ultra low power wirelessQ

QUARTER 3 | **AUTUMN 2017**

COVER STORY

Bike sharing transformed

Bluetooth 5 advertising extensions explained

Mesh networking comes to smart lighting

Wireless tech promises healthcare answers

NORDIC SEMICONDUCTOR

OPINION

Alf Helge Omre

Mesh networking marks major Bluetooth advance

Looking back, it's clear the adoption of Bluetooth 4.0 moved Bluetooth wireless technology from a consumer-focused personal area network (PAN) product to a foundation communication standard for the Internet of Things (IoT). Bluetooth 4.0 added Bluetooth low energy, which equipped sensors with a battery-friendly wireless technology. Later, when Bluetooth 4.0 smartphones hit the market, Bluetooth low energy built on smartphone interoperability to open a gateway to the Cloud.

Since Bluetooth 4.0's adoption, the realignment of Bluetooth technology from PAN to IoT has continued apace. For example, Bluetooth 4.1 added a channel for IPv6 communication, and 4.2 added a Profile allowing devices to discover and communicate with others using IPv6 packets. Bluetooth 4.2 also featured an increase in packet capacity and strengthened security. Bluetooth 5 added higher speed, greater range, advertising extensions to help enhance connectionless broadcast applications such as beacons (*see this issue pg21*), and improved coexistence.

Despite these impressive advances, Bluetooth technology still had a critical weakness for many IoT and Industrial IoT (IIoT) applications: No support for mesh networking. Mesh networking passes packets from node to node until they reach their intended destination, without recourse to a central hub device, and endows a system with built-in redundancy and range extension.

Mesh networking supports many applications but perhaps smart lighting is the simplest illustration of the benefits it brings. Without mesh, wireless commands must be sent to individual lights from a central hub, restricting the position of each light to ensure it remained within range. With mesh, a command to switch all (or a group) of lights on rapidly propagates through the network with no position restriction provided individual nodes are close enough together to communicate.

With the announcement of the formal adoption of Bluetooth mesh 1.0, Bluetooth wireless technology has significantly advanced and is now on an equal footing with competing IoT technologies.

With Bluetooth mesh 1.0, the Bluetooth Special Interest Group (SIG) has adopted an architecture that particularly suits lighting but also introduces some compromises. But it's an architecture that addresses immediate challenges and forms the foundation of a system that can be readily enhanced through future revisions. And it's a system that builds on Bluetooth technology's interoperability with mobiles because it allows such devices to temporarily join a network (via a proxy node) and thus communicate with all nodes on the mesh without having to deal with a hub device, saving cost and complexity. (*See this issue pg10.*)

Notably, Bluetooth mesh 1.0 isn't limited to Bluetooth 5-compatible devices, rather it can be supported by any Bluetooth low energy chip from Bluetooth 4.0 onwards. That means, for example, Nordic's highly-successful and proven nRF51822 System-on-Chip (SoC) can support Bluetooth mesh in addition to the latest Bluetooth 5-compatible nRF52 Series SoCs.

Yours Sincerely,

Alf Helge Omre
Business Development Manager – Bluetooth low energy

Contributors

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Pär Håkansson is a Product Marketing Manager for Nordic. Here he examines how the adoption of mesh is a boost for Bluetooth low energy IoT applications

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Caroline Hayes is a U.K.-based technology journalist specializing in semiconductors. On page 16 she charts the rise of voice-activated RF remote controllers

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Kalon Huett is an Australia-based freelance journalist. On page 20 he takes a closer look at the company behind the world's first directed illumination smart pendant lamp

Dockless bike-sharing models are enjoying a rapid growth curve

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NEWS

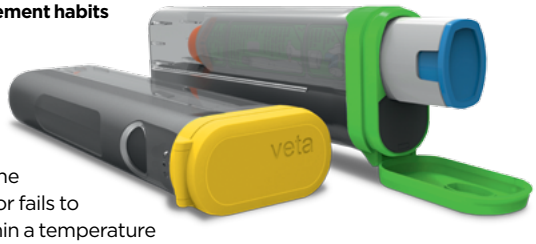
The latest developments from Nordic Semiconductor

Smart case for allergic reaction auto-injectors offers peace of mind

Canadian firm Aterica Health has developed the Veta Smart Case & App, a Bluetooth low energy wirelessly connected carrier for EPIPEN and Mylan-authorized generic auto-injectors. The smart case helps individuals and families keep their epinephrine auto-injectors nearby in the event of anaphylaxis, brought on by an allergic reaction.

The Veta Smart Case is paired using Bluetooth low energy wireless connectivity (provided by Nordic's nRF51822 System-on-Chip) to the user's Bluetooth 4.0 (and later) iOS or Android smartphone. The Veta Smart Case then wirelessly transmits data to the smartphone-hosted Veta App. This notifies the user in the event that they become separated from their auto-injector; if the auto-injector fails to remain within a temperature range they set; if it is approaching expiry; or if it is removed from the Smart Case for any reason.

The Veta Smart Case reinforces self-management habits



If the Veta Smart Case is ever misplaced, the user can also activate a 'FindMe' function that enables GPS tracking of the device, and triggers the Veta Smart Case to emit a flashing light and audible 'ping'. Additional notifications and reminders are said to help build and reinforce good self-management habits.

Powered by two AAA batteries, the device's battery life matches the life of the auto-injector.

"Nordic provides the best combination of low power, radio sensitivity, price, performance, and memory capacity that enabled Aterica engineers to create an exceptional user experience across a complex, secure system," says Adrian Fung, Director of Engineering and Manufacturing of Aterica.

Multiprotocol wireless gateway supports advanced smart home applications

Danish Internet of Things (IoT) product manufacturer, Develco Products, has launched its multiprotocol 'Squid.link Gateway', an open Linux platform providing multiple wireless technologies to a range of smart home devices and the Cloud.

In addition to Bluetooth low energy wireless connectivity provided by Nordic's nRF52832 SoC, the Squid.link Gateway supports cellular 2G/3G, Wi-Fi (b/g/n), Wireless M-Bus, Sub-1GHz proprietary, zigbee, and Z-Wave. The gateway also supports Ethernet wired networking. Developers can build smart home applications with the Linux environment using single or multiple (simultaneous) wireless technologies for configuration and control of a wide range of sensors. The gateway has also been tested for connectivity with third-party Cloud platforms, making it straightforward for developers to implement full IoT solutions.

The market is demanding a gateway that supports multiple WLAN technologies as well as Cloud connectivity

The Squid.link Gateway includes a powerful ARM9 processor power, ample memory for data storage and logging, and can be specified with only the wireless technologies required for the application, reducing cost.

"It is important to include Bluetooth low energy in the Squid.link Gateway because it's an increasingly popular smart home wireless technology that's been adopted by many sensor vendors," says Henning Mærkedahl, CTO with Develco. "We selected the Nordic SoC because the company's technology is popular ... and the powerful processor supports any application."

In brief

Enterprise-wide mesh networking solution

ANT Wireless has announced the release of ANT BLAZE, a robust and reliable enterprise-ready 'connectionless' mesh network for handling high node count IoT applications in large scale environments. Operating independently of existing on-premise IT infrastructures, ANT BLAZE targets monitoring and control applications in challenging environments. It can be used concurrently with smartphones and tablets without interfering with these Bluetooth-enabled devices.

Nordic posts record revenue

Nordic Semiconductor has reported record high revenue of $58.7 million during the second quarter of 2017. The result represents growth of 11.3 percent over the same period in 2016. Sales of Bluetooth low energy solutions contributed $36 million towards the result, or 61.4 percent of total revenue during Q2 2017. The results build on triple digit growth in the home, retail, and industrial connectivity sector, as well as continued strong performance in the consumer electronics market.

Xiaomi takes top spot in wearables

According to the latest research from Strategy Analytics, Xiaomi has overtaken Fitbit and Apple to become the world's largest wearables vendor, as global wearables shipments reached 22 million units in Q2 2017. Total shipments rose 8 percent annually as strong demand for low cost fitness bands in China, and premium smartwatches across the U.S. drove the uptick, the analyst said. Xiaomi shipped 3.7 million wearables in Q2 2017, rising 23 percent compared with Q2 2016.

In brief

Nordic exhibits at Asian trade shows

Nordic Semiconductor will be demonstrating its latest Bluetooth 5-ready Bluetooth low energy SoCs at two industry-leading Asian trade shows in October: CEATEC Japan and IoT Korea. CEATEC Japan will showcase state-of-the-art cyber-physical systems (CPS) and IoT solutions, and will be held from October 3 to 6 in Chiba City. IoT Korea will be held from October 11 to 13 in Seoul, and will feature a range of smart home, office, and industrial IoT solutions. Nordic welcomes visitors to Booth D125 at CEATEC Japan, and Booth B119 at IoT Korea.

Market for smart inhalers booming

According to a new report from analyst Market Research Future, the market for wireless 'smart inhalers' for the management of respiratory diseases is expected to grow at a rate of nearly 43 percent over six years, to reach a value of $1.6 billion by 2022. Smart inhalers monitor use and track data such as dosage timing. Smart inhalers can generate alerts for the user via smartphones connected to the smart inhaler with Bluetooth low energy. North America holds the largest market share which is forecast to reach $888 million by the end of report period.

Smart home growth surging

Zion Market Research has released a report that claims the global smart home market was valued at around $24 billion in 2016, and will reach approximately $53.45 billion by 2022, growing at a CAGR of 14.5 percent between 2017 and 2022. The report, '*Smart Home Market: Global Industry Perspective, Comprehensive Analysis, and Forecast, 2016-2022*', claims North America has the largest share of the smart home market due to population size and rising home healthcare demand, with the European market also a significant contributor.

SIM card powers Bluetooth low energy solutions for POS firms

Norwegian smart payment company, AblePay Technologies, has unveiled its BlueSIM2 smart card, designed for integration into point of sale (POS) payment terminals to enable Bluetooth low energy contactless payment from Bluetooth 4.0 (and later) smartphones.

Employing Nordic's nRF52832 System-on-Chip (SoC), BlueSIM2 is designed for companies providing POS payment solutions, with the SIM card enabling them to easily rollout Bluetooth low energy as a payment platform to complement existing merchant payment infrastructure. As BlueSIM2 comes in a SIM card form factor, it is simply inserted into the Secure Access Module (SAM) slot in existing payment terminals, and enables payment via compatible smartphones using Bluetooth low energy connectivity.

