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Wearables merge wellness and lifestyle

NORDIC
SEMICONDUCTOR

OPINION

J. Darren O'Donnell

Bluetooth low energy technology's long tail wags

Here at Nordic we don't pay too much attention to speculated numbers because many unpredictable factors can influence exactly how many shipments end up being made in any given year. But there's no denying Bluetooth low energy is tracking a steep growth curve which doesn't look like it's going to reach a plateau for a few years yet.

This growth is driven primarily by three factors: Bluetooth technology's interoperability with smartphones and tablets; the integrated silicon, tools, and support that chip vendors such as Nordic supply to make it much easier for non-RF experts to develop wireless products; and the incredible innovation of customers that come up with increasingly novel ways to use a Bluetooth wireless link.

Such innovation is likely to multiply with the introduction of Bluetooth 5, a revision of the technology that significantly enhances range and throughput. Nordic's first fully-compatible Bluetooth 5 chip, the nRF52840, complete with a new Bluetooth 5 SoftDevice (protocol 'stack'), is now available for engineers wanting to take immediate advantage of the new technology. (*See page 3.*)

We're proud of our association with blue-chip companies such as the world's fourth largest smartphone firm, Xiaomi, which has just selected a Nordic chip for the remote control used with its latest mobile VR headset. (*See page 8.*) Or U.S.-based navigation and sports-monitoring equipment maker Garmin, which has selected Nordic products for its latest children's activity tracker. (*See page 4.*) Or South Korea's consumer giant, LG, which is using Nordic technology in its latest range of wireless mice. (*See page 5.*)

But these large, well-known companies form just a small proportion of the thousands of commercial applications that employ Nordic technology, and we're equally proud of our association with the hundreds of other companies that are yet to become household names, in part because they represent the fruition of Nordic's strategy to encourage and offer technical support to even the lowliest start-up.

For several years now Nordic has recognized the groundswell of innovation coming from sectors such as crowdfunded start-ups and the Maker Movement—amateur engineers with a passion for design, assembly, and writing lines of code—and has targeted chips, development kits, and online technical support to help these sectors bring their ideas to life. The rapidly increasing sales of development kits (18,600 in the first half of this year alone) and questions published on Nordic's DevZone community (18,000 and climbing daily) proves there are plenty of would-be technical entrepreneurs in the world.

These tiny, small, and medium concerns represent a gratifyingly long tail on Nordic's shipment reports. And it's a tail that's wagging enthusiastically. Individually, these companies might not purchase tens of millions of chips per year, but collectively they contribute significantly to Nordic's market share. And there's a good chance that a company which could grow to the size of Xiaomi, Garmin or LG, is among them.

Yours Sincerely,

J. Darren O'Donnell
Director of Marketing & Sales - Americas

Contributors

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John Leonard is Product Marketing Manager with Nordic. On page 9 he looks at how wireless technology is set to further disrupt the automotive industry

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Sally Ward-Foxton is a freelance journalist specializing in electronics. On page 14 she examines the global roll-out of the BBC micro:bit STEM project

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Caroline Hayes is a U.K.-based technology journalist specializing in semiconductors. Here she takes a closer look at Nordic's new dedicated IoT Lab

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Nordic's Bluetooth 5 ready SoC redefines single-chip wireless

Nordic Semiconductor has launched a Bluetooth 5 ready System-on-Chip (SoC), the nRF52840. The SoC offers features and capabilities that redefine the performance envelope of single-chip Bluetooth low energy smart home, advanced wearables, and Internet of Things (IoT) applications.

Compliance with the Bluetooth 5 specification, coupled with increased maximum output power, enables the SoC to deliver Bluetooth low energy wireless connectivity with up to 4 times the range, or two times the raw data bandwidth (2Mbps), compared with the previous Bluetooth low energy implementation (Bluetooth 4.2).

In addition to Bluetooth 5 support, the nRF52840 SoC includes an IEEE 802.15.4 wireless technology capability,

The Bluetooth 5 compliant nRF52840 System-on-Chip boasts a host of feature enhancements

significantly extending the SoC's capability as an interoperable foundation technology for IoT networks using several different wireless technologies.

The nRF52840 SoC's hardware enhancements include a doubling of Flash memory to 1MB and quadrupling of RAM memory to 256kB, as well as a full speed (480Mbps) USB 2.0 controller, and a host of new peripherals

including a quad-SPI interface.

Designed to address the inherent security challenges faced in IoT applications, the SoC incorporates an ARM CryptoCell-310 cryptographic accelerator offering "best-in-class" security for Cortex-M based SoCs. Extensive crypto ciphers and key generation and storage options are also available.

The introduction of the nRF52840 SoC will be accompanied by the release of the S140 SoftDevice, the company's latest addition to its family of RF protocol software 'stacks'.

"The nRF52840 builds on the success of the nRF52 Series but enables developers to embark on even more ambitious single-chip smart home, wearables, and IoT applications," says the company's Thomas Bonnerud.

Nordic named 'most respected' IC company

Nordic Semiconductor has been voted 2016's 'Most Respected Public Semiconductor Company' (achieving annual sales of $100 to $500 million) by fellow members of the Global Semiconductor Alliance (GSA). The announcement came during a ceremony held in Santa Clara, CA. The GSA is a 400-member strong, non-profit international trade organization headquartered in the U.S.

The GSA says the award identifies the public company garnering the most respect from the industry in terms of its products, vision, and future opportunities. In addition, profitability and market capitalization, among other financial and product successes, were considered.

"A GSA award is considered one of the most prestigious prizes a semiconductor company can win," says Nordic's CEO, Svenn-Tore Larsen. "Being named the 'Most Respected Public Semiconductor Company' by the alliance is probably the highest independent recognition Nordic has achieved as a company, even surpassing being named last year's 'Most Outstanding EMEA [Europe, Middle East, and Africa] Semiconductor Company' by the GSA."

Nordic's Chris Hansen receives the GSA's 'Most Respected' award on behalf of the company

Over the past decade, Nordic has transformed from a little-known supplier of sub-1GHz and 2.4GHz proprietary ultra low power chips into the world's largest Bluetooth low energy solutions provider.

"A global wireless revolution called the Internet of Things is happening and Nordic's technology is right at its center," says Larsen.

In brief

Nordic winner of Bluetooth SIG award

Nordic Semiconductor's Leif-Alexandre Aschehoug has been recognized for his contribution to the Bluetooth SIG's working groups, being named a 'Key Contributor' in the recent Working Group Awards. According to the Bluetooth SIG, the Working Group Awards recognize outstanding contributions made by working group members in advancing Bluetooth technology, particularly in the promotion, development, and execution of the Internet of Things (IoT).

Dynastream launches dual-protocol module

Long-term Nordic design partner, Dynastream Innovations, has released its D52Q ANT and Bluetooth low energy modules designed to fast-track wireless sports, fitness, and broader Internet of Things (IoT) product development. The module, available in two variants depending on the application, employs Nordic's nRF52832 System-on-Chip to offer manufacturers a comprehensive, certified RF solution for complex dual-protocol wireless products.

Wireless overtakes wired headphones

Bluetooth headphones outsold wired headphones for the first time ever in the first half of 2016, according to consumer research firm NPD Group. According to the analyst, the growth of Bluetooth low energy and the reduced cost of wireless headphones were major factors in the result. It said Apple's decision to eliminate the headphone jack from its latest generation iPhone would further push overall adoption of Bluetooth wireless headphones.

In brief

Bluetooth low energy market set for lift-off

Research analyst, Beige Market Intelligence, forecast the worldwide Bluetooth low energy market to grow at a CAGR of around 28 percent between 2015 and 2021. It said the growth in connectivity is primarily driven by an increasing consumer appetite for "accessing content without barriers". The consumer electronic segment was valued at around $485 million in 2015 and is expected to reach over $2.4 billion by 2021. The healthcare Bluetooth low energy market is expected to grow at a lower rate, as the market is more mature, the analyst said.

Aalberg releases wireless switcher

Aalberg Audio has launched a Bluetooth low energy wireless switcher, allowing guitarists to simultaneously and remotely control amplifiers, effects pedals, and MIDI equipment. The MOON MO-1 wireless switcher employs Nordic's nRF51822 System-on-Chip, and works in conjunction with Aalberg's AERO AE-1 wireless remote controller attached to their guitar. The MOON wireless switcher can then be plugged into an amplifier or any piece of equipment with a MIDI input, allowing the musician to control that device from the AERO.

Connected appliance shipments on the rise

The number of connected home appliance shipments is set to reach 202 million globally by 2021, rising from just 17 million in 2016, according to Juniper Research. Juniper said with the additional cost of including basic connectivity now less than $10, hardware manufacturers will increasingly introduce the functionality into many mass market, as well as high-end items, including fridges, ovens and washing machines. The analyst said many smart appliance vendors were focusing on making the fridge the hub of the 'smart kitchen'.

