Vol. 1, p. 7, Fall 2008

Raman Sharma has 10 years of high-tech experience. He has worked in several functions, ranging from ASIC design engineer, applications engineer, sales and marketing and management. Raman has a masters in electrical and computer engineering from Carnegie Mellon University and an MBA from the Kellogg School of Management. At Carnegie Mellon, Raman focused on wearable computing and biomedical engineering. At Freescale, Raman is the Global Medical Segment manager responsible for business strategy, marketing, new product roadmaps and revenue growth.

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