Designing Wireless Products for the Home Healthcare Market

By Paul Williamson, Cambridge Consultants

Wireless healthcare applications present some fascinating challenges for wireless design engineers and integrators. The adoption of wireless technology in healthcare is

RFID technology could be used to improve the management of diabetes

growing rapidly, as medical equipment firms realize the benefits and competitive advantage it can deliver. In hospitals, where the electronic management of patient records is becoming commonplace, the need to provide access to this data has driven the uptake of wireless solutions. Many hospitals will now have a wireless data system in place and as the safety and reliability of these systems is demonstrated, the old concerns of legacy wireless products are disappearing.
Regulation provides a structured framework within which these products can be developed, and provision has been made specifically to enable and encourage certain wireless products in the hospital environment. For example, the FCC provision of the WMTS bands (Wireless Medical Telemetry Service) enables the safe and efficient transmission of data from patient monitoring systems in hospital environments.

Despite recent developments, pressure continues to grow on healthcare infrastructure around the globe. Performance targets are increasing as budgets and resources are restricted. This trend is increasing as is the need to treat patients at the lowest level of intensity &#151 in their home. In this emerging area of home healthcare, wireless technology enables new products, devices and methods of treatment. Coupled with the strong growth of wireless home networking technologies the gap between home and healthcare provider can be bridged. This scenario of care-in-the-home not only benefits the healthcare provider, but it also provides the patient with increased levels of comfort and control.

For wireless design engineers and integrators, wireless healthcare applications

present a number of unique and yet fascinating challenges. Below are four areas in which wireless technology is addressing healthcare in the home.

Implantable

Wireless technology is currently being developed to provide better control and data logging facilities for implantable electronics. Devices such as cardiac pacemakers, cochlear implants and neuro-stimulators, all contain local digital processing within the unit that can be optimized and adjusted for the specific individual. A wireless connection built into an implant provides the low-level control necessary for down-loading previously logged performance data and updating device control parameters through a low-level messaging protocol.

The radio engineering challenge is to design a reliable short-range radio that consumes very little power and yet can communicate at a high bit-rate. Such ultra-low power radios are typically asleep for most of their life and use a complex wake-up scheme to ensure they only communicate with a known interrogating device. When they are woken by an external unit, they will transmit at a high data rate for a short period of time, thereby minimizing the amount of energy consumed from the battery.

To ensure adequate radio sensitivity and a short transmit duty cycle an asymmetric link is often used, providing forward and reverse link rates at about ~20 kb/s and ~200 kb/s. Note that the link

range is compromised by the size of the implant antenna, which is necessarily small, leading to inefficiencies of electrically-small antennas at low frequencies. On the flip-side, although the antenna performs better at higher frequencies, the signal attenuation through flesh also increases and begins to dominate the link budget above 900MHz. For this reason the common ISM bands at 2.4GHz and 5.2 GHz and the 5.7 GHZ UNII band are all unsuitable for implants.

Depending on the available size for the antenna there is an optimum frequency for wireless implants. This has led to successful lobbying of regulatory authorities around the world for a special frequency band for medical implants at 402 to 405

MHz with a power limit of 25&#181 W e.r.p. In the US this is called the MICS band (Medical Implants Communication Service), in Europe it is the Ultra-low power Active Medical Implants band (ULP_AMI), and it is rapidly becoming adopted in other countries around the world.

Disease Management

Devices for the treatment of chronic or long term conditions such as asthma and diabetes represent an opportunity to improve the patient's management and control of their treatment. When implemented correctly a wireless solution should reduce the impact of treatment on the lifestyle of the patient, and can improve outcome in the long term.

Short range point-to-point communication technologies are well suited to this area. They allow the patient to remotely control a medical device or treatment data to be stored and viewed locally. In the treatment of diabetes, for example, a measurement device (glucose meter) records the current level of blood sugar while a separate device (pump or injection pen) delivers doses of insulin. The key concerns for these devices are security, reliability and interference.

There are a number of ways to address this problem. A common approach is to use a proprietary wireless technology. A well designed device can offer some protection from crosstalk and interference of other devices and as a result you may be able to secure your data in a unique way over the air. In addition, a proprietary solution provides the additional benefit of applying your power saving methods at the lower layers of the radio link. In contrast, however, standards-based solutions offer the benefit of development ease, as you no longer need to place development effort into the detail of the radio link. Details such as medium access control, link negotiation, error handling and security methods are already implemented. By selecting the appropriate standard you can also reduce your susceptibility to interference. Bluetooth, for example, uses adaptive frequency-hopping technique to achieve strong robustness to interference and high link reliability.