Garmin unveils first children's activity and sleep monitor

Garmin has launched an activity monitor targeted at children and designed to let parents track their offspring's steps and sleep from their smartphone. The monitor employs Nordic's nRF52832 System-on-Chip (SoC) to provide Bluetooth low energy wireless connectivity with the handset.

The swim-friendly vívofit jr. is said to offer all the accuracy and sophistication of Garmin's adult vívofit activity trackers, including the same 64 by 64-pixel display featured on the Garmin vívofit 3, but with a stripped-down feature-set relevant to children. This enables the device to deliver a one-year-plus battery life from a user-replaceable CR1632 coin cell battery to eliminate the hassle of recharging for parents.

Designed for children to wear around the clock, the swim-friendly device allows parents to assign chores and rewards via a companion smartphone app, that can also simultaneously monitor multiple activity trackers.

Chidren's monitor offers the same accuracy as Garmin's adult trackers

"Garmin has been using various Nordic Semiconductor Bluetooth low energy and ANT wireless technology chips in a wide range of its sports products for many years," comments Justin Lyons, Design Engineering Manager, Fitness Segment, at Garmin.

"We find by employing Nordic's ultra low power wireless technology we are able to develop and engineer sports products that give our customers the high-quality experience and reliability they have come to

expect and rely on from Garmin."

"The Garmin vívofit jr. demonstrates the level of sophistication driving the wearables market forward," says Geir Langeland, Nordic's Director of Sales & Marketing.

"Even activity monitors designed for kids now offer comparable leading-edge performance and feature sets as their adult-targeted equivalents."

The Garmin vívofit jr. will be showcased on Nordic's booth at International CES 2017 in January.

Power Profiler kit for embedded design

Nordic Semiconductor has released its Power Profiler Kit, a development tool comprising PC-based software and an extension board for the company's nRF51 and nRF52 Series Development Kits (nRF51-DK and nRF52-DK).

Targeting software and hardware engineers designing embedded solutions, the low-cost Power Profiler Kit development tool provides a simple method to measure dynamic power consumption in embedded solutions.

Embedded devices continuously change between low power- and active-modes. In addition, precise power consumption measurement becomes more difficult as duty cycle decreases. In some Bluetooth low energy applications power mode changes are frequent and the duty cycle may be less than 1 percent, making the use of standard power measurement tools impractical.

The Power Profiler Kit overcomes these challenges and is designed to be used for the entire wireless product development cycle. The kit's low cost allows every engineer working on a project to have their own unit.

The PC-based tool also makes it easy to detect

flawed- or non optimized-software because it clearly indicates unusually high power consumption, for example from active modules that the software should have disabled.

During the initial phase of product design, the kit can be employed to measure the power consumption of the nRF51 or nRF52 Series System-on-Chip (SoC) while the prototype product is developed on the nRF5x-DK. For later stages it is possible to measure the power consumption for the entire design on the final PCB. Continuous power consumption measurement at all stages of development ensures power problems are identified early making it easier to avoid later time-consuming revisions of code.

The Power Profiler Kit is designed for the entire wireless product development cycle
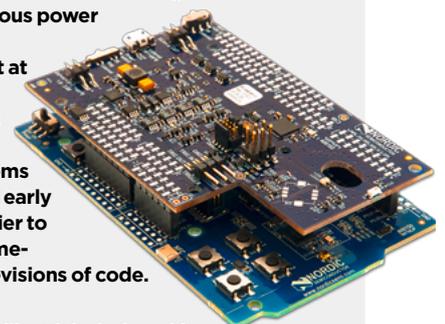
LG Electronics selects Nordic multiprotocol SoCs for dual-operating optical mouse

Multinational electronics giant, LG Electronics, has unveiled its MEB-300 dual-operating optical mouse, which simultaneously supports Bluetooth low energy and 2.4GHz proprietary operation by employing Nordic Semiconductor's nRF51822 multiprotocol System-on-Chip (SoC).

The use of Nordic's multiprotocol ultra low power (ULP) wireless technology allows consumers to use the LG MEB-300 mouse with older PCs that are incompatible with Bluetooth 4.1 (and later), while ensuring interoperability with Windows PCs, tablets, and smartphones that do support the later versions of the Bluetooth standard.

When used with older PCs the MEB-300 employs the nRF51822 SoC's 2.4 GHz proprietary RF

The LG MEB-300 mouse features a 'beetle-style' sliding cover

protocol software and connects via Nordic's nRF24LU1+ 2.4 GHz USB dongle plugged into a USB port on the PC. When paired with Bluetooth 4.1 (and later) compatible equipment no additional hardware is required. This dual operation allows consumers to, for instance,

seamlessly switch operation between a Bluetooth 4.1 incompatible and Bluetooth 4.1 (or later)-equipped PC.

The three-button LG MEB-300 mouse is powered by two AAA batteries and features a unique, 'beetle-style' sliding cover, making the mouse larger and more

comfortable for operation, while retaining a slimline form factor for portability.

"People are increasingly using tablets, and even smartphones, more like a PC and there is a need for easier control," says Michael Park, Vice President of LG Electronics. "The LG MEB-300 supports any device, and easily switches between Bluetooth low energy and 2.4GHz modes so there is no need to buy additional mice for incompatible devices.

"We wanted a dual-mode mouse and Nordic's nRF51822 SoC is a very powerful single-chip solution that supports multiprotocol operation. Other chipset makers don't have a single-chip multiprotocol [IC] that is an effective solution from both a cost and engineering overhead perspective."

Latest nRF5 development kit boosts device security

Nordic Semiconductor has unveiled its nRF5 SDK v12.0, supporting secure and signed over-the-air device firmware updates (OTA-DFU) to strengthen application updates from potentially damaging malicious device upgrade attacks. The SDK uses secure signatures to authenticate that updates from a verified and trusted source can be made on a given device.

In operation, a classic public/private key security structure is employed whereby public keys are distributed and private keys remain solely with the sending party, thus ensuring one-to-one security. Using ciphers to create keys in the Nordic nRF5 SDK v12.0 can be done in various ways, providing developers with flexibility to create ciphers in whatever

The latest nRF5 SDK protects application updates from malicious device upgrade attacks

way they prefer. This includes Nordic-authored examples using, for example, ECDH using the P256 curve to establish secure connections in Bluetooth low energy.

"Security is of paramount importance amongst companies involved in the IoT

[Internet of Things] and you need to know that something as important and fundamental as a firmware upgrade in a product is what it says it is and comes from a trusted source," says John Leonard, Product Marketing Manager at Nordic.

"The ability to perform software and firmware updates is an absolute necessity, and the easiest and safest way to do this in Bluetooth low energy products is via secure, signed OTA-DFU updates which is what our latest nRF5 SDK v12.0 is all about."

If a secure OTA-DFU is interrupted, a 'resume-from-failure' feature allows updates to resume from the last know good point and complete instead of restarting the entire upgrade process from scratch.

Retail driving beacon uptake

Research analyst, Technavio, predicts the global Bluetooth beacon devices market will grow at a CAGR of around 223 percent by 2020, thanks to the evolution in organized retailing amongst supermarkets and department stores. Bluetooth beacons are mostly used to track inventory and also to offer discounts to consumers based on their buying patterns. According to Technavio, surveys indicate that around 70 percent of shoppers would use personalized messages generated by Bluetooth low energy beacons to make purchasing decisions.

Security fears in smart home trend

The rapid rise of smart home connected devices is seeing vendors and new startups scramble to get a share of a sector predicted to ship 360 million smart home devices by 2020, analyst ABI Research has claimed. However many companies are leaving major security flaws in the wake of their hurried attempts to penetrate the market, producing products riddled with bugs and unpatched vulnerabilities. ABI said numerous attack vectors have been identified in popular smart home communication protocols, such as ZigBee, Z-Wave, and Wi-Fi.

In brief

Wearable word counter tracks verbal engagement with infants

Californian childhood education technology company, VersaMe, has launched an educational wearable for infants and toddlers that tracks verbal engagement between the children, parents, and carers.

The pacifier, star-shaped device, called Starling, attaches to the child's clothing, and employs Nordic's nRF52832 System-on-Chip (SoC) to provide Bluetooth low energy wireless connectivity between the device and iOS smartphones and tablets.

According to VersaMe, research shows the number of words a child is exposed to before the age of four is the greatest predictor of their future success. The Starling wearable word counter is designed to help parents monitor this engagement, counting the number of words a child says and hears each day, measuring the total against a customized daily word goal. Starling works in any language and has been successfully tested in English,

Starling counts the number of words a child hears each day

French, Mandarin, Hindi, Japanese, and Hebrew amongst others.

To start using Starling, the device is first calibrated to recognize the voices of the

infant's caregivers, filtering out background noise, such as television sound or other voices in restaurants. Once calibrated, Starling processes the audio signals from a parent's verbal engagements with their child, and via its proprietary algorithms measures and tracks the number of words spoken to a child each day.