The SIM card enables POS payment solution providers to easily rollout Bluetooth contactless payment functionality

"Bluetooth low energy is the standard for [low power] wireless communication in smartphones, and so something we carry with us every day," says Espen Krangnes, a VP with AblePay Technologies. "Consumers want to pay with their smartphones, and are looking to enhance and complement their purchasing.

"Bluetooth low energy offers a better user experience and infrastructure than competing solutions. It gives providers a cross-platform payment solution with enhanced user features such as Bluetooth low energy beacons, customer loyalty programs, and coupons, to enrich and enhance the offline and in-store purchasing experience. These systems are currently being rolled out in the Nordic zone, and are setting the standard for the rest of the world."

Nordic releases development solution for building Bluetooth 5 qualified products

Nordic Semiconductor has released a production-ready Bluetooth 5 software solution for its nRF52832 System-on-chip (SoC). The S132 v5.0 SoftDevice and nRF5 SDK v14.0 are designed to help developers speed production of high performance Bluetooth 5-ready products based on the nRF52832 SoC.

The S132 v5.0 SoftDevice is a 20-link multirole, prequalified, Bluetooth 5 protocol stack offering full link concurrency in all role combinations. The SoftDevice has support for new features of Bluetooth 5 including the 2Mbps PHY, offering developers higher throughput possibilities with Bluetooth low energy. It also offers the possibility to shave up to 50 percent from existing power budgets because the higher throughput of Bluetooth 5 reduces time on air.

Other new features supported in the S132 v5.0 include L2CAP connection oriented channels, Network Privacy, and support for the new Bluetooth Channel Selection Algorithm (CSA #2) that introduces more advanced channel hopping sequences, and aims to improve interoperability and robustness between Bluetooth low energy devices operating in the busy 2.4GHz band.

The nRF5 SDK v14.0 complements the S132 v5.0 with full nRF52832 SoC peripheral driver support. Additionally, an L2CAP example is included for the Object Transfer Service, Direct Test Mode (DTM) for 2Mbps PHY and Coded PHY (long range mode), and a 'buttonless' Device Firmware Upgrade (DFU) example.

Smart home solution developers can now take advantage of Bluetooth 5's enhanced features

"Many developers are now eager to take advantage of Bluetooth 5's exciting new features including higher-speed throughput," says Kjetil Holstad, Product Manager Short-Range Wireless, Nordic Semiconductor. "This solution is available now so they can start building products with a pre-qualified Bluetooth 5 protocol stack and get to market faster."

‘World first’ smart watch for vision-impaired displays smartphone functions in Braille

D.O.T, a Seoul-based wearables specialist, has introduced a watch which uses electrodynamic cells to power a refreshable Braille display to relay information transmitted from a smartphone to partially-sighted and blind users. Wearers can use the watch to tell the time and date, accept or decline incoming calls, and view notifications such as text messages, via the four-cell (24-dot) Braille watch face.

The ‘Dot Watch’ employs Nordic Semiconductor’s nRF52832 System-on-Chip (SoC) to wirelessly connect with the user’s Bluetooth 4.0 (and later) iOS or Android smartphone through a companion app.


The visually impaired can now receive smartwatch notifications

Two touch sensors allow the user to scroll through and read each notification, while two buttons and the “Dot Crown” dial operate the various functions available on the 43-mm diameter wearable device. From the companion smartphone app users are able to configure watch settings, monitor battery status, store saved prioritized notifications, and learn from a simple Braille education module.

“Having searched across the globe to find the best Bluetooth low energy fit for our flagship product, we decided to use the Nordic nRF52832 SoC in order to optimize the user experience of the Dot Watch,” says Ki Kwang Sung, Chief Technology Officer with D.O.T.

Sung says the ultra low power characteristics of the Nordic SoC help extend the watch’s average battery life to approximately two-weeks.

“The long battery life avoids the need to frequently charge the device and is a significant lifestyle benefit to our target customers,” adds Sung,

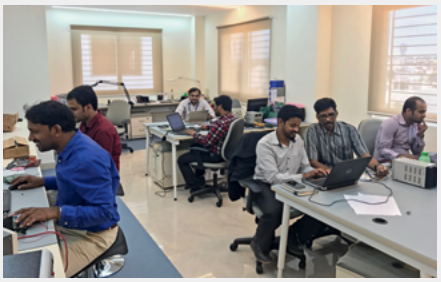
D.O.T is currently preparing for a global launch of the Dot Watch.

Nordic signs two new Asia Pacific distribution deals

Nordic Semiconductor recently signed two new distribution agreements covering India, and New Zealand and Australia, extending the company’s well-established presence in the Asia Pacific (APAC) region.

The agreements with SM Electronic Technologies in India, and Glyn Ltd in New Zealand and Australia, cover the distribution of Nordic’s Bluetooth low energy, ANT+, IEEE 802.15.4, and 2.4-GHz proprietary ultra low power (ULP) wireless connectivity solutions, including Nordic’s complete range of ULP wireless connectivity hardware, firmware, development tools, and reference designs, as well as the recently launched nRF52840 and nRF52810 SoCs.

Bangalore-based SM Electronic Technologies has over 100 employees across seven locations with inventory held locally. The company employs sales engineers with specialist RF expertise, offers RF design services, and has in-house labs in both Bangalore and Delhi.


SM Electronic Technologies offers RF design services and boasts in-house labs

“We are witnessing the emergence of wirelessly-connected products across many sectors, but particularly industrial, automotive, and consumer products,” says M S Manjunath, Managing Director, SM Electronic Technologies. “Nordic’s chips are particularly suitable for these applications because their multiprotocol support allows engineers to use the same hardware for products employing different wireless technologies.”

New Zealand-based Glyn Ltd. is a high-tech component distributor with a focus on wireless technologies. The company’s local HQ and warehouse is located in Auckland, with sales offices in Sydney, Brisbane, Melbourne, and Auckland.

“Nordic is a clear market leader in the booming Bluetooth low energy sector,” says David Newman, ANZ Sales Manager, Glyn Ltd. “Glyn’s decision to partner with Nordic was influenced by Nordic’s online support, which accelerates design schedules, and design partnerships with many of the module makers in our region.”

In brief

Bluetooth use in cars rises

According to analyst Market Research Future, market revenue for automotive Bluetooth solutions is forecast to reach $109.9 billion by 2023, increasing at a CAGR of 34.65 percent from $13.8 billion in 2016, as major global automakers increasingly offer Bluetooth as a factory-installed feature. According to the research the growth will be driven by a range of factors including the growing consumer demand for smartphone features in cars, as well as the ability to carry out vehicle diagnostics using Bluetooth low energy.

Smart underwear eases back stress

A team of Vanderbilt University engineers has designed a smart, mechanized undergarment that helps ease back stress during strenuous activity. The device is operated via a smartphone using Bluetooth low energy connectivity. The undergarment comprises two fabric sections connected by sturdy straps across the middle back that engage it only when needed. The straps are activated either from the user’s smartphone or by double tapping the garment itself. When an activity is complete, another double tap releases the straps.

The smart lamp allows wireless control of direction, brightness, and color

Directed illumination smart pendant lamp is a 'world first'

Austrian smart lighting company, Luke Roberts, has released the 'Luke Roberts Smart Lamp', a Bluetooth low energy-powered lamp that wirelessly connects to the user's smartphone or tablet. From the device, the user can control the direction, brightness, and color of the light through a low-latency, tap-and-drag 'paint' gesture using a companion app.

Employing Nordic's nRF52832 System-on-Chip (SoC) to provide Bluetooth low energy wireless connectivity between the smart lamp and the user's Bluetooth 4.0 (and later) smartphone or tablet, lamp settings can be saved to enable a single tap to reset the light to a specific ambience. Proximity detection via infrared sensors ensures the light automatically switches off when a person leaves the room and switches back on when they return.

The single pendant lamp employs 300 high-power LEDs and custom optics to alter the color and direction of emitted light. The nRF52832 SoC's ARM Cortex M4F processor supports a 'smart learning' algorithm which learns from the user's behavior at specific times of the day and days of the week, enabling immediate selection of preferred light settings when the light is switched on.

The Luke Roberts Smart Lamp will be commercially available across Europe and North America by the end of 2017 for both consumers and larger commercial lighting installations such as offices, bars, or restaurants. (*See page 20.*)

Gesture detection bracelet provides reminders of negative actions reinforcing behavioral change

US company HabitAware has launched a smart bracelet that uses custom gesture detection to help people suffering from negative 'subconscious' behaviors to modify their actions. Worn on the wrist, 'Keen' employs a nine-degrees-of-freedom (9DoF) inertial measurement unit (IMU) to accurately measure gesture characteristics unique to each user, then provides haptic feedback in the form of a gentle vibration when the gesture is recognized. Keen helps users become aware of their hand movements so they can gradually retrain their brain and make a conscious choice to stop engaging in behaviors such as hair pulling, nail biting, skin picking, or thumb-sucking.

To begin using the device, the user must first download the iOS or Android Keen app, then pair the charged bracelet to their smartphone or tablet using Bluetooth wireless connectivity provided by Nordic's nRF52832 SoC. To 'train' the bracelet, the user mimics the behavior they wish to reduce for a short period, during which time the device gathers motion information and generates unique user characteristics which are compared against a running dataset during detection.

To avoid false positive results, the device uses proprietary algorithms to generate unique orientation and position features, and auto-selects a tolerance based on the signal amplitudes to accurately identify specific micro-gestures and distinguish them from similar benign behaviors.

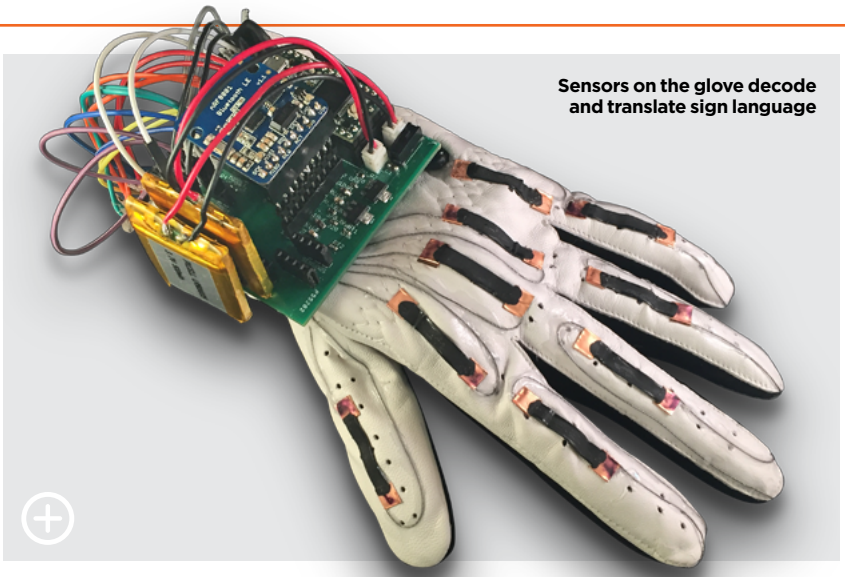
The bracelet helps users retrain their brain and stop engaging in negative behaviors

The app displays visualizations so the user can identify behavioral patterns, for example typical times of day the events occur, and other patterns requiring context to assist in modifying repetitive behaviors.

