Low-energy DECT variant targets sensor networks

By Steven Leussink

Wireless sensor nodes need to run on batteries for many years. SiTel Semiconductor and RTX Telecom are proposing a new ultra-low-energy extension to the existing DECT standard especially for this kind of application. There is already a host of low-energy networking standards available. But according to SiTel's Steven Leussink, DECT ULE offers many unrivalled mix of advantages for bandwidth, interference preventions and network topology.

The market for wireless home networks has grown steadily over the last few decades. Market research agency In-Stat predicts that at least 300 million households will have a wireless network installed by 2011. Networks for computers and computing accessories are already well established, and now applications such as home automation, security and control are advancing rapidly. These applications aim to make our daily lives more comfortable, safer and more energy efficient.

Technical requirements such as range, power consumption and quality of service vary greatly between application categories – and even within the same category. So a multitude of wireless technologies has arisen to try to answer these different networking needs.

For computing networks, there are now clear winners: Bluetooth, Ethernet, USB and Wi-Fi. But for the new markets, we are yet to see which technologies will survive from a selection that includes 6Lowpan, Homeplug, Insteon, Lonworks, M-bus, Power line, RF4CE, X10, Wavenis, Zigbee and Z-wave.

A proven performer

One technology that is often overlooked in this area is DECT. This well-known standard is inextricably linked to cordless telephony and is a clear winner in that arena with some 250 million systems installed. But DECT is more than just telephones. Whole cities in Brazil and

Romania are covered by Wireless Local Loop (WLL) DECT networks. Modified DECT technology is used in the Microsoft Xbox and the famous Guitar Hero game.

The technology itself isn't standing still either. Its latest generation is officially called Cordless Advanced Technology – internet and quality (CAT-iq), although the name is not yet well established beyond the DECT community. CAT-iq is already being integrated into DSL-routers so consumers can make wireless calls via VoIP. It also offers a number of new services such as data services and a central phone book.

Now there is a new DECT development. DECT ULE is an ultra-low-energy extension to DECT. It was developed by Dutch firm SiTel Semiconductor and RTX Telecom of Denmark as a solution for wireless sensor nodes that need to run for years from a single battery.

DECT ULE is a powerful extension on a proven standard, and brings all the benefits of DECT to the sensor / actuator domain. Its combination of range, high data rate and zero interference with the potential to run on batteries for years is unique.

SiTel and RTX introduced DECT ULE at the DECT World Forum 2010. The event's participants voted it the most promising DECT-related technology on show. The DECT Forum has also established an international Lower Power Working Group to drive development within the DECT community and present an open standard proposal to the European Telecommunications Standards Institute (ETSI). This will ensure that devices from different suppliers will work together seamlessly.

Moreover, in September 2010, SiTel and RTX received 600,000 Euro subsidy from Eureka's Eurostars Programme to develop a DECT ULE module. SiTel will create the chip, while RTX will handle the module integration. The total budget for the project is 1.5 million Euros.

Low current, high capacity

DECT ULE's low current consumption is achieved in the same way as in other low-power systems – by allowing the IC to operate in a *sleep mode* for most of the time. This sleep state is available as a service within CAT-iq. Importantly, because DECT ULE is an extension of the existing standard, the low current consumption doesn't come at the expense of DECT's proven reliability and flexibility.

DECT operates in the 1880 to 1900 MHz frequency band (outside Europe the 1910-1930 MHz and 1900-1920 MHz bands are also used). This 20 MHz of radio spectrum is split into ten channels with a spacing of 1.728 MHz. In addition to this division by frequency (Frequency Division Multiple Access or FDMA), DECT also splits up the available space into time slots (Time Division Multiple Access or TDMA). In total, there are 24 time slots per frequency band (12 “down” and 12 “up”). And 100 frames per second can be sent over each of the ten frequency bands.

To transmit data, DECT equipment first scans the entire DECT band and selects a channel by choosing a specific time slot combination on a specific frequency. For instance, after scanning it may decide that downlink slot 2 and uplink slot 14 in frequency band 2 (1888.248 MHz) are available.

With twelve possible time slot combinations and ten frequency bands, there are a total of 120 radio channels available. The total capacity can be extended further by adding more basestations. As long as basestations are far enough apart so as not to disturb each other, each one can manage its own sector. In this way, hundreds of thousands of users in a single office environment can be supported. What’s more, unlike many other low-power technologies, there is no need for frequency planning because the system dynamically selects the best channel to use.

Tailored for wireless sensors

In a DECT network, the basestation emits a timing signal every ten milliseconds to synchronize all the nodes. However, if a node has no connection, to save the battery, it goes into standby mode and only listens for the timing signal every 640 milliseconds. This so-called *low scan paging mode* enables a balance between battery usage and system reaction time. In either case, the telephone has to listen to the basestation regularly to check for incoming calls.

With sensors, though, things are different. Sensors do nothing most of the time so they can go into *sleep mode*, making much lower current consumption possible. By stretching the low scan paging mode interval from 640 milliseconds to 20 seconds and reducing the current during this period to a few microamps, it is possible to create a node that can run off of batteries for years. The 20 second sleep time is a practical trade-off between power consumption and timing requirements.

Long range

As an extension of DECT, DECT ULE offers numerous advantages over other well-known low-power networking technologies. These include range, bandwidth, interference elimination and network integration.

Each application has its own range requirements. Most consumer electronics, home security and building control applications need full-building coverage. However, many low-power standards have a limited range per node, so have to rely on mesh techniques to cover a whole building.