This meta-data (no speech is recorded) is then transmitted via Bluetooth low energy connectivity to the Starling app running on Bluetooth 4.0 (or later) iOS smartphones. From the Starling app the user can set word goals for their child and view the number of words the child has been exposed to that day and since they first started using the device. The app also monitors battery life, and accesses age appropriate activities to help boost children's word exposure.

"Our engineers have worked with Nordic on multiple occasions and were set on Nordic from the start," says VersaMe Founder, Nicki Boyd.

Rigado Bluetooth low energy modules offer ultra-compact IoT and wearable connected products solution

U.S. engineering firm Rigado has launched a Bluetooth low energy module designed to provide developers of Internet of Things (IoT) and wearable connected products with a plug-and-play solution that can lower development costs and speed time-to-market.

Fully certified to Bluetooth 4.2, the BMD-350 employs the 3 by 3.2mm wafer-level chip scale package (WL-CSP) variant of Nordic's nRF52832 System-on-Chip (SoC) which results in an 8 by 6.4 by 1.5mm form factor and makes the module suitable for a wide range of space-constrained, low power applications.

As with Rigado's other

wireless modules, the BMD-350 benefits from the company's DeviceOps tools for faster development and secure over-the-air firmware updates. These tools allow product design teams to speed up time-to-market for IoT product lines, reduce customer risk, and efficiently manage the secure future updating of device firmware and configuration.

"Our clients, especially those creating commercial and wearable IoT devices, are focused on reducing time-to-market and entry risk by leveraging our certified modules and software," explains Ben Corrado, CEO of Rigado. "A plug-and-play

The module is suitable for space-constrained, low power applications

Bluetooth low energy module, certified to the latest Bluetooth

specification, that ranges well beyond 100 meters and is only the size of an aspirin, opens up a whole range of new applications."

"For IoT products, customers expect their smart devices to stay smart and even 'get smarter' over time," says Justin Rigling, Rigado's VP of Engineering. "Our clients require the ability to update and extend their connected devices to maintain compatibility and also unlock new feature capabilities as those become available. The BMD-350 module's over-the-air software update feature enables us to meet those expectations."
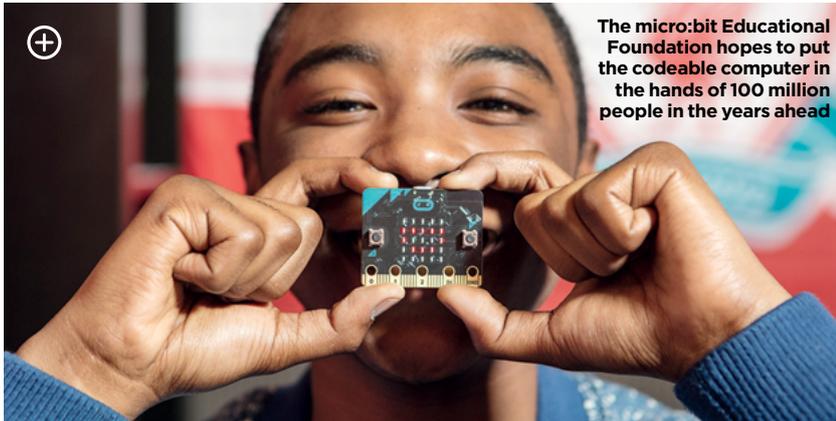
The micro:bit Educational Foundation hopes to put the codeable computer in the hands of 100 million people in the years ahead

Codeable micro:bit computers plan for world domination in education

The BBC micro:bit, the codeable computer Britain's public broadcaster gave away to every 11-12 year old school child in the U.K earlier this year in an effort to encourage children to learn coding skills, now has its sights set on a global audience with a plan to put the device in the hands of 100 million people worldwide.

At the heart of the BBC micro:bit is a single Nordic's nRF51822 System-on-Chip that integrates a 32-bit ARM Cortex M0 microprocessor where user-created software code runs. The SoC also allows the micro:bit to wirelessly communicate with smartphones and other micro:bits, via Bluetooth low energy wireless technology.

Beyond the U.K, micro:bits are also already in use in schools across the Netherlands and Iceland, but a new non-profit foundation that is taking over from the BBC, intends to coordinate a wider rollout. "Our goal is to go out and reach 100 million people with the micro:bit," says Zach Shelby, Chief Executive of the foundation. "That means [selling] tens of millions of devices over the next five to ten years."

The foundation plans to ensure micro:bits can be bought across Europe before the end of the year and is developing Norwegian and Dutch-language versions of its coding web tools to boost demand. In 2017, the foundation plans to target North America and China, which will coincide with an upgrade to the hardware. "We will be putting more computing power in," says Shelby. (*See this issue pg14.*)

Bluetooth technology is helping disabled swimmers achieve personal bests

Connected swimming cap aids Paralympians

A Bluetooth low energy-powered swimming cap that automatically alerts blind swimmers when to turn around for another length was unveiled at the 2016 Paralympic Games in Rio de Janeiro.

Developed by Samsung and Cheil Spain, the device—as yet only available to elite swimmers—is said to be the first major technological advance in blind swimming since the event was introduced to the Paralympics 56 years ago.

The current method for letting visually impaired swimmers know when it's time to make their turn is for coaches to tap them on the head with a big stick as they approach the poolside. The drawback is that this relies on arm reach and pinpoint timing. With the connected swim cap, the coach just has to press a button on their smartwatch or smartphone to create a slight vibration in the swim cap which notifies the swimmer to turn.

Split-second precision is easier to achieve with the press of a button instead of a long pole, which means the swimmer gains valuable time.

Toyota pilots device to unlock doors wirelessly from mobile app

Drivers may soon be able to lock and unlock car doors and start vehicle engines without the need for a key, using their smartphone and a Smart Key Box (SKB) inside the vehicle employing low-power wireless connectivity.

Recently unveiled by Toyota, the device is set to be piloted with U.S.-based car-sharing company Getaround in January 2017. The SKB forms part of a new Mobility Services Platform (MSPF) that has been established by Toyota to support a range of mobility services including car sharing, by allowing drivers to instantly access codes to unlock doors directly through a mobile app.

"To enhance MSPF-based car sharing, Toyota developed the SKB that can be placed in a vehicle without modification," says
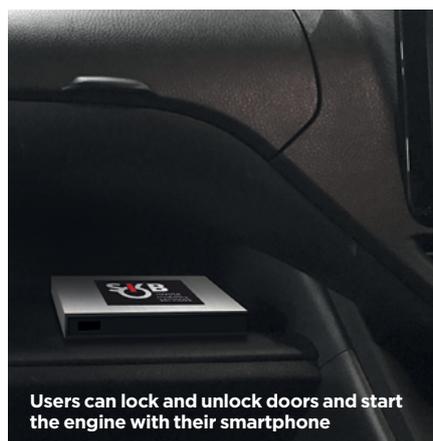
Users can lock and unlock doors and start the engine with their smartphone

Toyota. "Car-sharing users can lock and unlock doors and start the engine with their smartphone, thus providing a safer and more secure way of lending and renting cars.

"A smartphone application will receive codes to access the SKB device, which the assigned vehicle owner has placed in the vehicle. When the smartphone is brought near the vehicle, the codes are authenticated with the SKB [via lower power wireless connectivity] and the user can operate the key with the smartphone.

"The time and period when the user can access the SKB is set and managed by the reservation center. Toyota will consider using the MSPF for other services in Japan," says the company. (*See this issue pg9.*)

Nordic backs Xiaomi's push into burgeoning China mobile VR market

Smartphone-based headsets allow consumers to experience VR on-the-go. Now, Nordic wireless connectivity has enabled Xiaomi to make the experience even more compelling

For decades VR promised users an alternative 'reality' to the one in which they were physically present by donning an all-encompassing headset connected to a computer. The vision was that the user could ride Colorado River rapids, climb Everest, or play the lead on Broadway without leaving the comfortable surroundings of their living room. Unfortunately, limited computing power, creaky software, and pixelated graphics undermined the experience. But the technology has accelerated, allowing the VR experience to finally realize its potential.

Analyst Deloitte Global, for example, predicts that 2016 will be the first billion-dollar year for the technology. Of that total, the company says around $700 million (comprising some 2.5 million headsets) will come from hardware with the rest being made up of (around 10 million) game purchases. China is the largest market for VR by some distance (based on game sales) with an estimated three million headsets already in circulation in a dramatically-growing market.

The sector divides into two segments: expensive high-end headsets tethered to PCs or games consoles; and a rapidly-expanding mobile VR category. Mobile VR combines a smartphone-powered app with the optics of a lightweight headset to create a VR experience at a fraction of the cost of the high-end products. Deloitte Global forecasts at least half a million mobile VR units will be sold in 2016.