"The [high level of integration], raw performance, and memory capacity of the nRF52832 SoC were important to us. [The SoC's compact dimensions allowed us to] considerably reduced device size without sacrificing function," says Kirk Klobe, HabitAware Lead Firmware Engineer.

ULP WIRELESS TRENDS

The latest developments in technology



Sensors on the glove decode and translate sign language

Smart glove gesture recognition can translate sign language into text

Engineers at the University of California San Diego have developed a smart glove that wirelessly translates sign language into text, and controls a virtual hand to mimic sign language gestures. The device employs a glove with nine stretchable sensors made of thin strips of a silicon-based polymer coated with a conductive carbon paint, adhered to the back at the knuckles. Stainless steel thread connects each of the sensors to a low power, custom-made printed circuit board attached to the back of the wrist.

The sensors change their electrical resistance when stretched or bent enabling interpretation of the sign language based on knuckle position. The electronics then transmits the signals via Bluetooth low energy to a smartphone or computer screen.

In addition to decoding American Sign Language gestures, researchers are developing the glove to be used in a variety of other applications ranging from virtual and augmented reality to telesurgery, technical training, and defense.

"Gesture recognition is just one demonstration of this glove's capabilities," says Timothy O'Connor, a nanoengineering Ph.D. student at UC San Diego. "Our ultimate goal is to make this a smart glove that in the future will allow people to use their hands in virtual reality."

The Nucleus 7 is the first cochlear implant designed to connect directly with iOS devices

First iOS-connectable cochlear implant

Cochlear Ltd has launched what it claims is the smallest and lightest 'behind-the-ear' implant sound processor available. The Nucleus 7 sound processor cochlear implant is the first such implant designed to connect directly with iOS devices, allowing individuals to stream sound from their compatible smartphone or tablet, as well as control, monitor, and customize their hearing.

"The Nucleus 7 Sound Processor is a turning point for people with hearing loss, opening the door for them to make phone calls, listen to music in high-quality stereo sound, watch videos, and have FaceTime calls streamed directly to their cochlear implant," says Cochlear CEO, Chris Smith.

The device offers a hearing tracker feature which records coil-off time and time in speech, as well as an application to locate lost sound processors using location services. The system can also be used in combination with a hearing aid with synchronized streaming to both ears, the company said.

Biofuel cells extract energy from sweat to power wearables

A team of engineers has developed stretchable fuel cells that extract energy from sweat and are capable of powering electronics such as LEDs and Bluetooth low energy radios. The biofuel cells generate 10 times more power per surface area than any existing wearable biofuel cells and could be used to power a range of wearable devices.

The biofuel cells are equipped with an enzyme that oxidizes the lactic acid present in human sweat to generate current. This turns the sweat into a source of power. The engineers from the University of California successfully connected the biofuel cells to a custom-made circuit board, and demonstrated the device could power an LED for four minutes while a person wearing it exercised on a stationary bike.

The stretchable fuel cells extract energy from sweat and could power wearable devices

To be compatible with wearable devices, the biofuel cell needs to be flexible and stretchable, so engineers decided to use a 'bridge and island' structure. Essentially, the cell is made up of rows of dots that are each connected by spring-shaped structures. Half of the dots make up the cell's anode; the other half the cathode. The spring-like structures can stretch and bend, making the cell flexible without deforming the anode and cathode.

However, future work is still said to be needed. First, the silver oxide used at the cathode is light sensitive and degrades over time. Also, the concentration of lactic acid in a person's sweat gets diluted over time. The team is exploring a way to store the energy produced while the concentration of lactate is high enough and then release it gradually.

Nordic first to launch Bluetooth mesh Software Development Kit

The nRF5 SDK for Mesh enables developers to embark on Bluetooth mesh designs with Nordic's nRF51 and nRF52 Series SoCs immediately upon official specification adoption

Regular updates of the Bluetooth low energy specification clearly indicate the Bluetooth Special Interest Group's (SIG's) ambition to ensure the technology gains an unassailable position as a vital building block for the Internet of Things (IoT). Bluetooth 5, for example, introduced range, throughput, and security enhancements that extended the technology's capabilities for smart home and commercial building automation applications. (*See ULP WQ Spring 2017, pg16.*)

Now the SIG has taken things a step further by adding mesh networking, a key requirement for IoT applications. Bluetooth mesh 1.0 extends Bluetooth low energy wireless connectivity to multinode installations for consumer, smart home, and industrial applications. With Bluetooth mesh, users can instantly and simultaneously control up to hundreds of Bluetooth low energy-equipped sensors from a single Bluetooth 4.0 (and later) smartphone or tablet. (*See this issue pg10.*)

"The official adoption of Bluetooth mesh is going to have a transformative impact on the lighting sector," says Rafał Han, CEO of Silvair, a smart lighting company. "The industry is finally getting a wireless technology that's technically capable of delivering the qualities and services everyone has been waiting for.

"It's an open, global, and interoperable standard enabling wire-like reliability even in large, sensor-driven lighting installations. On top of that, you get many exciting value-added services, such as beacons, asset tracking, and indoor navigation."

Bluetooth low energy now features mesh networking – a key requirement for IoT applications

Industry first

In an industry first, Nordic has introduced nRF5 SDK for Mesh, a Software Development Kit (SDK) which allows engineers to develop with Bluetooth mesh. The launch of the SDK coincided with the Bluetooth Special Interest Group's (SIG) formal adoption of Bluetooth mesh 1.0.

nRF5 SDK for Mesh includes the company's first release of its Bluetooth mesh software protocol ("stack"). The SDK is compatible with the Nordic nRF51 and nRF52 Series Systems-on-Chip (SoCs), and the S110, S130, and S132 Bluetooth 4.0, 4.1, 4.2, and 5-compatible SoftDevices (Nordic's Bluetooth low energy stacks). With the nRF5 SDK for Mesh, developers who already have a Nordic nRF52 Development Kit (DK) can immediately start building Bluetooth mesh-based applications.

"Mesh capability allows Bluetooth to take a giant leap from consumer into industrial applications such as lighting that employ tens or even hundreds of nodes"

Nordic's Bluetooth mesh stack incorporates additional features not included in the Bluetooth SIG's Bluetooth mesh 1.0 specification. For example, Nordic's stack includes secure side-by-side and blocking device firmware updates (DFU), a feature which allows scalable, secure DFU across the mesh without interruption of service while the new firmware is transferred. The Nordic Bluetooth mesh stack also includes a solution for provisioning over relaying nodes and a serialization interface which allows control of the mesh over a serial interface when using a two-chip Bluetooth mesh solution. (For example, when employing an Internet gateway as part of the application.)

"Bluetooth mesh is a significant development for Bluetooth wireless connectivity adding new network capabilities far beyond the point-to-point and star topologies for which it was originally designed," says Alf Helge Omre, a Business Development Manager at Nordic Semiconductor. "Mesh capability allows Bluetooth to take a giant leap from consumer into industrial applications such as lighting and other implementations that employ tens or even hundreds of nodes over wide areas."

Omre adds: "Nordic has been closely involved in the development of proprietary Bluetooth mesh stacks and has turned that expertise to accelerate bringing a Bluetooth standard-compatible mesh stack to market ahead of competitors." The alpha version of the nRF5 SDK for Mesh can be downloaded from Nordic's website. ■

New dockless bike-sharing systems are a snap to use

Bike-sharing systems are growing fast. And a new 'dock-free' model eliminates the 'last kilometer' problem. ULP Wireless Q reports

Bike-sharing, something akin to a bike rental automat, is growing rapidly. The combination of low-maintenance bikes, smartphones, and the Internet has provided the catalyst for bike-sharing systems that transform transportation into an invitation to save time, improve health, and clean up the air. In the U.S., for example, bike-sharing riders took over 28 million trips in 2016, a 25 percent increase over the previous year, eliminating the hassle of buying, storing, and maintaining a bike.

Traditional bike-sharing systems feature long rows of bikes parked in a fixed docking station that's both bike lock and registration system. One disadvantage of this arrangement is the inconvenience of locating the fixed docking station at both the start and end of journeys; if the docks are far from the desired destination, the novelty of pedaling can wear thin for a rider who knows the last kilometer will have to be completed on foot.

Sometimes the docking station closest to the destination is full and users are forced to find another even further from where they want to be. Worse yet, with many docking systems, it can be difficult to tell if the returned bike has been accepted, as the lock, mounted inside the docking station, is not always visible.

Mobike's 'dockless' bike-sharing model allows its bikes to be parked anywhere and unlocked in an instant with a smartphone

Smart bikes go dockless

A new type of system is disrupting bike-sharing by overcoming the drawbacks of the fixed dock: the 'dockless' smart bike. It's a system pioneered by companies such as Mobike, one of the world's largest bike-sharing companies which operates shared bike systems in over 100 cities throughout China, Singapore, Japan, and the U.K. Dockless bikes are smart bikes. Mobike has combined a smartphone app with GPS, QR code scanning, and Bluetooth low energy to eliminate the fixed docking station, allowing users to (hopefully) locate a bike near them and deposit it at their destination (with a few restrictions such as ensuring the bike is outside and is not an obstruction to others).

The key to Mobike's dockless system is a smart lock, permanently fixed to the bike and incorporating Nordic Semiconductor's nRF51822 Bluetooth low energy System-on-Chip (SoC). The SoC powers a wireless link between smartphone and lock, which when combined with GPS and QR code scanning enables people to locate, pay for, and unlock a Mobike machine with unprecedented convenience. At the end of a ride, users park the bike in any suitable location close to their destination. To secure the bike, the user slides a mechanical switch which causes the lock to engage around the rear wheel. This also triggers the Mobike smartphone app to log the ride as complete and publicize the bike's location to the next user. Users know how long they have had the bike out, distance travelled, and the fee charged.