A common measure for defining the range of a wireless networking protocol is the *link budget* – the difference between the transmitter power and the receiver sensitivity. Covering a whole house usually requires a minimum link budget of 115 dB. Table 1 shows the link budgets for various wireless standards.

Because DECT allows a transmitter power of 250 mW, a link budget of 123 dB is possible at a 1 Mbit/s data rate. This is more than enough to cover a typical house, as has been clearly proven in the cordless telephone market. Thus DECT ULE can cover a whole house from a single basestation (a star network configuration) rather than introducing the complexity of a mesh. Avoiding mains-powered mesh routers that must be carefully located in strategic places has big advantages for installation, maintenance and system cost.

Interference free

Another important factor is interference. Interference between radio signals reduces the chance of information reaching its desired destination. Many proposed home networking technologies operate in the popular 2.4 GHz Industry Science Medicine (ISM) band. This is available worldwide but is very crowded with Wi-Fi, Bluetooth and microwave radiation. For sensor networks, given the number of nodes, this is a big obstacle to success.

By contrast, DECT operates in the 1.9 GHz band. Uniquely, this band is licensed (reducing interference issues) but is free from royalties. Moreover, DECT is designed at protocol level to prevent interference. The dynamic channel selection system ensures that the best available band is used.

In addition, a 1 Mbit/s raw data rate and high link budget make high voice quality and reliable data transmission possible in DECT. Some baby monitors and door phones even send video over DECT.

Power to last

Objectively comparing the power consumption of different technologies is difficult. For example, a Zigbee terminal may use less power in a certain application than a DECT terminal. But on a system level, the cost, complexity and extra power of adding a Zigbee router to achieve the necessary range could negate that saving. Similarly, the power savings of asynchronous systems can be wiped out by the large overhead these systems require to establish a reliable connection.

However, for a synchronous DECT ULE node, the typical standby current consumption is 20-40 microamps. So, as well as offering all the unique properties of DECT, a DECT ULE node could run for many years on two AAA batteries.

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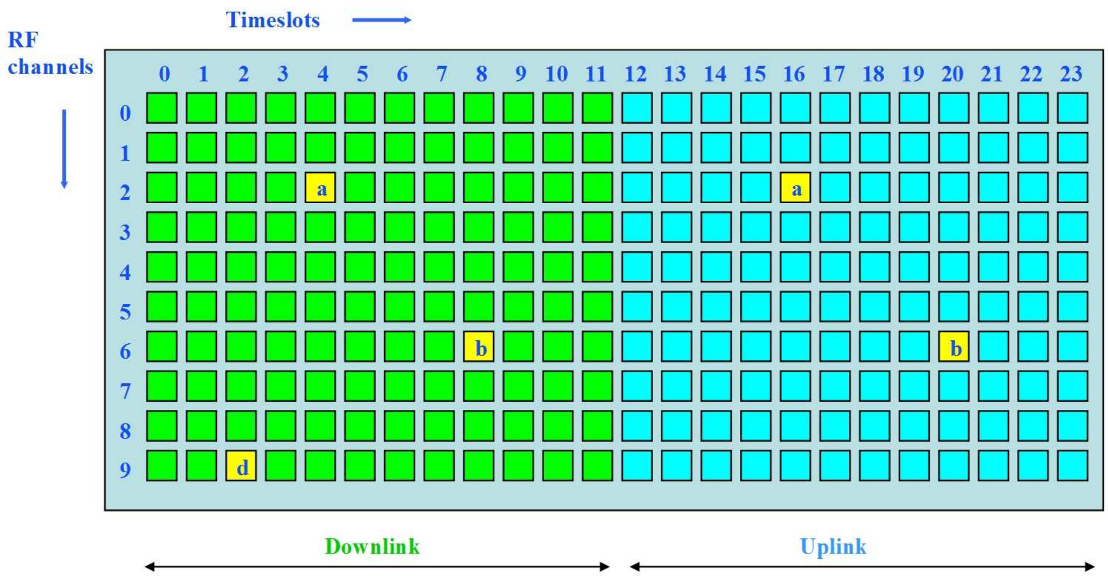
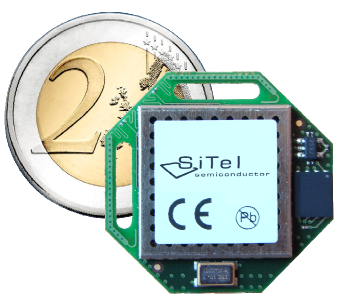
[Table 1]

The link budget for various low-power networking standards

Technology	Data rate	Frequency	Sensitivity	Transmitter power	Link budget
Bluetooth	1 Mbit/s	2400 MHz	-85 dBm	7 dBm	92 dB
DECT	**1 Mbit/s**	**1900 MHz**	**-98 dBm**	**25 dBm**	**123 dB**
Wavenis	19 kbit/s	900 MHz	- 107 dBm	14 dBm	121 dB
Zigbee	250 kbit/s	2400 MHz	-98 dBm	8 dBm	106 dB
Z-Wave	40 kbit/s	900 MHz	-101 dBm	up to 0 dBm	101 dB



DECT divides up the available spectrum in time as well as in space. In total, there are ten frequency bands and twelve time slots for both the uplink and the downlink. The DECT protocol demands that equipment first scans the network and then in response chooses the best combination of frequency and time slot.



SiTel developed a module for wireless nodes that combines a radio and baseband integrated into a single chip.