Extending mobile VR

The world's fourth-largest smartphone manufacturer, Beijing-based Xiaomi, is a leading mobile VR player in its home market with headsets based on its 'Mi' family of smartphones. The

By using the nRF52832 SoC, Xiaomi reduced the Mi VR wireless controller's complexity, cost, and power consumption, without any compromise in performance

"Nordic's chip ensures the user has an exciting VR experience free of the motion-sickness effects that many competitive products exhibit"

company has built market share with its 'Mi VR Play' and has now introduced the highly-portable 'Mi VR' to extend the reach of high-quality mobile VR to price-conscious consumers. The Xiaomi smartphone hosting the VR app is inserted into the side of the headset and held securely in place allowing the user full freedom of movement. Xiaomi says the Mi VR headset enables users to recreate the same VR experience as more expensive competitive products.

The company specified Nordic's nRF52832 Bluetooth low energy System-on-Chip (SoC) in the wireless motion controller bundled with the Mi VR headset. The wireless motion controller—which incorporates a nine-axis Inertial Measurement Unit (IMU) and three-degrees-of-freedom motion tracking—is held by the user during play to translate their movements in the real world to movements of the player within the smartphone VR app. In addition, the wireless controller, powered by a pair of AAA batteries, includes control buttons to enable the user to interact with the VR app.

"Xiaomi has built an impressive reputation for 'cool', high-quality consumer products at an affordable price," notes Geir Langeland, Nordic's Director of Sales & Marketing. "And now with the Mi VR Play and Mi VR, the company has applied its renowned development skills to the rapidly expanding mobile VR sector, a market which China's consumers have embraced more enthusiastically than anywhere else in the world. We're pleased to be part of that initiative."

The performance of the nRF52832 SoC was a key reason for Xiaomi's selection of the Nordic device in the Mi VR's wireless motion controller. "The [ARM M4F] processor has ample performance to cope with our specification," explains Jiesi Ma, Xiaomi VR Product Director. "This ensures that, combined with the chip's low latency, the user has an exciting VR experience free of the motion-sickness effects that many competitive products exhibit."

Previously, such a complex application would require a two-chip solution comprising a microprocessor and separate

RF transceiver. By using the Nordic chip, Xiaomi reduced the wireless controller's complexity, cost, and power consumption without any compromise in performance. The SoC's embedded ARM M4F processor offered ample computing power to cope with the wireless motion controller's specification of a calculation time of less than 1 ms for the user's position and motion ('attitude') and less than 16 ms latency for attitude information to be transferred to the smartphone app. In addition, Xiaomi was impressed with the SoC's over-the-air (OTA) upgrade functionality.

The company has also developed a VR Software Development Kit (SDK) for the Mi VR's wireless motion controller, allowing third-party developers to design new interactive modes in their own applications or games. The company says more than 250 developers have expressed interest in working on content for the Mi VR store and it is collaborating with several major content partners to create a wide selection of original "VR worlds". ■

Birth of the connected car

Wireless technology could disrupt the automotive industry, says John Leonard

By **John Leonard**, Product Marketing Manager, Nordic Semiconductor

Automotive makers are no strangers to electronics and the modern vehicle bristles with chips. According to a report from network equipment maker, Cisco, for example, today's premium vehicles each feature the equivalent of 20 portable computers running around 100 million lines of software and collating some 25 GB of data per hour. The electronics are dispersed throughout the car in the form of up to 100 microprocessor-based electronic control units (ECUs) embedded in the vehicle body.

Today, much of the technology serves three functions: optimizing the vehicle's performance, improving safety, and ensuring passenger comfort. By embracing wireless connectivity tomorrow's "connected car" will do those jobs much better while adding a whole host of additional capabilities such as automatic driving, collision warning and avoidance, and even driver health monitoring.

Bluetooth low energy technology will play a key role in introducing such capabilities. Technology that will be available soon includes in-car wireless charging using industry-consortium AirFuel's Resonant system (which uses Bluetooth low energy connectivity to precisely control the charging activity). The advantage of the consortium's technique is that it can support multiple devices on the charging platform and those devices don't need to be precisely aligned. That means both driver and passenger can drop their smartphones on the car's charging pad, and bumps in the road surface won't disturb the charging process.

In the future, a key application for Bluetooth low energy technology will be to multiply

the sensors—for example, engine temperature, oil pressure, and airbag—already mounted on a vehicle without the need to modify an already expensive, highly-complex, and heavy wiring loom. Examples include things like tire pressure sensors and proximity monitors that detect a driver's smartphone as they approach and adjust seat- and mirror-positions, and climate control, to suit a driver's individual needs.

Predicting faults

Bluetooth low energy sensors could also be deployed to predict faults by detecting subtle changes in engine vibration well before the cause becomes serious, scheduling repairs ahead of a breakdown. It's even possible that some faults might even be fixed via an over-the-air software

"Bluetooth low energy technology will play a key role in the introduction of the connected car"

upgrade through a smartphone acting as an Internet gateway without the owner even knowing.

Some companies have even started to experiment with Bluetooth-equipped infotainment systems that link to the driver's wearable. Vital signs such as heart rate and body temperature are relayed to the infotainment system which in turn assesses if a driver is alert and thus in a fit condition to continue behind the wheel. If not the system issues a warning to stop and rest.

Nordic Semiconductor

is doing its bit to hasten the connected car by offering automotive companies an AEC-Q100 stress-test qualified Bluetooth low energy solution in the shape of the nRF51824 System-on-Chip (SoC). (Because a car's heat, vibration, and dirt—particularly under the hood—can take their toll on electronics, the U.S.-based Automotive Electronics Council (AEC) came up with the stress test back in 1994. AEC-Q100 is now a widely-used internationally recognized standard for automotive electronics.)

Based on Nordic's proven nRF51822 SoC, the nRF51824 SoC offers an ARM M0 microprocessor allied to a 2.4GHz multiprotocol radio, 256 kB Flash and 16 kB RAM, sophisticated power management, plenty of peripherals, and multiple I/O support. As part of the nRF51 Series, the nRF51824 SoC benefits from the Nordic development tools that have been regularly introduced since the product series' inception in 2012. These development tools build on the mature and popular ARM development environment.

One particularly relevant development tool is the nRF5 Software Development Kit (SDK) for AirFuel (Resonant wireless charging). Together with the S130 SoftDevice (one of Nordic's highly-optimized Bluetooth low energy software 'stacks') the SDK allows the developer to quickly come up with an in-car wireless charging system that supports charging of multiple mobile devices on a single surface.

Bluetooth low energy looks set to form a foundation technology for the connected car and, together with other wireless technologies such as Wi-Fi and Long Term Evolution (LTE) cellular, will ensure vehicles take their place within the rapidly-expanding IoT. When that day comes, those cars will make today's look as primitive as a horse-and-buggy. ■

With wireless connectivity the connected car will feature a host of new capabilities such as automatic driving, collision warning and avoidance, and even driver health monitoring

Speak up for remote control

Voice assistants are established in smartphones and speech-activated smart speakers are flooding the market, now the humble remote control is catching up. ULP WQ reports

Voice control has finally moved from the realms of science fiction to science fact. It's nearly 50 years since HAL 9000's spine-chilling response of "I'm sorry Dave, I'm afraid I can't do that" to the human spacefarer's spoken request to "open the pod bay doors" during the sci-fi movie *2001: A Space Odyssey*. Yet it's only in the last few years that iOS's voice assistant 'Siri' and Android equivalents such as 'Robin' have become established.

Fortunately, today's voice assistants are a lot friendlier than the malevolent computers from yesterday's movies and politely inform smartphone users what the weather's like or add important meetings to the calendar. Moreover, voice-activated control is starting to permeate other areas of work and home. Siri has migrated to Apple's desktop computers, and devices such as Amazon's Echo, a voice-activated smart speaker which will, among other things, stream music on command and access online encyclopaedia articles, are commercially available. Google Home is a competing device that answers to the name Alexa and similarly responds to questions about traffic congestion while also controlling smart devices around the home such as thermostats and lights.

The market is still immature; some devices among the dozens now on the market are limited in capability and introduce unacceptable latency. And many users are self-conscious when talking to a gadget, causing unusual voice intonation. For products designed to interact with natural speech this can cause problems. But the technology is developing rapidly, and voice control is here to stay. And the next device to gain the capability is the modest remote control.

Adding voice recognition to a remote control eliminates button pushing which can be slow, error ridden, and particularly taxing in the typical darkened home-cinema room. In contrast, voice commands are simple, rapid, and not reliant on the TV's predetermined menu structure - making the process of controlling the set far more relaxed.

Remote revolution

Remote controls have recently been undergoing a revolution. Venerable infrared (IR) remotes have served well since the 1970s and will continue to find a niche where cost and simplicity are important. But modern remote controls increasingly adopt wireless connectivity such as Bluetooth low energy.

Compared with IR, Bluetooth low energy offers lower latency, bidirectional connection, non-line-of-sight control, and extended range compared to IR. The technology allows devices to be controlled through obstacles and even interior walls. And RF has sufficient bandwidth over a bidirectional link to support advanced user interfaces while consuming modest battery power and meeting mass-market cost constraints. These are major advantages for consumers accessing the huge array of digital content typically stored on home entertainment devices.