Consumers who prefer their own bike can still make it smart with wireless locks. For example, with Noke's Bluetooth padlock—which is also powered by an nRF51822 SoC—users can open the lock without even removing their smartphone from a pocket or bag. Similarly, Lattis' Ellipse Nordic-powered smart bike lock offers keyless entry, theft alert, and even a solar panel that charges the lock's battery. The Ellipse smartphone app can also send a secure code and the location of the lock to friends so they can use the bike too.

Communities are encouraging bike-sharing to make the activity a growing part of their city's culture. Initiatives include promoting bike-sharing services for low-income users by subsidizing passes - easing access to far-flung grocery stores (with healthier food) and encouraging exercise. These activities, and others, are expected to expand the growth of the bike-sharing sector by as much as 30 percent in the U.S. alone in 2017.

New technologies have spawned unexpected shifts in how people live and work. And it doesn't have to be expensive and complicated technology. By making it easy to access something as simple and elegant as a bike, Mobike, Noke, Lattis, and others are improving others' lives in a meaningful way. ■

Mesh strengthens Bluetooth wireless' IoT credentials

Bluetooth low energy's expansion beyond its consumer roots continues with the release of a mesh specification that boosts its suitability for building automation applications

By Pär Håkansson, Product Marketing Manager, Nordic Semiconductor

Mesh support extends Bluetooth low energy technology into an even wider range of applications

While Bluetooth low energy has made major inroads as a foundation technology for the Internet of Things (IoT) it has an Achilles' heel. Because it was primarily designed to support battery-powered peripherals communicating with a central device such as a smartphone, the technology is unable to support mesh networking. But now, the adoption of the Bluetooth mesh 1.0 specification has eliminated the weakness.

Mesh networking allows devices within a network ("nodes") to communicate with any other node using packets relayed via other nodes if necessary and without recourse to a central hub device. Such a system enables extended range, flexibility, and redundancy, and is a prerequisite for any self-respecting IoT wireless technology. Key applications for Bluetooth mesh include enterprise lighting installations, back-ends for managed beacons, and industrial monitoring.

Several companies, notably Silvair, considered this requirement so fundamental that it developed proprietary mesh solutions based on Bluetooth low energy technology to fill the gap. (*see ULP WQ Summer 2017, pg5*). It's perhaps little surprise then that the company's engineers have taken a key role in the drafting of the official Bluetooth mesh specification which was formally released in July.

Not just for Bluetooth 5

Because developers are familiar with a linear progression for the technology it might be assumed that Bluetooth mesh is an update of Bluetooth 5 - but that's not the case. Rather, with a software update, any Bluetooth low energy chip compatible with Bluetooth 4.0 (or later) can support Bluetooth mesh. This allows networked Bluetooth low energy installations that currently employ a proprietary mesh solution to be upgraded over-the-air to become Bluetooth mesh compliant.

That's not to say that the firmware updates are insignificant. Bluetooth mesh is a new architecture with seven layers (bearer, network, lower and upper transport, access, foundation models, and models) on top of the standard Bluetooth low energy physical layer (radio). (See Figure 1.) A node, upon receiving a message, passes it up the layers from the underlying Bluetooth low energy physical layer, via the bearer layer to the network layer. The network layer applies various checks to decide whether to pass the message higher up the stack or discard it. (Further details on the function of these layers can be found in reference 1.)

"Until now, Bluetooth low energy technology had an Achilles' heel; Bluetooth mesh eliminates that weakness"

The Bluetooth mesh specification details four types of nodes: "Relay Nodes", "Low Power Nodes", "Friend Nodes", and "Proxy Nodes".

Relay nodes can retransmit received packets and are the mechanism by which packets rapidly propagate across the entire network. The downside of relaying is increased current consumption because it relies on the nodes being continuously 'awake'. While Bluetooth low energy's power consumption in a mesh network configuration will compete favorably with competitive technologies, such an operational mode isn't sustainable with battery power alone. This is not a disadvantage for applications such as smart lighting, because fixtures are wired into the mains supply to power the LEDs, but it could be a problem for other non-mains powered devices incorporated into the network such as switches.

To overcome this problem, Bluetooth mesh includes "Low Power Nodes" (LPNs) which can operate from batteries or energy harvesting. LPNs work in tandem with "Friend Nodes". Friend Nodes are typically mains powered so can remain permanently awake; the devices cache any messages destined for the LPN. The LPNs switch to

'receive' mode according to a predetermined schedule, accept cached messages, operate as instructed, and then rapidly return to a power-saving 'sleep' state.

"Proxy Nodes" allow devices that run the Bluetooth low energy stack but don't support Bluetooth mesh (for example, the current generation of smartphones) to connect to a Bluetooth mesh network. Interaction is achieved via both the node and device's Generic Attribute Profile (GATT) interface. (See Figure 2.)

Bluetooth mesh follows Bluetooth technology's architecture whereby GATT "Profiles" allow many use cases to share a common information structure. However, because of the distributed nature of a mesh network, the design of the Profiles is different. And to avoid GATT Profiles being mistaken for the mesh equivalent, mesh profiles are called "Models".

Bluetooth mesh 1.0 includes "Configuration", "Heartbeat", and "Health" Foundation Models. The Foundation Models are complemented by "Mesh Models" for use cases such as "Generic", "Lighting", "Sensors", and "Scene". Mirroring GATT Profiles, it is also possible to create custom Foundation and Mesh Models. (Models is an involved subject and readers are advised to consult reference 1 for more detail.)

Driven by lighting

Smart lighting is a pioneer application for wireless IoT technologies so its perhaps little surprise that much of the initial Bluetooth mesh specification has been tailored to this role. In a blog, the Bluetooth Special Interest Group (SIG) explains as much, saying: "Bluetooth mesh will make the largest initial impact in commercial lighting".

That said, the mechanisms incorporated for smart lighting conveniently support other key applications such as beacons, security networks, as well as heating, ventilation, and air conditioning (HVAC) networks. Key among these mechanisms is communication via "flooding"; each packet is broadcast to every node in the network until it reaches the target node(s).

Flooding is complemented by three types of addressing: "Unicast" (used during initial node set-up), "group", and "virtual" (primarily used by device manufacturers to 'label' their products). Of these, group addressing is the most applicable to everyday operation. A group address is a multicast address which represents one or more elements in the network. The SIG has defined four "Fixed Group Addresses" named "All-proxies", "All-friends", "All-relays", and "All-nodes" to specifically address the types of nodes defined above.

In addition to these group addresses, the installer will likely allocate dynamic group addresses during configuration to reflect the physical mesh layout. For example, dynamic group addresses could be allocated to the lights in each room of a building.

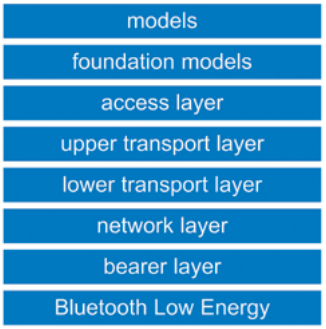
A flooding mesh and group addressing makes sense for key smart home applications such as lighting. A flooding mesh allows an "ON" command from a switch to a group of smart lights to rapidly propagate through a network with every node receiving the command and acting accordingly. The lights in the target group illuminate almost instantaneously. The latency is much lower than, for example, a star network, where the hub is required to transmit an individual command to connected light.

A flooding architecture brings other advantages ... and some compromises. A key additional advantage is simplicity, underscored by limiting communication to Bluetooth low energy technology's three advertising and scanning channels (remembering that the technology has 40 frequency channels in total). But this comes at the cost of reduced bandwidth due to the need to manage traffic to prevent packets overwhelming this limited subset of frequencies.

The specification includes several mechanisms to mitigate advertising and scanning channel congestion. The first is a "Time-To-Live" (TTL) counter that defines how many times a specific packet can be relayed – after a defined number of steps, the packet will not be relayed further.

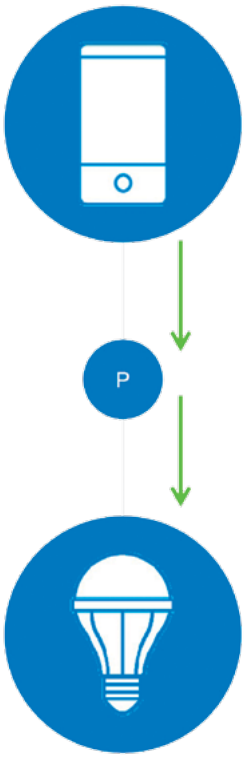
Setting the TTL counter to three, for example, allows a packet to move a maximum of three steps from its source before it's not retransmitted.

Figure 1: The Bluetooth mesh stack sits on top of the Bluetooth low energy physical layer



COURTESY: BLUETOOTH SIG.

The second congestion-prevention mechanism is a message cache of transmitted packets. A packet can only arrive in the cache once it has circulated completely around the mesh – at which point it can safely be assumed that further transmission is unnecessary. An "optional relaying" feature also limits mesh congestion. By switching off relaying, nodes can receive packets but not pass them on. Optional relaying adds complexity—because the designer must trade-off mesh flexibility against bandwidth consumption—but in doing so improves overall mesh performance.



COURTESY: BLUETOOTH SIG.

Figure 2: Proxy Nodes ("P") allow Bluetooth low energy devices that don't support Bluetooth mesh (for example, smartphones) to connect to a Bluetooth mesh network

Security first

Bluetooth mesh draws Bluetooth technology ever tighter into the Internet of Things (IoT) - making security vital. Consequently, the designers of Bluetooth mesh have ensured the network, individual applications, and devices are all secure and cannot be switched off or otherwise restricted. With Bluetooth mesh, security is not optional, it's mandatory.

This mandatory approach starts with 'provisioning'. Provisioning is the process by which otherwise isolated devices become nodes on the mesh network and can be implemented via an app supported on a smartphone or tablet. The process follows five steps: Beaconing (indicating availability to join the mesh); Invitation (from the provisioning device); Public Key Exchange; Authentication; and Session Key Exchange (securing the subsequent distribution of data to complete provisioning).

The provisioning process implements a high degree of security. Thereafter, packets are end-to-end encrypted with AES-128, with privacy enhanced by additional AES-128 encryption between each relay (in part to hide the node addresses). In addition, procedures are included to periodically refresh the encryption keys, and to detect and repel "replay attacks".

Further information on Bluetooth mesh is available from Nordic's website and DevZone. Nordic's recently introduced nRF5 SDK for Mesh allows developers to start designing Bluetooth mesh applications with the company's nRF51 and nRF52 Series SoCs. Nordic's implementation of the Bluetooth mesh stack includes some useful features that aren't included in the Bluetooth mesh 1.0 specification. (*See page 8.*) ■

Reference:

[1] "Bluetooth Mesh Networking/ An Introduction for Developers", Bluetooth SIG, August 2017.