A new standard that may offer power consumption benefits to these devices is NFC (Near Field Communication). This technology offers short range (10 cm) data communication in the globally license-free 13.56 MHz band. As an inductive technology, this offers a passive mode of operation where the communication field is driven by an active initiator. The passive device can draw power from the field, and modulate the field to provide two way communications. This allows one end of the communication link to have a very low impact on the power budget of the device.

Personal Wellbeing Management

The wellness or wellbeing area is seen by many as one of the largest growth areas in the healthcare market. The opportunity is to enable the 'worried well' to better manage and monitor their general health. A range of products already exist to address some of the specific needs of this market, such as electronic blood pressure monitors and pedometers. As consumer interest in their health grows there are

opportunities for devices that provide a connected view of health. These systems offer the potential to prevent health complications while prioritizing access to the existing health services.

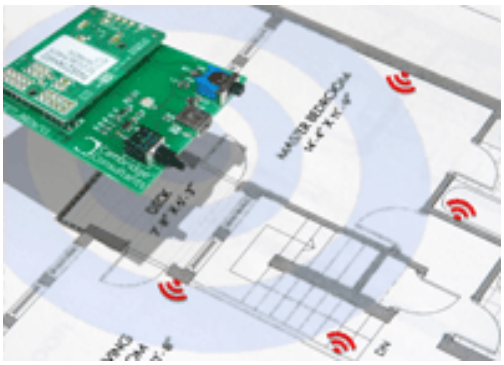
Wireless connectivity for these products will allow periodic readings to be centrally gathered from around the home, and a coordinated picture of overall health indications to be delivered. Coupled with internet connectivity these systems will be able to deliver real-time dietary and health advice.

Products in this market will be driven primarily by cost and convenience. It is likely that applications will use the widely-used WiFi and Bluetooth standards to achieve maximum interoperability and connection to wide area networking services. International standardization and use of the 2.4 GHz ISM band will ease global deployment.

Low-cost platforms, achieved through utilizing single-chip radio designs, will be important, as will ease of use. For customers these devices should work out of the box, as no one wants to be an IT administrator in their own home. Therefore simple pairing and connection is a major challenge that wireless system designers need to overcome. For example, consider a device enabled with a WiFi chipset connecting to a home network. The device must present an interface that allows the user to implement security features such as WEP or WPA. One option is careful product design to lead the consumer through the set-up process, but an alternative is to implement wireless pairing techniques. This presents another application for NFC. Here the user holds the new device close to their wireless access point, and an NFC link is used to transfer the setup information to the device. The idea of touching the two devices together is simple and intuitive for the consumer.

Elderly Care

The opportunity in care of the elderly is harder to define. The first opportunity in this area is to provide supportive technologies to enable the person to live independently in their home. Wireless technology is already in this market in the form of simple push button alarms. However, there is an opportunity to use wireless mesh network technologies, such a ZigBee, to improve these systems. By installing a number of low-cost sensors it is possible to



unobtrusively monitor the behavior of the home occupant and generate warnings or alarms for care givers. The simple sensors can monitor signals such as bed occupancy or a door opening to provide an

indication of activity. Long-term behavior trends could also be monitored to give early warnings of changes in health. ZigBee offers a low-cost, low-data rate platform in the 2.4 GHz band. Its mesh topology works to extend the range of sensors placed throughout a building, and offers robustness by providing multiple routes for data flow.

The second opportunity is to engage the elderly with new technologies. This preventative approach aims to improve independence by maintaining fitness of mind and body, and while it may be less relevant to the current group of octogenarians, the baby boomer generation is highly engaged with technology, and will be looking to the products of tomorrow to improve their health in their twilight years. Wireless technology will be critical in this market as it matures, providing social and intellectual connectivity.

In Summary

In both the US and Europe, wireless medical solutions address the tremendous gap between the services of a hospital/clinic or primary care provider, and the home. Structural barriers to adoption remain, such as the present ill-defined reimbursement schemes and the need to integrate wireless home health systems with clinical workflow processes. Yet the compelling economics of lower cost health care is driving the wireless health care market forward &#151 as well as the receptivity of patients using these systems to date.

A range of mature and emerging wireless standards offer a strong platform for home-based healthcare devices, while proprietary radio solutions are addressing some of the most challenging requirements. The emphasis is now on wireless system designers, who offer the tools to create new and innovative medical products to address this rapidly growing market.

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