However, adding voice capability to a remote control is not simple: The device must receive and understand the instruction (often among considerable background noise), digitize, interpret and compress the information, and transmit it to the TV all in a matter of a few hundred milliseconds. (Some engineers suggest it might be easier for the consumer to talk directly to the TV, after all, modern sets include powerful electronics well suited to the task. The key issue is privacy; to work seamlessly, the set would need to listen for commands continually through its built-in microphone - a capability that understandably concerns those who'd rather keep their conversations hidden from an Internet-connected smart appliance. In contrast, a remote control can be activated to receive a voice command via a single button press and then switched off immediately.)

Fortunately, today's powerful Bluetooth low energy Systems-on-Chip (SoCs), such as Nordic Semiconductor's ARM M4F microprocessor-powered nRF52832, are more than capable of supporting voice recognition. Better yet, the SoCs modest power consumption enables voice control without rapidly draining batteries.

To make it easier for engineers to design voice-activated remote controls, Nordic recently introduced the 'nRFready Smart Remote 3' based on the nRF52832 SoC. (*See* ULP WQ *Autumn 2016 pg5*.) According to Nordic's John Leonard: "The nRF52832's extra processing power allows the new reference design to support audio functionality including two digital microphones and all required signal processing in a single-chip implementation for state-of-the-art voice input search and control of home media devices." Among other functions, such capability allows for on-chip noise and echo cancellation, resulting in much cleaner sampling of audio streams.

The nRFready Smart Remote 3 for nRF52 Series supports a range of popular audio compression formats including Opus, Broadvoice, and ADPCM. It comes complete with all the necessary embedded software to complete a voice remote control design, including host-side support software for Linux boxes.

The Smart Remote 3 is about more than just voice input though, offering a comprehensive range of functionality including keyboard matrix, six-axis motion sensing, multitouch trackpad, infrared LED for legacy appliance control, NFC Touch-to-Pair, and on-board buzzer implementing the Bluetooth low energy Find Me Profile. ∎

Voice activation is starting to permeate all areas of work and home including remote controls

"Adding voice capability to a remote control is not simple"

Wireless future builds on complementary technologies

Rapid growth for Bluetooth low energy is forecast, but it will share the limelight as application demands are increasingly met by interdependent RF technologies

While the quality of analysts' forecasts is generally checkered, some buck the trend. ABI Research, with over 25 years of experience of tracking the technology sector, is one of the latter. And the company says the future for Bluetooth low energy is bright ... although the short-range wireless technology won't have things all to itself.

The company reports that the imminent release of Bluetooth 5 (which brings range and throughput enhancements (*see* ULP Wireless Q *Autumn 2016 pg 11*)), Bluetooth mesh, and support for IPv6 will boost chip shipments to five billion per year by 2021. Bluetooth low energy will be the fastest growing wireless connectivity technology, achieving 34 percent compound annual growth rate (CAGR) between 2016 and 2021 to reach around 1.35 billion shipments per year. While Bluetooth technology's share of the market will be impressive, other short-range technologies (for example, Wi-Fi, IEEE 802.15.4, Near Field Communication (NFC), and Z-Wave) will play a significant role in boosting the market for short-range wireless to over ten billion shipments per year by 2021.

The company reports that a key area where Bluetooth low energy and other short-range technologies will share the market is the smart home. ZigBee and Thread—protocols based on IEEE 802.15.4 layers—promoters are collaborating which will grow the base for both technologies. While Wi-Fi, already established in many homes as a networking technology, is extending its reach to smart home applications via a low-power variant.

These established mesh

A number of short-range wireless technologies will power the smart home

"Bluetooth low energy will be the fastest growing wireless connectivity technology, achieving 1.35 billion shipments per year by 2021"

networking technologies—which have, for example, been endorsed by key industry players for smart lighting applications—will continue to thrive but will face stronger competition once Bluetooth mesh is rolled out. Bluetooth technology will also gain market share through its smartphone and tablet interoperability, an advantage most competing technologies don't share and one which allows consumers to control all the lights in their home from a single handset.

ABI Research's Industry Analyst, Andrew Zignani, suggests other characteristics of Bluetooth low energy wireless will differentiate the technology, explaining: "OEMs can utilize

Bluetooth's throughput advantage versus [IEEE] 802.15.4 and lower power consumption versus Wi-Fi to create new and unique use cases that separate them from competing connectivity solutions."

The company also suggests chips that combine different protocols will become increasingly important citing an example of Bluetooth low energy working with NFC to securely pair 'headless' Internet of Things (IoT) devices. Ultra low power consumption will also become more important as will reference designs and development tools.

Beacon boom
While the smart home offers significant growth, ABI Research

says it's beacons that represent one of the largest opportunities for Bluetooth low energy. The company explains that by 2021, it will be the third largest market for Bluetooth devices, and the fastest growing of all segments.

Retail applications of beacons grab the headlines, but the future of Bluetooth low energy beacon shipments is not in that sector says the company. The volume of shipments made in the personal tracking and real-time location system (RTLS)/asset tracking markets will easily surpass those in retail. (*See* ULP Wireless Q *Autumn 2016 pg 14.*) The overall Bluetooth low energy beacon market continues to grow rapidly with shipments set to break 500 million units per year by 2021.

Elsewhere, ABI Research expects to see Bluetooth low energy combine with Low Power Wireless Area Network (LPWAN) technologies to support large scale deployments in smart cities.

The company says the new 3rd Generation Partnership Project (3GPP) IoT standards—such as Narrow Band-IoT (NB-IoT)—will account for more than 50 percent of cellular IoT radio node shipments by 2021. NB-IoT alone will comprise one third of cellular IoT shipments.

But rather than replacing non-3GPP LPWAN technology, ABI Research suggests the new 3GPP standards will again complement established solutions.

The new standards make it relatively easy to configure a Long Term Evolution (LTE) network through a software upgrade to the existing LTE radio interface, which is why ABI Research expects rapid growth and worldwide deployment of NB-IoT to start as soon as 2017. (*See* ULP Wireless Q *Autumn 2016 pg 9.*) ∎

ULP PRODUCT SELECTION GUIDE

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: CPU	FPU/DSP	Memory (OTP: One Time Programmable)	MPU/PA/Balun	Oscillators	Peripherals	Applications	Ref. Designs	Dev Tools	WLCSP Wafer-level chip-scale package option
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	●
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	

micro:bit goes global

The BBC's micro:bit project is moving beyond the U.K. for an international roll-out starting in Europe then heading for N. America and Asia. By Sally Ward-Foxton

Sally Ward-Foxton is a freelance journalist specializing in electronics

Since the BBC's micro:bit—a compact single board computer aimed at 10- and 11-year old schoolchildren—rolled out across the U.K. earlier this year, the project has been embraced by teachers, parents, and children alike. Even the U.K.'s HRH the Princess Royal has had a go at programming one.

The small programmable devices are intended to pique children's interest in coding, with on-board sensors and LEDs helping the device respond to the physical world. Children can write their own code using one of several code editors (for example, Microsoft Block Editor, Code Kingdoms JavaScript or Mu MicroPython Editor). And their software runs on the ARM M0 processor integrated into Nordic Semiconductor's nRF51822 System-on-Chip (SoC). The SoC also provides the device's Bluetooth low energy wireless connectivity. (*See* ULP WQ *Summer 2016* pg10.)

The micro:bit is now going global. To manage the international roll-out, control of the project has been transferred from the BBC to a new not-for-profit organization, the micro:bit Educational Foundation. The BBC is a founding partner of the foundation, along with ARM, Microsoft, Nominet, Samsung, and the IET. (Nordic is a partner organization.)

Targeting 100 million

Philip Meitiner, the foundation's International Program Manager, explains that there are big plans for the micro:bit's future including a step-by-step global roll-out.

"Our founding mission is that the micro:bit will reach 100 million
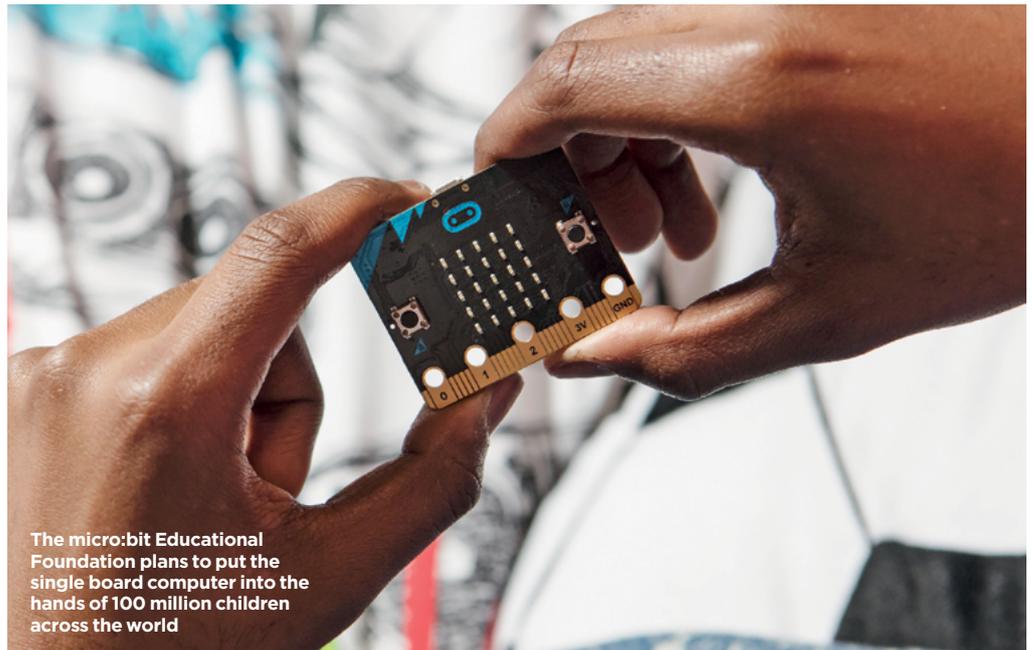
The micro:bit Educational Foundation plans to put the single board computer into the hands of 100 million children across the world

"We are really inspired by what the BBC has done with micro:bit in the U.K. and want something similar to happen in Norway" Cathrine Simonsen, NRK

people, and with the results that we're seeing so far, and the interest that we've been getting, that's not unreasonable," says Meitiner, explaining that "reaching people" really means affecting their lives with the technology.