Ultra low power wireless connectivity solutions

Find the chip you need using this latest listing of every Nordic product

ICs	Operating Band	Wireless Protocol					IC Type			On-Chip						Peripherals																		Applications													Ref. Designs	Dev Tools	WLCSP Wafer-level chip-scale package option
		Bluetooth 5	Bluetooth LE	ANT	802.15.4	2.4GHz Proprietary	System-on-Chip	Connectivity	Transceiver	CPU	FPU	DSP	Memory	MPU	PA	Balun	Oscillators	NFC-A tag	2-Wire	ADC	AES	Analog Comparator	I2S	PDM	PWM	Real Time Clock	ARM CryptoCell	TRNG	SPI	QSPI	Temperature Sensor	UART	USB	PC Peripherals	Sports & Fitness	Gaming	Cellphone Accessories	Consumer Electronics	Automation	Healthcare	Toys	Wearables	Smart Home	Beacon	Wireless Charging	Automotive Graded			
nRF52 Series																																																	
nRF52840	2.4GHz	●	●	●	●	●	●			Cortex M4F	●	●	256kB RAM 1MB Flash	●	●	●	32MHz / 32kHz Crystal 64MHz / 32kHz RC	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		-	Single Board Dev Kit, Power Profiler Kit	●
nRF52832	2.4GHz	●	●	●		●	●			Cortex M4F	●	●	64kB RAM 512kB Flash	●		●	32MHz / 32kHz Crystal 64MHz / 32kHz RC	●	●	●	●	●	●	●	●	●		●	●		●	●		●	●	●	●	●	●	●	●	●	●	●		PC Desktop, Smart Remote, Smartphone Demo Apps	Single Board Dev Kit, Power Profiler Kit, Nordic Thingy:52	●
nRF52810	2.4GHz	●	●	●		●	●			Cortex M4		●	24kB RAM 192kB Flash	●		●	32MHz / 32kHz Crystal 64MHz / 32kHz RC		●	●	●	●		●	●	●		●	●		●	●		●	●	●	●	●	●	●	●	●	●	●		-	Single Board Dev Kit, Power Profiler Kit	
nRF51 Series																																																	
nRF51822	2.4GHz		●			●	●			Cortex M0			32kB or 16kB RAM 128kB or 256kB Flash	●			16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●		●	●	●	●	●	●	●	●	●	●	●		PC Desktop, Smart Remote, Smartphone Demo Apps, Beacon	Single Board Dev Kit, Dongle	●
nRF51422	2.4GHz		●	●		●	●			Cortex M0			32kB or 16kB RAM 128kB or 256kB Flash	●			16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●		●	●	●	●	●	●	●	●	●				Smartphone Demo Apps	Single Board Dev Kit, Dongle	●
nRF51824	2.4GHz		●			●	●			Cortex M0			16kB RAM and 256kB Flash	●			16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●					●					●	●	●		Smartphone Demo Apps	Single Board Dev Kit, Dongle	
nRF8000 Series																																																	
nRF8001	2.4GHz		●					●		-			-				16MHz / 32kHz Crystal 32kHz RC												●		●			●	●	●	●	●	●	●	●						PC Desktop, Smart Remote, Smartphone Demo Apps	nRFgo Dev Kit, Prog. Kit	
nRF8002	2.4GHz		●				●			-			-				16MHz Crystal 32kHz RC																				●										Key Tag, Smartphone Demo Apps	nRFgo Dev Kit, Prog. Kit	
nRF24AP Series																																																
nRF24AP2-1CH	2.4GHz			●				●		-			-				16MHz / 32kHz Crystal												●		●				●		●		●	●						Smartphone Demo App	ANT Dev Kit	
nRF24AP2-8CH	2.4GHz			●				●		-			-				16MHz / 32kHz Crystal												●		●				●		●		●	●						Smartphone Demo App	ANT Dev Kit	
nRF24AP2-USB	2.4GHz			●				●		-			-				16MHz Crystal																●				●		●		●	●						ANT USB Dongle	ANT Dev Kit	
nRF24L Series																																																
nRF24LE1	2.4GHz					●	●			8051			1kB + 256B RAM 16kB + 1.5kB Flash				16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●		●		●		●	●		●						PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24LE1 OTP	2.4GHz					●	●			8051			1kB + 256B RAM 16kB + 1kB OTP				16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●		●		●		●	●		●						PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24LU1+	2.4GHz					●	●			8051			2kB + 256B RAM 16/32kB Flash				16MHz Crystal				●								●			●	●		●		●		●	●		●						PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24LU1+ OTP	2.4GHz					●	●			8051			2kB + 256B RAM 16kB + 1kB OTP				16MHz Crystal				●								●			●	●		●		●		●	●		●						PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24L01+	2.4GHz					●			●	-			-				16MHz Crystal												●						●		●			●							-	Eval Kit	
nRF24 Series																																																
nRF2460 (mono)	2.4GHz					●		●		-			-				16MHz Crystal		●			●							●							●		●			●							Microphone	nRFgo Dev Kit	
nRF900 Series																																																
nRF9E5	433 / 868 915MHz					●	●			8051			4kB + 256B RAM				4 / 8 / 12 / 16 / 20MHz Crystal			●					●	●			●			●						●							-	Eval Kit	
nRF905	433 / 868 915MHz					●			●	-			-				4 / 8 / 12 / 16 / 20MHz Crystal												●										●							-	Eval Kit	

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An apple a day: Technology transforms healthcare

As the global population ages, and chronic diseases continue to rise, wireless technology has a critical role to play in delivering better and more affordable healthcare outcomes

There is a paradox in healthcare, in fact there are several. We are living longer, but getting sicker. We are spending more money than ever on healthcare, yet service levels are declining. Governments want to increase health care affordability, and reduce health care delivery. These seeming contradictions are why alongside food security, climate change, and international financial stability, healthcare was touted as one of the leading global issues at last year's World Economic Forum Annual Meeting, held in Davos-Klosters, Switzerland.

According to the World Health Organization (WHO), in the last 15 years average life expectancy increased by five years, at the same time noncommunicable diseases—diabetes, heart disease, obesity, cancer—all continued to rise at an alarming rate. Together they have fueled a rising demand for healthcare products and services, and that has come at an enormous financial cost. According to market analyst Deloitte, the spend on global healthcare will reach approximately $8.7 trillion by 2020, as both the public and private sector invest heavily in improving healthcare outcomes for a graying and growing world population.

Technology, of course, has a crucial role to play. Not only the CT scanners and MRI machines that require a capital outlay in the tens of millions of dollars, but wireless technology too, that comes with a much more affordable price tag. Wireless technology is already well entrenched in hospitals for things like enterprise-wide tasks—such as analyzing operational data, managing staff workflow, automating environmental monitoring, or tracking medical equipment—and improving the quality of care by monitoring hand hygiene compliance and increasing patient security. The use of wireless technology, both inside and outside hospital walls, is set for a remarkable growth curve, and, once end products have passed strict regulators such as the U.S.-based Food and Drug Administration (FDA), Bluetooth low energy in particular promises much in medical applications.

Bluetooth low energy's interference immunity shields against other RF sources such as electrosurgical devices

The Bluetooth advantage

Bluetooth low energy technology offers a number of advantages in the healthcare sector. For example, the technology's interference immunity allows it to coexist alongside other 2.4-GHz wireless technologies such as Wi-Fi. 128-bit AES encryption keeps sensitive data safe during transmission, while ultra low power consumption extends battery life enhancing convenience. Further, medical staff can get on with their job of patient management, while Bluetooth low energy-enabled devices reduce human error by ensuring patient data is accurately and securely transmitted to a central computer or vital signs monitor.

These devices don't only dumbly transmit data. A Bluetooth low energy-enabled device, for example a blood glucose monitor, could also instruct an IV drip to alter its rate of delivery to suit a patient's insulin levels. By allowing medical devices to make routine determinations medical staff can direct their attention to decision-making that does require specialist human intervention.

The other key factor in the case for Bluetooth low energy extends beyond the hospital walls. Hospital-based health-care is one thing, but health care in all its forms happens far more outside hospitals than in them, away from medical staff, GPs, or trained healthcare professionals. Consumers have already adopted Bluetooth low energy technology into their daily lives, and the popularity of wirelessly connected wearable and non-wearable devices performing health-based functions is booming.

No cost barrier

While developing a smart Bluetooth low energy wireless medical device is not trivial, thanks to today's powerful, highly-integrated Systems-on-Chip (SoCs) and widely-used software and hardware development tools, design has never been easier. For example, Nordic Semiconductor's nRF51822 SoC is a proven and flexible Bluetooth low energy chip (with support for other RF protocols) incorporating a 32-bit ARM Cortex M0 CPU and

generous Flash memory and RAM resources that all make it a good choice for wireless medical applications. Moreover, this performance comes at a sub-$2 price point (for volume purchases) allowing use in low-cost medical devices, including disposable ones. This is a market which is set to boom as evidenced by a recent report from analyst Market Research Future which predict that the market for 'smart' (wireless) asthma inhalers would be worth $1.6 billion by 2022.

One company that sees the opportunity that exists for innovation in wirelessly-connected medical devices aimed specifically at consumers, is Canadian digital health specialist, Aterica Health Inc. Formed in 2012, the company recently released its Veta Smart Case & App, a Bluetooth low energy wirelessly connected carrier for epinephrine auto-injectors, used to administer a dose of adrenaline in the event of anaphylaxis as a result of an allergic reaction.

Veta Smart Case is compatible with EPIPEN auto-injectors and generic to EPIPEN auto-injectors, and employs Nordic's nRF51822 SoC to provide wireless connectivity to Bluetooth 4.0 (and later) smartphones and tablets running the Veta App. In turn, the Veta App notifies the user and their invited support network in the event they become separated from Veta Smart Case, if the auto-injector fails to remain within a temperature range they set, if it is approaching expiry, or if it is removed from the Smart Case.

"Veta Smart Case is a novel product that clearly demonstrates how the application of Bluetooth low energy wireless can make medical conditions easier to manage," says Geir Langeland, Director of Sales & Marketing at Nordic Semiconductor.