"The U.K. is our spiritual home, but our goal is to go global," adds Meitiner. "Our strategy is for European roll out in the first instance, followed by North America and Asia, particularly China, where we are already working with various organizations on pilot schemes. We will focus our energies in the first half of 2017 on getting into those markets in a big way."

While it's perfectly possible for independent organizations to set up their own micro:bit pilots (since some U.K. suppliers will ship abroad and all the teaching materials are available online), the foundation is also working closely together with its country partners

to establish pilot schemes following one of two models.

Some countries are working on a national roll out of the micro:bit to all their schools at the same time, similar to how the BBC managed the U.K. rollout. A scheme similar to the BBC's approach is taking shape in Singapore, while Iceland has already rolled out the micro:bit in a countrywide initiative spearheaded by the Icelandic Minister of Education, Science

and Culture, Illugi Gunnarsson. Iceland's project will provide micro:bits to all its 11- and 12-year-old students on an annual basis.

"We're really excited about Iceland. [The numbers are] small enough to implement quite easily, the cost isn't huge, and the logistical challenges are minimal," says Meitiner. "[However] it's a great demonstration of how effective [the BBC approach] can be outside the U.K."

The alternative roll-out model, which the majority of countries have adopted so far, involves individual schools, regional organizations or local authorities running their own independent micro:bit schemes. This is what's currently happening in the Netherlands where DevLab Academy, a not-for-profit organization working with technology companies, is carrying out a series of increasingly large pilots in primary and secondary

At a glance

- ↘ With the U.K.'s deployment complete, the micro:bit Educational Foundation is working on rolling out the device in many other regions
- ↘ Iceland, Singapore, China, the Netherlands, and Norway are already adopting their own micro:bit schemes
- ↘ A new version of the micro:bit will launch in 2017 with Nordic hardware at its heart

www.nordicsemi.com

schools to introduce the micro:bit into their curriculum.

"In the Netherlands, DevLab [is working] to attract other partners, bring in training organizations, broadcasters, marketing [to grow the project] and that's beginning to be effective; they are in the second round of pilots right now," explains Meitiner.

"There are two headline models, but there is a lot of variation on these around the world," says Meitiner. "Our strategy is to try and find a country partner in each country, ideally a not-for-profit-organization that is well-connected and able to upscale so we can reach children nationally rather than just regionally. There are at least five countries where there's big activity right now, with at least another dozen countries who are just engaging with the process."

Norwegian adoption

One country that's getting behind micro:bit is Nordic Semiconductor's home, Norway.

Simen Sommerfeldt, CTO at IT consultancy Bouvet, runs the not-for-profit organization Lær Kidsa Koding! (LKK) which organizes clubs all over the country to teach children coding skills.

"Children don't learn how to be creative with computers, they learn to be consumers [of content]," he says, citing a local university lecturer's frustration with students' complete lack of programming skills. "That would be like majoring in English but not knowing how to read!"

Sommerfeldt started by setting up a local children's club to teach coding in 2013, and within a few weeks his model had spread all over Norway, with a government minister presiding over the official launch of LKK. LKK's remit now includes arranging code clubs, organizing the annual 'hour of code' event together with code. org, teacher training, and helping schools to get started with teaching coding, and working with the government to include coding as part of the curriculum.

"One of the major challenges for any teachers is that PCs are either locked down by the school's computing department, or they are so old and battered

that you can't really do anything with them," Sommerfeldt says. "So the major hurdle to getting started [with, for example, Arduino] is to get anything installed at all. With Raspberry Pi, it's easier, but you still need a monitor, a keyboard and a mouse. When I first came across the micro:bit I was sceptical, but once I had tried it I found that the BBC and its partners had solved a really big challenge ... you don't need additional hardware to get started, so the hurdles [to start teaching coding] are removed."

Nordic recently donated 1000 micro:bits to LKK. These devices will be given away individually at LKK's teacher training courses and in bundles of five to any LKK club that would like to use them. One of LKK's clubs that received a package of micro:bits was the Science Factory Code Club for 11-13 year olds at the Jaermuseet's Science Factory, where they are already a big success.

"The children were encouraged to use their own imagination and see what they could do with the micro:bit," says club leader Hanne Madsen, an Educator at the Jaermuseet's Science Factory. "Several invented small games, animations or long complicated rolling texts - where many of them worked to solve the lack of the Scandinavian letters æ, ø and å [in the micro:bit's alphabet]. At the post-session wrap-up, all the kids were immensely pleased with the experience. Looking forward,

"The BBC and its partners have solved a really big challenge ... you don't need additional hardware to get started"

Simen Sommerfeldt, LKK

our tutors at The Science Factory Code Club are seeking to include a micro:bit course in spring 2017."

The micro:bit's range of simple to advanced code languages and editors mean it's also suitable for older students.

Benefit of a community

"We are planning to use the micro:bit in an introduction to electronics course where we will use the micro:bit as a first introduction to microcontrollers and as an interface to sensors," says Morgan Kjølerbakken, Physics Lecturer at the University of Oslo. "[We selected] micro:bit because it has a very straightforward interface with the Mu editor in combination with MicroPython. The students are already familiar with Python so we can focus on the electronics and not spend time on introducing another programming language. It's a huge advantage that there is a large community for the micro:bit."

According to Premier Farnell, the micro:bit's manufacturer, micro:bits will be fully available for organizations, schools, and individuals to purchase in Norway and several other European countries before the end of 2016. Looking further into the future, plans are afoot for a potential countrywide roll out orchestrated by the BBC's equivalent in Norway, national broadcaster Norsk rikskringkasting (NRK) or, in English, the Norwegian

Simen Sommerfeldt

Broadcasting Corporation.

"We are really inspired by what the BBC has done with micro:bit in the U.K.," says Cathrine Simonsen, Head of the Children's Department at NRK Super, the children's branch of NRK. "We really want [something similar] to happen here in Norway, and we are already discussing ideas with code clubs, financial backers, developers, and other potential partners."

Simonsen says NRK Super's initial idea is to incorporate micro:bit content into FlippKlipp Studio, the children's broadcaster's YouTube-based community that runs some technology, gaming, and coding related content both on video-sharing website YouTube, and on the NRK Super channel.

"From the content perspective, we'd like to do it in our own way; though it's an educational project, the entertainment aspect is also important to us as it needs to appeal to our target audience," she says.

While the roll out of the current device builds up momentum, the micro:bit Educational Foundation is looking to a future upgrade. "A new device will be released in 2017, and Nordic [SoCs] will continue to be a key part of the hardware," the foundation's Philip Meitiner reveals. "[And] we have identified enhancements to improve the user experience for children, including ways of addressing the challenge of displaying Chinese characters."

Meitiner stresses that while the hardware update will bring some new features, there is no intention for the micro:bit to become a complex minicomputer like the Raspberry Pi, since those options are already on the market for children to move on to if they become more enterprising with their coding. The foundation is also very conscious of the cost of the final devices. Given that their ambition is to roll-out in the developing world, the cost of any future version of the hardware can't be allowed to rise significantly. The hope is that micro:bit will encourage computational thinking and coding skills in an entire generation of children no matter where they live on the globe. ■

"If you pitch a great idea for an IoT device for your business, you can develop it without having to take a degree in engineering"
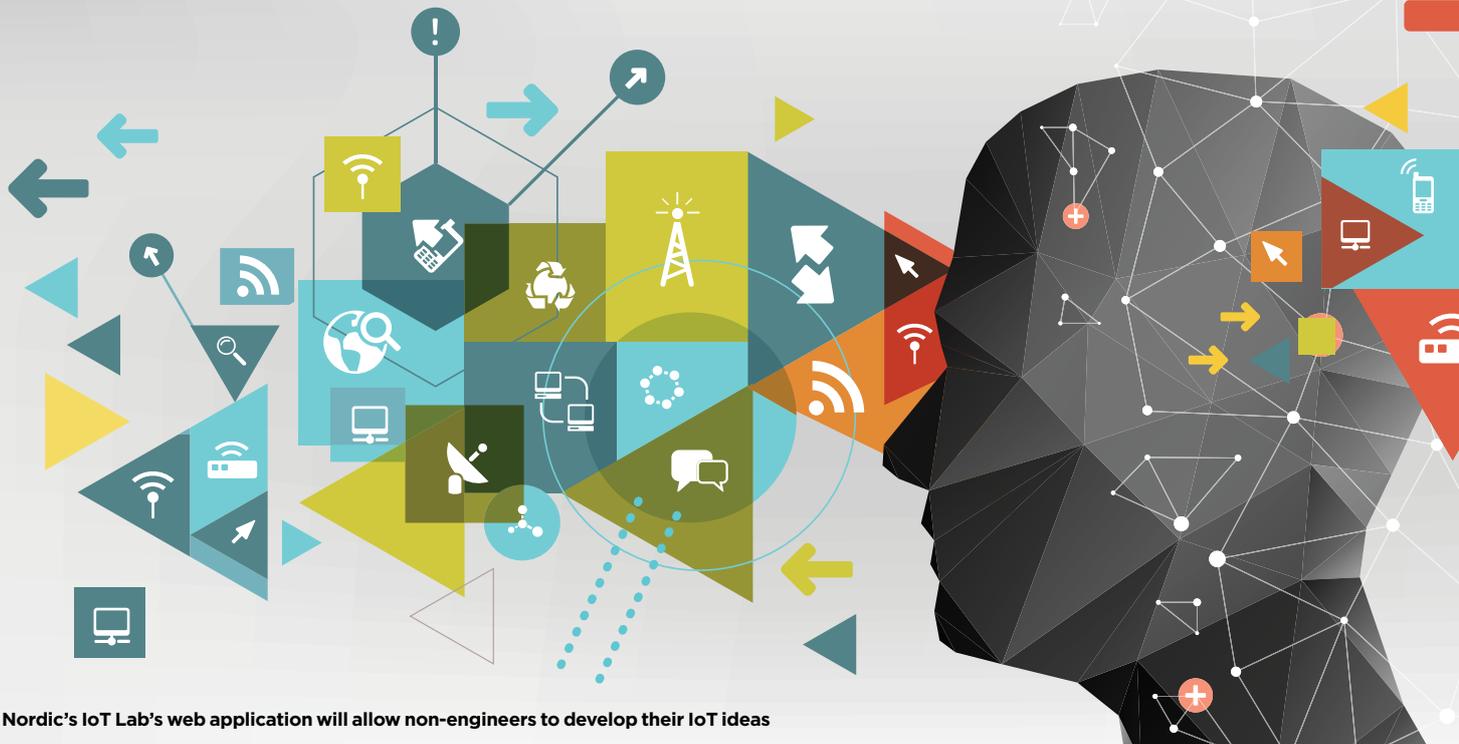
Nordic's IoT Lab's web application will allow non-engineers to develop their IoT ideas

Dedicated IoT Lab prepares for consumer boom

As the Internet of Things (IoT) proliferates, Nordic Semiconductor dedicates a facility to creating innovation for the masses. By Caroline Hayes

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

I n 2016, there were around 6.4 billion connected things worldwide, estimates analyst firm, Gartner. This is an increase of 30 percent from the year before, with 5.5 million new things connected every day.

Although predicted numbers vary, there is a consensus that the number of connected Internet of Things (IoT) devices will continue to grow rapidly. Ericsson has said that it expects there to be 28 billion connected devices by

2021, McKinsey puts the figure at 20 to 30 billion by 2020, and Gartner estimates there will be 20.8 billion connected devices worldwide by 2020.

Where will all of these devices be used? Application areas span industrial use, with transport and logistics, predictive maintenance, agriculture and utilities, to consumer applications such as telematics, connected healthcare, and wearable health and fitness devices.

Today, Bluetooth low energy wireless technology is commonly used in interconnected devices such as wearables, machine-to-machine (M2M), and smart

homes because it combines good bandwidth low power (coin cell) power consumption and, crucially smartphone interoperability.

But for all its advantages, Bluetooth low energy is limited to tens of meters at most. That's not a problem if a range boosting 'gateway' or 'bridge' is nearby but becomes more restrictive for connecting, for example, mobile 'things' such as packages and drones. The challenge for today's wireless protocols is to extend range, up to around tens of kilometers, while maintaining a low power budget. Low power cellular IoT modems promise to provide the answer.

A foundation technology

Despite its current lack of range, Bluetooth technology is expected to form a central part of the IoT's infrastructure. To an extent, the range issue will be addressed with the advent of Bluetooth 5. The latest version of the standard, due for imminent release (*see* ULP Wireless Quarter *Autumn 2016* pg 11), will see this range double or more, but it will still fall short of the distances required for many IoT applications.

So-called Low Power Wireless Area Networks (LPWANs) are expected to fill the gap between Bluetooth low energy-equipped

Innovator of Things

It is this approach that Chris is bringing to Nordic's IoT Lab. "We are trying to bring IoT to consumers," he explains.

"Today, the IoT is quite successful in industry, but to really get the growth that the IoT is forecast to achieve, we need to bring the IoT to consumer products."

The IoT Lab is developing a platform for Nordic Semiconductor silicon and aims to make the technology universally acceptable and easy to develop irrespective of a user's background.

Chris talks of an "army" of non-technical potential users, from farmers to accountants, who can develop their ideas for the IoT, and innovate.

"If you are not an engineer, you cannot compile code, but if you pitch a great idea for an IoT device for your business, you can develop it without needing a degree in engineering," he enthuses.

The IoT Lab's web application will guide the user through the development process. It uses plain, non-technical terminology to build applications, for example, "what reconnection rate is desired?", "is the device to be variable power with a slow response, or a high power device with faster response?".

"There are hundreds of variables, I can't even recall all of them, even though I wrote the spec," admits Hansen.

The web application means that the user does not have to keep all the variables in mind, but instead can buy a wireless device from Nordic, plug it in to the computer, go to the website to answer some questions and the device will be configured there and then.

The IoT Lab is offering initial kits that can be configured in this way, via the Internet. New ones will be introduced, and Hansen confirms the company is working with sensor vendors to address different needs and requirements for different applications. Although based in Oregon, the team is also working with their colleagues in Norway.

IoT roadmap

This summer, Nordic announced it would be releasing the nRF91 Series to address the emerging low power cellular IoT sector. The nRF91 Series includes integrated chipsets and software, and meet the 3GPP Release 13 Long Term Evolution-Machine type communications (LTE-M) and NarrowBand IoT (NB-IoT) cellular technology requirements for low power, low cost of deployment, and scalability of devices.

Both systems are expected to drive the cellular IoT market, with NB-IoT in particular addressing environmental monitoring, focusing on smart building and sensor data monitoring.

The IoT Lab will support devices so they can be developed into IoT products using LTE-M, confirms Hansen. LTE-M is a power-efficient technology that's custom designed for IoT applications like sensors, which send small amounts of data infrequently.

The technology has three benefits: lower cost for carriers, as they do not have to support large amounts of data transmission in basestations; lower design cost, due to the need to support relatively low bandwidth; and power savings, as the data is transmitted infrequently, allowing devices to be battery-operated.

The nRF91 Series will be supported by the IoT Lab and the products are expected to begin sampling in the second half of 2017, with availability and full production scheduled for the following year. ∎

devices and the potentially tens of kilometers distances to cellular network base stations.

Nordic Semiconductor has created the IoT Lab, based in Portland, Oregon, U.S., to forge tools and support developers' needs to exploit the potential of the IoT using Bluetooth low energy and cellular IoT technology. The lab is headed up by Chris Hansen, who joined Nordic Semiconductor in January 2016. (*See* ULP Wireless Quarter *Summer 2016 pg23.*)

Hansen, originally from Denmark, joined U.S. microprocessor giant Intel after gaining a post-graduate Masters degree in electrical engineering from North Eastern University, Boston. During nearly 20 years at Intel's Oregon facility, he also served with the Bluetooth Special Interest Group (SIG) including a three-year spell as Chairman of the Board. "This introduced me to Bluetooth technology, and to a lot of my now colleagues at Nordic Semiconductor," recalls Hansen.

It was also the time that Bluetooth technology evolved rapidly. "It went through great growth spurts," says Hansen, "from an unknown technology to a big brand – everyone now knows what Bluetooth is."

The introduction of Bluetooth low energy as a hallmark element of Bluetooth 4.0 was a turning point. According to Hansen, it marked the point that Bluetooth was no longer an upstart technology and was clearly going to be successful. At the same time, the board changed from a technology-driven organization to a marketing oriented one.