Another company providing Bluetooth low energy medical innovation outside of hospitals, but in a professional healthcare environment, is Fort Lauderdale-based CarePredict Inc. The company recently released a wrist-worn device that monitors an individual's activity and behavior patterns, location, as well as providing a touch-button call system for real-time communication with caregivers. With an aging population increasingly requiring formal, facility-based care, the 'Tempo' wearable provides a solution to the problem of improving healthcare service levels while at the same time controlling the cost of doing so.

Tempo combines real-time observations with a machine learning platform to observe changes in seniors' activity

"Technology, of course, has a crucial role to play in healthcare. Not only machines that require a capital outlay in the tens of millions of dollars, but wireless technology that comes with a much more affordable price tag"

Designed for seniors or other users requiring supervised care, Tempo is based on the premise that changes in patterns of daily activities—such as eating, drinking, bathing, walking, and sleeping—are an earlier indicator of upcoming declines in health than physiological measures. The wearable combines continuous, real-time observations with a machine learning platform to observe patterns in daily activities and alert on anomalies, for example if the user is failing to eat or bathe with their usual frequency.

The Veta Smart Case notifies the user if they become separated from their epinephrine auto-injector

"In person, caregivers act as the human observers who are best situated to catch these changes in activity patterns," says Satish Movva, Founder and CEO, CarePredict Inc. "But human observation is unreliable. Hence we came up with a system that can take their place using continuous machine observation to [follow] patterns and alert on anomalies."

Tempo employs a wide range of sensors and proprietary algorithms monitor daily activities. This data is combined with contextual information to replace human observation for most activity and behavior patterns. The data is transferred to communication hubs placed throughout a senior group living facility or care home, using Nordic's 2.4-GHz proprietary wireless connectivity provided by the 3 by 3.2mm wafer-level chip scale package (WL-CSP) variant of Nordic's nRF52832 SoC.

Each hub also employs a Nordic nRF52832 SoC ensuring interoperability and allowing the data to be synced to the closest hub as a user moves throughout a facility. The hubs in turn forward the data to the machine learning back-end via the facility's Wi-Fi network. The machine learning back-end analyzes the data for anomalies and if one is detected, an alert is raised.

Veta Smart Case and Tempo are examples that demonstrate how Bluetooth low energy-enabled devices capable of improving healthcare outcomes now proliferate, and it's a trend that will continue as the cost of the wireless chips continues to fall dramatically, while at the same time offering the capability to perform ever more complex processing tasks. The universality of Bluetooth-enabled smartphones completes the picture. While technology may never replace a doctor's clinical experience or instinct, the traditional healthcare model of complete reliance on the physician is shifting, and technology is increasingly sharing the burden while reducing the costs. ■

Listen out for the voice-activated remote control revolution

Voice activation helps busy people at work and home. Bluetooth technology is bringing the same revolution to the humble remote control. Caroline Hayes reports

Caroline Hayes is a U.K.-based technology journalist

Voice-activated remote control will be a boon for the elderly

Wirelessly-connected voice-activated devices are on the rise. Personal assistants such as Apple's Siri have been helping users do things like access a calendar and digitize a voice command to send as a text since Siri's introduction in the iPhone 4S model in 2011. Speech-activated speakers, such as Amazon's Echo, using the Alexa voice assistant service, followed, and were quickly used to stream music and access information via the Internet. Amazon is estimated to have sold over eight million Echo devices since its launch in 2014 and general release in June 2015. Since they first appeared on the market in 2011, voice-activated RF remote controls have followed a similar trajectory.

According to analyst Technavio, in a report published earlier this year, the voice-activated device market will grow at a healthy eight percent compound annual growth rate (CAGR) to at least 2020. Over 90 percent of those devices will be smartphone or speech-activated speaker devices, but that still leaves a healthy and expanding market for voice-activated RF remote controls.

RF remote control has established a niche controlling smart TVs and games consoles because of its clear advantages over infrared (IR) technology. Attributes such as non-line-of-sight control, longer range, and bidirectional communication suit the demands of modern media appliances.

Voice-activation brings much more because it allows advanced cognitive instructions or searching. Simply replacing button pushes with voice commands such as "play" and "change channel" has limited potential, but instructing the device to "dim the lights by fifty per cent and change color to warm white" or "show me pictures featuring Mike from my September 2016 trip to Tokyo" has much greater appeal.

"The enhancements introduced in Bluetooth 5 are accelerating innovation in voice-activated remote controls"

Adding HID support

Bluetooth low energy has established a competitive position in RF remote controls in part aided by the Bluetooth Special Interest Group's (SIG) implementation of Human Interface Device (HID) support via the HID-over-Generic Attribute Profile (GATT) or "HoG" for short. GATT defines the data transfer protocol between two generic Bluetooth low energy devices while HoG defines the protocol for the HID use case. The HID profile was originally developed for classic Bluetooth and was the first Profile to be migrated to Bluetooth low energy.

In addition to Bluetooth low energy technology's bidirectional support, it boasts a high throughput (up to 2 Mbit/s with Bluetooth 5) and robust protocol which enables, for example, rapid and secure over-the-air device firmware updates (OTA-DFU).

According to John Leonard, a Product Marketing Manager with Nordic Semiconductor, the company uses a method dubbed "Voice-over-HoG" (VoHoG) which uses the HoG profile to capture, digitize, and transmit—using Nordic's Bluetooth low energy solutions—the sampled voice data received by the remote control's built-in microphone. At the receiver, the RF signal is decoded and software reconstructs the voice command and forwards it to a voice engine for action. Leonard points out that besides carrying voice commands, Bluetooth low energy allows other gesture, touch, and motion-based inputs including using remote controls as motion-controlled devices to point to areas on a TV screen.

The benefit of mature tech

The TV makers are always looking to enhance their products but can't afford to put their brand at risk by employing a technology that is not reliable or readily embraced by consumers. The lackluster response to 3D TV and curved screens illustrates what

happens when consumers are unconvinced by a technology. Bluetooth technology's consumer profile has convinced the makers that the low energy version is an established and trusted technology that can be safely incorporated into new TV sets. And the technology offers a degree of flexibility that competing solutions lack. That's good news for Bluetooth low energy remote controls in a market where several technologies are vying for supremacy.

Another consideration in the TV market is cost, and here again Bluetooth low energy scores well. Bluetooth low energy Systems-on-Chip (SoCs) are less expensive than other RF alternatives such as Wi-Fi, notes Nordic's Leonard. Crucially, Bluetooth low energy is also supported by the Linux and Android operating systems commonly powering smart TVs.

Other advantages of Bluetooth low energy in remote controls are its interoperability with Bluetooth v4.0 (and later)-enabled smartphones and tablets, and ease of over-the-air firmware updates. Further, Bluetooth low energy SoCs typically integrate powerful ARM microprocessors for single-chip solutions that require less space and extend battery life.

Manufacturers differentiate their products with clever application software and additional sensors, to track or detect motion or gesture, for example, or multitouch sensors to allow for scrolling or expanding.

To help accelerate novel RF remote design, Nordic Semiconductor has released the third generation of its Bluetooth low energy remote control reference design, the nRFready Smart Remote 3, for nRF52 Series SoCs.

Two versions of the remote are provided, one with a touchpad to support gesture control, one without for evaluation, testing, and demonstrating the remote-control design. Voice input is via two digital microphone inputs. The microphones support noise- and echo-cancellation for clarity in the audio input. The software framework supports multiple audio codecs that software developers can access and adapt to shape their solution to their exact needs. Functions can be removed to simplify design and save cost, and the modular software can be configured without coding – simply by selecting tick boxes.

Internet-connected speakers like Amazon's Echo demonstrate the power of voice activation

COURTESY: AMAZON

The reference design is an add-on for the Nordic's nRF52 Development Kit (DK) and contains external sensors to interface with the DK. Firmware and host software is included. The firmware runs on the nRF52 Series SoCs and the host software supports Linux.

Education program required

Despite some clear advantages for Bluetooth low energy in voice-activated remote control applications, it still faces challenges in gaining full acceptance. Chief among these is perception. According to Leonard, at present many companies see Bluetooth low energy only as a personal area network (PAN), limited to applications like fitness trackers.

"To change this perception requires an education program," says Leonard, "and that perception needs changing because Bluetooth low energy is now able to support a huge range of applications across all sectors, including those that demand mesh network topologies.

"For example, with the adoption of Bluetooth 5 [which doubles data throughput], Bluetooth low energy technology's power consumption is halved because communications take half the transmission time. This reduced time-on-air also improves coexistence with other 2.4-GHz technologies because there is less chance of packet collisions."

Such capabilities enable Bluetooth 5 to accelerate innovation in voice-activated remote controls. The latest version of the Bluetooth specification extends range, which, for example, allows users to control media sources at the other end of a large house. The increased throughput also accelerates over-the-air firmware upgrades limiting inconvenience when an update is needed.

Companies such as RFsen, a Shanghai-based original design manufacturer (ODM), are using Bluetooth 5 to enhance its remote-control designs. RFsen employs Nordic's nRF52832 Bluetooth 5-compatible SoC to power its BT5 Bi-Direction Audio Remote Module. The module powers remote audio streaming between the audio source and the user's mobile device. Thanks to Bluetooth 5's 2-Mbps throughput, RFsen's module can support high-bandwidth audio streaming via Bluetooth low energy, offering a 48-KHz audio sampling rate (superior to CD quality) with much lower power consumption than classic Bluetooth or Wi-Fi.

Thanks to RF technology, the remote control is undergoing a revolution that's just getting started. Voice-activation, allied with advanced cognitive instructions and searching, will accelerate that revolution and see RF remote controls being used for dozens of new applications. ■

Nordic's nRFready Smart Remote 3 reference design makes it easy for designers to select the hardware and software options for their next voice-activated remote

The Squid.link Gateway provides multiple wireless communication technologies to a range of smart home devices and the Cloud

Bridging the smart-home connectivity divide

The growing popularity of smart-home devices demands equally smart gateways to address interoperability and connectivity issues. ULP Wireless Quarter reports

Back in 2010, when the smart home concept was in its relative infancy, early pioneers proclaimed energy efficiency was the 'killer app' that would drive product development and in turn consumer adoption.

At the time, less than half a percent of homes in North America had a connected device. But fast forward to 2017, and according to analyst IHS, nearly seven percent of households in the region now have at least one connected smart-home device. By 2025, IHS predicts, the figure will reach 10 percent globally. While reducing power bills has indeed proved a catalyst for growth; convenience, security, and entertainment have emerged as equally important drivers.

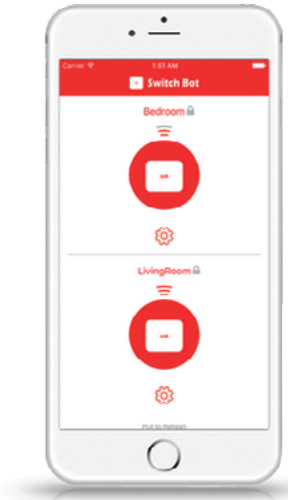
However, if the adoption of smart home solutions is to meet predictions, then certain hurdles will need to be overcome, not least of which is ironing out some connectivity and interoperability issues.

Smart-home device manufacturers currently have several low power wireless protocols to choose from when designing a connected product. Bluetooth low energy wireless technology, ANT, Thread, Z-Wave, zigbee, and several proprietary solutions all have their proponents: But regardless of the protocol and application, to make them truly 'smart' requires Internet connectivity. While developments are in hand, most of the commercial low power wireless solutions can't connect directly to the Internet; to do so means employing a gateway—typically a sophisticated device with its own processor and firmware—to provide that connection.

The smartphone option

Thread and Bluetooth low energy wireless technologies are leading the market for smart-home device connectivity. Thread, first released in 2015, is a low-power, easy-to-use, and secure open-standard protocol for wireless home automation networks. Thread gains an advantage over most other protocols targeted at smart-home applications by supporting Internet Protocol (IP), allowing Thread devices to communicate with all other IP-addressable devices without relying on an expensive and complex gateway. Instead, Thread networks employ relatively inexpensive 'border routers' to simply relay the short-range WPAN signals to the Internet proper.

Bluetooth low energy gains from its smartphone interoperability



Bluetooth low energy wireless technology gains market advantage because of its unique interoperability with most of the current generation of smartphones and tablets. These devices can provide a ready-made solution by acting as the gateway between the smart-home device and the Internet. According to analyst, Pew Research Center, roughly three quarters of Americans now own a smartphone, and a similar number have a broadband connection at home, so the mobile solution is effective - but only so far.

Smartphones are expensive, they are also power hungry, but more to the point, they aren't always in the home. While turning lights on and off from a smartphone or tablet when in the house is one thing, being

able to control the lights, or lock or unlock a door remotely, from anywhere, is where the potential of the smart home really comes into its own. And that requires something other than a smartphone for Internet and Cloud connectivity, to cater for when the mobile owner is out.

The missing link

Today, proprietary gateways provide the answer. Gateways aggregate data from multiple smart-home sensors, and relay that data directly to the Internet (via a wired link or Wi-Fi connection), allowing users to retrieve information about their smart appliances from the Cloud wherever they are in the world. Importantly, the connection is bidirectional, allowing for the remote operation of smart-home devices either from their smartphone or tablet, or via a Cloud platform.

Some advanced gateways go a step further by supporting multiple protocols ensuring interoperability between devices employing different wireless technologies. This affords smart-home product developers design flexibility while the smart-home market shakes out, and means end users don't need to hitch their wagon to a single Wireless Local Area Network (WLAN) technology.

"The smart home will be powered by several wireless technologies including Bluetooth low energy," notes Geir Langeland, Director of Sales & Marketing with Nordic Semiconductor. "Because of this, the market demands gateways that support multiple WLAN technologies and Cloud connectivity via Wi-Fi and cellular."

The recently launched 'Squid.link Gateway' from Denmark's Develco Products is a case in point. The gateway is an open Linux platform providing multiple wireless communication technologies to a range of smart home devices and the Cloud. In addition to Bluetooth low energy wireless connectivity provided by Nordic's nRF52832 System-on-Chip (SoC), the Squid.link Gateway supports cellular 2/3G, Wi-Fi, Wireless M-Bus, Sub-1GHz proprietary, zigbee, and Z-Wave.

Proprietary gateways link smart-home devices to the Cloud

"The market is demanding gateways that support multiple WLAN technologies as well as Cloud connectivity via Wi-Fi and cellular"

The gateway also supports Ethernet wired networking.

"It's important to include Bluetooth low energy in the Squid.link Gateway because it's an increasingly popular smart-home wireless technology that's been adopted by many sensor vendors," says Henning Mærkedahl, CTO with Develco Products. "But the gateway is modular and can handle many different wireless protocols at the same time, so solution providers are no longer dependent on one vendor."

For more complex applications—for example mesh-networked smart lighting—networks can use more than one gateway in a single installation. Last year Norwegian wireless network solutions company, Vitir, launched its 'MergeRF' system, a sub-1GHz self-forming and -healing mesh network enabling long-range communication between Bluetooth low energy devices. Each Vitir 'bridge' includes a Nordic nRF51822 SoC providing Bluetooth low energy connectivity between other gateways, Bluetooth low energy devices, and Bluetooth 4.0 (and later) smartphones and tablets.

The gateways act as routers for any payload, irrespective of origin in the network, and regardless of the original RF protocol. Together with a Central Unit (CU), interoperability between devices using any RF protocol is enabled. The CU acts as a gateway to the Cloud with a single RF connection point to the mesh, allowing new gateways or new protocols to be added to the mesh without the need to recertify the CU.

Vitir's Central Unit acts as a gateway to the Cloud with a single RF connection point to the mesh, easily allowing new bridges to be added

An eye to the future

While proprietary gateways and bridges provide a perfectly serviceable workaround to the smart-home Internet connectivity and interoperability conundrum, in the longer term better solutions exist.

Wi-Fi presents one option because many homes already employ a gateway in the form of a Wi-Fi router. At present Wi-Fi routers can't communicate directly with the protocols typically used for smart-home applications. While many enterprise routers already come with Bluetooth low energy wireless technology built-in, for example, consumer Wi-Fi router manufacturers have been slow to seize the opportunity. However, if these makers could also be persuaded to incorporate Bluetooth low energy wireless connectivity into omnipresent domestic Wi-Fi routers it would eliminate the need for today's proprietary solutions in a vast number of homes.

Integrating IPv6 into Bluetooth low energy devices so they can connect directly to any other IP-addressable device on the Internet (for example, a Cloud server) is another solution and would follow the path paved by Thread. As Bluetooth low energy wireless technology doesn't natively communicate using IPv6 the best way to achieve this is by incorporating a Network Adaption Layer and 6LoWPAN layer into the Bluetooth RF software protocol. This enables "IPv6 over Bluetooth low energy" in a similar way to that which the Thread protocol has employed.

Nordic offers developers this option with its nRF5 Software Development Kit (SDK) for IoT, but IPv6 over Bluetooth low energy is still some way from mass adoption. When it is, we'll be much closer to the end goal of low-power smart-home devices that can communicate directly with each other, and the Internet, in a standardized way without proprietary gateways or smartphones sitting in the middle. Such technology will form a genuine Internet of Things finally making smart-home products truly intelligent. ■

Smart pendant lamp directs ‘perfect light’ on any situation

With the support of Nordic Semiconductor, smart lighting company, Luke Roberts, has developed a wireless smart pendant lamp that can illuminate specific parts of a room

Kalon Huett is an Australia-based freelance journalist

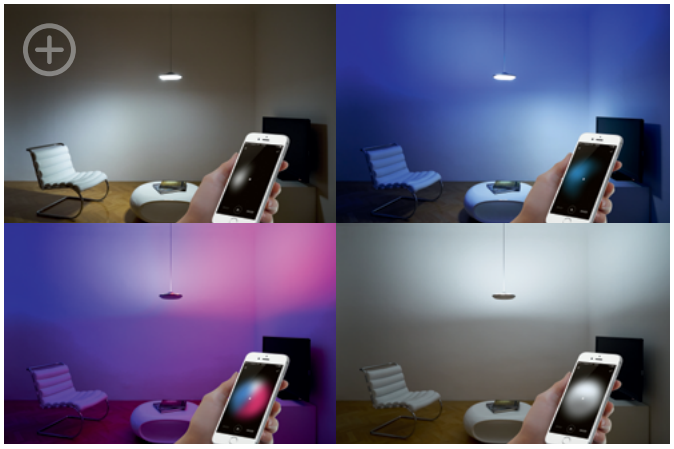
As the birthplace of Red Bull energy drink, the PEZ dispenser, blood transfusions, and even the humble postcard, Austria boasts a proud history of innovation. That innovation has now extended to the “Luke Roberts Smart Lamp”, which the Vienna-based inventors claim is the world’s first directed illumination smart pendant lamp. (*See this issue pg6.*)

The smart lamp is the inspiration of Luke Roberts, a lighting company developing LED-powered luminaires that produce high-quality light to suit a given scenario. The lamp embraces complex engineering to optimize a single home-automation function.

Powered by Nordic Semiconductor’s nRF52832 System-on-Chip (SoC), the product allows Bluetooth 4.0 (and later) smartphone or tablet users to “paint with light”, with the lamp reacting rapidly to user input via the smartphone app. The more ‘painted’ light, the brighter the lamp gets. And by using the connected smartphone or tablet’s digital compass along with the lamp’s own data, the app edit screen automatically aligns to the lamp’s orientation making it easy to direct the light to the preferred spot.

Lamp settings can also be saved enabling a single tap to reset the light to a specific ambience, while proximity detection ensures the light switches off when a person leaves the room and switches back on when they return, saving energy.

The technology sounds impressive, but it’s in operation



Colored uplight can project ambient light towards the ceiling

that the unique benefits of the Luke Roberts Smart Lamp shine brightest. For example, warm white light can be directed onto a table for dinner while simultaneously choosing a soft, cool-white ambient glow for the rest of the room. The user can even employ colored uplight to project various ambient light settings towards the ceiling for the ultimate ‘mood lighting’.

Start-up support

With several established technologies vying for a share of the lighting market, Bluetooth low energy’s widespread interoperability was a key reason for Luke Roberts to embrace the technology. “[Competitive technology] zigbee requires a hub or bridge device to communicate with the user device, resulting in complex set-up procedures and additional always-on hardware,” explains Lukas Pilat, Co-founder of Luke Roberts. “Bluetooth low energy was our choice due to its easy and hassle-free proximity-based approach for establishing a connection with a new device, and its widespread presence in almost any smartphone and tablet, avoiding the need for additional

“As a startup with initially only a single product, the wrong chip decision might be fatal for the entire company”

communication hardware.”

According to Pilat, when it came to the choice of chip, Nordic’s nRF52 Series SoC’s enhanced RF capabilities, Bluetooth 5 support, good link budget, on-chip balun, and processing power enabled Luke Roberts to implement all the features it envisioned without compromise.

The lamp reacts rapidly to inputs from the accompanying app

“Moreover, Nordic’s Software Development Kit [SDK] and the clean separation of Bluetooth stack software [SoftDevice] from our application code simplified the design process,” he adds.

While Nordic’s technology was part of the decision for Luke Roberts to partner with the company—for example, the nRF52832 SoC’s ARM M4F processor is powerful enough to support Bluetooth low energy operation while simultaneously running a ‘smart learning’ algorithm which learns from the user’s behavior, and the 512kB Flash memory provides ample capacity to store saved light settings—there was much more to the choice than that.

“As a startup with initially only a single product, the chip decision is a tough one, as a wrong choice might be fatal for the entire company,” says Pilat. “The risks of spending a year of development effort on a chip that is then not easily available, or having a lack of technical support that leaves you stuck with an issue for weeks is too high for a start-up. We chose Nordic because it was the most start-up supportive option.”

That supportive attitude extended to hardware, software, and access to other like-minded developers. Pilat cited the reference designs which shortened the PCB design cycle, open-source “friendliness” of Nordic’s code, and the Nordic DevZone which provided rapid answers to technical questions, as all influential reasons for partnering with Nordic.

With the Luke Roberts Smart Lamp becoming commercially available by the end of the year, a new chapter in the proud history of Austrian innovation is about to begin. ■

Bluetooth 5's advertising extensions

In addition to increased range and throughput, the updated Bluetooth 5 specification includes advertising extensions to improve applications like beacons

When Bluetooth 5 was adopted in December last year, the hype was about the specification's increased range and throughput enhancements. (*See* ULP Wireless Q, *Spring 2017, pgs16 & 17.*) Perhaps that excitement was understandable as these capabilities added much to Bluetooth low energy's suitability for the Internet of Things (IoT), but Bluetooth 5 did bring other improvements, notably "advertising extensions".

Bluetooth low energy uses 40 x 2-MHz channels across the 83-MHz wide 2.4-GHz ISM spectrum. Of these, three are dedicated primary advertisement channels (37 (2402 MHz), 38 (2426 MHz), and 39 (2480 MHz)), while the remaining 37 channels (0 to 36) are typically used for data channel transmission once a connection has been made.

The advertisement channels are used by devices to "advertise" their presence by broadcasting information to any "observer" devices within range. Observer devices "discover" the broadcasting device and can receive the information it transmits without a formal connection being made.

Bluetooth 5 technology's longer data packets and lower on-air transmission speeds while employing extended range operation (for example 125 kbit/s) have the potential to cause the three advertising channels to become congested. This could be a major challenge for applications such as beacons because the devices typically use these advertising channels to send information to nearby smartphones.

Advertising extensions were included in the Bluetooth 5 specification to overcome this problem. Now, advertising information commences as advertising packets sent over

Advertising extensions will boost indoor navigation because consumers won't need to install specific apps or create a connection to receive location-based information on smartphones

some or all of the three primary channels, but extra packets are then accommodated by "offloading" them to a normal data channel (which then acts as a "secondary" advertisement channel). Better yet, advertising extensions enables "chaining" of advertising packets to create greater advertising data payloads of up to 255 bytes. (See Figure 1.)

Connectionless broadcast

In addition, advertising extensions also bring a capability called periodic advertisements. This functionality comprises packets sent at a fixed interval to synchronized devices via

"Advertising extensions will have a major impact on the beacon sector"

"connectionless" broadcasting. By using periodic advertisements, scanning devices can more consistently "follow" the advertiser and monitor its updates more frequently. Connectionless broadcasting is further boosted because Bluetooth 5 features an eight-times higher broadcast capacity compared to previous versions of the technology. Connected devices can also make use of these enhancements to send more data and allow connections using secondary advertising channels (again freeing-up the primary advertising channels).

Advertising extensions, periodic advertisements, and connectionless broadcast will have a major impact on beacons. Before Bluetooth 5's advertising extensions, advertising packets were limited to 31 bytes which rationed the information that could be transferred in a connectionless broadcast. Now, for example, instead of being able to send just a URL to a smartphone which a consumer must then visit for more information, a retailer can directly send information about a special deal or new product. And indoor navigation will receive a boost because consumers won't need to install specific apps or create a connection to receive location-based information. This won't happen overnight because few current smartphones incorporate Bluetooth 5, but expect beacons to proliferate over the next several years as new smartphones are rolled out.

Nordic's nRF52810 and nRF52832 Systems-on-Chip (SoCs) support Bluetooth 5's high throughput and advertising extensions, periodic advertisements, and connectionless broadcast, while the nRF52840 SoC additionally supports range extension. The S132 (v5.0) SoftDevice, a 20-link multirole, pre-qualified, Bluetooth low energy protocol stack with full link concurrency in all role combinations is fully compliant with all features of Bluetooth 5. ■

Further technical information on Bluetooth advertising extensions can be found on Nordic's DevZone, starting with the blog at https://devzone.nordicsemi.com/blogs/1093/taking-a-deeper-dive-into-bluetooth-5/.

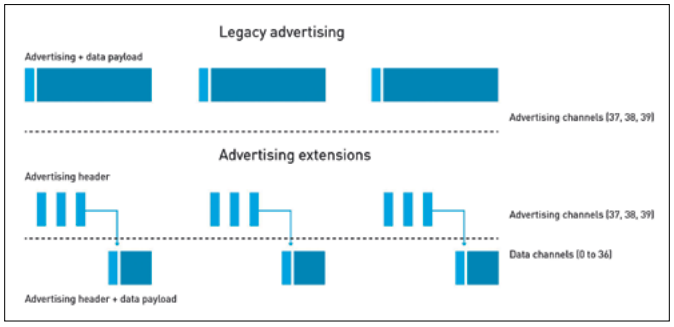


Figure 1: Prior to Bluetooth 5, advertising packets were limited to the technology's three advertising channels. Busy use risked congestion. With advertising extensions, advertising data packets can be offloaded to normal data channels acting as secondary advertising channels

Humon Hex Muscle Monitor

This Bluetooth low energy wearable muscle performance monitor provides athletes with instant feedback on training intensity

According to analyst, Crystal Market Research, by 2025 the wearable sensors market is projected to be worth $4 billion, with motion sensors holding a significant share of the market owing to the increase in smart devices tracking physical activity. Humon's Hex muscle monitor helps people doing endurance sports or interval training improve their performance by employing near-infrared spectroscopy to measure the way their muscles are using oxygen. This provides real-time feedback on when and how hard to push themselves for optimal benefit

'Hitting the wall', a term athletes use to describe an abrupt decline in the ability to maintain the desired intensity of endurance exercise performance, was first coined back in the 1950s. The phenomenon, also known as 'bonking' is caused by the depletion of liver and muscle glycogen reserves and the accumulation of blood lactate

The Humon Hex is strapped to the user's thigh where LEDs emit light into the muscle tissue, and detectors measure the intensity of light that propagates through the muscle. This allows the calculation of the muscle's hemoglobin saturation, a key metric in ensuring appropriate exercise intensity

The muscles in the front of the human thigh, or quadriceps, are the strongest and leanest of all muscles in the body. German track cycling sprinter Robert Förstemann, nicknamed 'Mr Thigh', has a thigh diameter of 86 centimeters, as wide as the waist of an average man

Performance data is processed in real-time and using the Nordic nRF52832 SoC's multiprotocol Bluetooth low energy or ANT+ wireless connectivity, syncs to the user's Bluetooth 4.0 (and later) smartphone, tablet, or compatible Garmin watches. The generated metrics instantly inform the user when they are exerting themselves within the limits of their threshold

PEOPLE & PLACES

Patrick Noordhoek

Flying high at work and at home

Hi, I'm Patrick Noordhoek and I'm a new Regional Sales Manager within Nordic's EMEA (Europe, Middle East, and Africa) sales team.

Before joining Nordic, I was Field Marketing Manager for Bluetooth and Wi-Fi products at Atmel and later Microchip. Prior to that I worked in a design architect role on remote controls for Universal Electronics, and before that I led a very talented team of hardware and software design engineers at S3-Group in Poland, focusing on set-top box development.

My main objective is to get even more Nordic chips designed into even more wireless products, and there are a number of ways I can help make this happen. One is training and motivating Nordic's distribution partners to promote Nordic's chips. Another is identifying new markets where Nordic's chips could be used. Another is maintaining top quality relationships with and within Nordic's existing customers. I also work closely with module makers that sell modules employing Nordic silicon.

Today Nordic's overriding sales focus is Bluetooth low energy chips. But this will soon expand to include cellular IoT products too, which will open up a whole new world of application opportunities for the company.

Outside of work, Noordhoek enjoys physically active pursuits

One of the things I am really enjoying about my new job is the opportunity to work within a winning team, selling class-leading wireless technology relevant to an ever-expanding range of applications that genuinely improve people's lives.

What makes this even more exciting is that Nordic's competitors are always chasing hard to catch-up, so the company can never stand still in any area—from R&D, technical support, and marketing—to sales.

A good example for me is the Nordic Thingy:52. I've seen a lot of reference designs, eval kits, and demos in my career; but nothing quite like the Thingy:52. Most Bluetooth dev solutions require you to install an app on your phone first before they start working. Amazingly though in the case of Thingy:52, there was no app required. It connected to my phone and started sending data and displaying it on my screen straight out-of-the-box. I thought this was both remarkable and brilliant.

Outside of work, possibly because I spend a lot of time at a desk, I spend my free time in a physically active way doing things I enjoy. This includes daily long walks with our dog—a 150-pound Black Russian Terrier that was bred to work hard all day and therefore needs a lot of exercise—as well as playing tennis, running, and like any self-respecting Dutchman, quite a bit of cycling too. In the holidays, I often drag my family up a few mountains in beautiful Scotland which is a great way to spend quality time together.

Finally, I am also passionate about building and flying unmanned drones. It's a truly engrossing hobby that would benefit from even more hours than I've managed to invest over recent years. But the complexity involved and possibilities are endless and the sophistication that can be built into these drones nowadays is truly amazing. My own experiments in building resulted mostly in crashing; but it needs perseverance. That's the path to mastery. And from a professional perspective, Bluetooth 5 is definitely a great wireless technology for control of shorter range drones. I'd like to give that a try one day. ■

Personal Profile

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JOB TITLE:
Regional Sales Manager

JOINED NORDIC:
May 2017

BASED:
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INTERESTS INCLUDE:
Drones, running, walks with dog, tennis, cycling

"I've seen a lot of eval kits in my career, but nothing like the Thingy:52. It connected to my phone and started sending data and displaying it on my screen straight out of the box"

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