"Although Bluetooth was very successful from a technology perspective, what was lacking was the marketing component that really made the name take off. I think that is a big factor in gaining acceptance," says Hansen.

He credits the increase in numbers, when Bluetooth devices rose from hundreds of millions each year to three or four billion per year, to the technical work carried out by people on the SIG, but adds: "That growth needs good technology, plus good marketing and strategy."

Chris Hansen, Director, Nordic Semiconductor IoT Lab: bringing the IoT to consumer products

Smart lighting company Gooee has launched mesh networking development kits based on Bluetooth wireless technology ahead of the formal release of Bluetooth mesh. The company's Nordic nRF51822-powered smart lights are networked and can also act as beacons

The promise of wireless mesh

Mesh networking is inherently complex, but supporting technologies such as ANT and the forthcoming Bluetooth mesh promise to simplify implementation. By Kat Kent

Kat Kent is a Canada-based technology journalist and a wireless applications engineer

Understanding how to deliver successful products that take advantage of the latest technology is particularly challenging when that technology is as complex as wireless mesh networking. These networks are finding favor in situations where many devices need to be monitored and controlled, and where universal accessibility is preferred over dedicated user interfaces. Typical applications include home automation, industrial wireless sensor networks, and building management.

One way to get to grips with mesh networks' complexity is to imagine that, unlike, for example, a star topology where individual nodes communicate solely with a central hub, every node in a mesh network is directly or indirectly connected to every other node. In most practical implementations, nodes send data to each other via other nodes that provide simpler routing. Typically, there's more than one way for each node to send data to another; automatically building in redundancy. Redundancy improves network reliability.

Smart home applications benefit from mesh networks. For example, smart lights connected in a mesh network allow a consumer to connect to any light in the network via a smartphone, hub, or remote control, and send commands to control the status, intensity, and color of any other light in the network while receiving status information back.

When such technology becomes commonplace, wired wall switches would go the same way as landline wall sockets.

Ultra low power wireless protocols such as ANT or Bluetooth low energy are among the technologies upon which mesh networks are based. Wireless connectivity solutions such as Nordic Semiconductor's nRF51422 or multiprotocol nRF52832 Systems-on-Chip (SoCs) allow developers to embed either protocol (or a proprietary 2.4GHz protocol if preferred) into their smart home products.

And if required, ANT or Bluetooth low energy connectivity to a Wi-Fi hub device enables Internet connectivity enabling the consumer to control their system while away from home.

Building in reliability
To ensure long-term network reliability and ease of operation, designers need to consider adding self-forming and -healing capabilities to the mesh network. Self-forming refers to the ability of each new node (for example, an additional smart light) to detect nearby nodes and either join the existing mesh network, or initiate the formation of a new network without requiring input from the user. In the above example, this would mean that the user could install one or dozens of smart lights in their home, and then sit back and relax while the smart lights search for and discover each other, and form

connections automatically. Self-forming networks simplify installation and eliminate the need for a user to understand how the lights communicate.

Self-healing refers to the ability of the network to continue to operate while one or more nodes are inoperable, and/ or while certain wireless links are blocked. For example, a self-healing network would respond to a broken light by sending messages via another smart light instead. Similarly, if one smart light lost its connection to another (perhaps due to interference, or an obstruction), a self-healing network would reroute to send messages between these two lights via other smart lights.

A bonus is that the user could immediately be informed about failed nodes, something which could be particularly useful if the node was, for example,

nobody wants a neighbor accidentally dimming lights which don't belong to them.

Simple but complex

Well-designed mesh networks are simple for users to control but delivering this simplicity is not easy, and requires a detailed analysis of how, when, and where communication within the network will occur. Allowing the user to connect to the network at any point, possibly at the same time as other users, complicates firmware design. For example, in a mesh network messages travelling in a certain direction can't be prioritized as there is no built-in hierarchy.

As multiple users need to be able to control the lights in a typical home, conflicting commands could be simultaneously issued leading to unpredictable results - depending on the path each command takes

reach their destination(s) within the network. This requires defining an addressing scheme to identify each node; using acknowledged messages and retries as needed; and handling command prioritizations and timings to achieve synchronized responses when appropriate.

There are several commercial technologies available for mesh networking, some based on proprietary technologies, others based on standards such as IEEE 802.15.4. Engineers can even select turnkey solutions such as SecuRemote Smart, by Delphian Systems, which facilitates the building of Nordic nRF51422 ANT SoC-based mesh networks of up to 250 devices.

The Bluetooth Special Interest Group (SIG) has announced plans to launch Bluetooth mesh—a standards-based mesh networking technology—soon after the release of Bluetooth

mesh (ahead of the formal release of the technology).

Until Bluetooth mesh is formally introduced, ANT has the edge on Bluetooth technology. ANT provides the most flexible capabilities per node, allows developers to configure each node as both a master and a slave, and optionally runs a background scan at the same time. IEEE 802.15.4-based technologies such as ZigBee and Thread, were purpose-built for forming mesh networks, but can require significantly more power than Bluetooth low energy and ANT (depending on the configuration).

ANT has well-developed reference designs to simplify implementation of mesh-like topologies including auto-shared channels that can be controlled by multiple remotes. This topology includes a defined hub, which acts as the relay between controllers and sensors. Connecting several networks together via the hubs results in a close approximation of a mesh network as perceived by the user.

Using ultra low power wireless protocols to implement mesh networks allows for products that need not rely on continuously available Wi-Fi connections. It also allows for minimal power usage to operate the network, which in turn can allow for reasonable operating windows when relying on battery power, and allowing nodes to be completely wireless. ■

"A consumer could install one or dozens of smart lights in their home, and then sit back and relax while the smart lights search for and discover each other, and form connections automatically"

intended as an external security illumination.

Home security could be improved by networking lights in a neighboring building so that they switched on to illuminate an area left dark by the failure of the nearest light. Additional layers of control would be needed for such a system as

through the network. The lack of constraints inherent to mesh networks creates "edge cases" that need to be handled, and the difficulty of predicting these extends the time required to test mesh network designs.

At the most fundamental level, designers need solutions that ensure important messages

5, the next version of the technology slated for imminent release. Bluetooth mesh will make it much easier to build networks with Bluetooth technology. Smart lighting company Gooee has already introduced an Internet of Things (IoT) sensor platform based on its interpretation of a Bluetooth

Tomorrow's wearables merge wellness and lifestyle

Consumers are increasingly seeking advanced wearables capable of sophisticated wellness monitoring. Nordic is helping technology company Vinaya meet this demand

Back in 2011, one in five U.S adults owned a tablet. Dubbed by some marketers at the time as an 'overhyped' sector, five years later and that number is closer to three in five. It's a statistic likely to interest developers of wearable technology because as of 2016 one in five U.S adults now also owns a wearable device. Again some are claiming the influence of the technology has been exaggerated, but current research suggests wearables will follow a similar trajectory.

According to Scalar Market Research, the global wearable technology market is anticipated to grow from $29.92 billion in 2016 and reach $71.23 billion by 2021. Notably, the market for wearable wellness devices currently sits at $13.2 billion, because it is this market segment where perhaps the greatest opportunity lies.

Wearable devices are no longer just focusing on one measurement—for example the number of steps taken in a day—but are now capable of a variety of body measurements such as heart rate, blood pressure, breathing patterns, even stress level and 'mood'; increasingly blurring the lines between wellness and lifestyle wearable devices to the point where the U.S. Food and Drug Administration (FDA) has seen fit to find a category for them, defining them as 'general wellness devices'.

So far so good for consumers who understandably don't want a forearm full of wearable devices each undertaking a different task. But the challenge for developers is how to pack this additional functionality into their device without compromising on either performance, or the discreet form factor their customers will insist on. As a result, developers are increasingly seeking out powerful single-chip solutions in a compact package size, capable of supporting the intensive computational requirements of their multifunction devices.

Wrist-worn wellness

This scenario was exactly that faced by U.K.-based technology design company, Vinaya, whose new health and wellness wearable ZENTA, will launch in Spring 2017. ZENTA is a Bluetooth low energy wrist-worn device that tracks the user's physical activity, sleep quality, breathing patterns, stress levels, emotional states, and mood, offering actionable insights, suggestions, and a methodology for self-improvement against an individual's personally set goals.

ZENTA employs a range of sensors to capture a wealth of data about the user and their surrounds. The device is equipped with an accelerometer, a microphone, biometric sensors, and a haptic engine that gather environmental noise, movement, as well as biological signals from the user including heart rate, heart rate variability, breathing patterns, electrodermal activity (EDA), skin temperature, pulse transit time, pulse wave velocity, and blood oxygen saturation.

ZENTA's sensor data is automatically synced to a smartphone—via Bluetooth low energy wireless connectivity—after which each one of these data points is cross-referenced with other data points from the user's smartphone; for example location, calendar events, or digital activity to log 'bio-events' that provide insight into significant deviations in the user's baseline or habitual behavior. Through learning algorithms, ZENTA then builds a profile of the user, providing insights and recommendations from the iOS or Android smartphone app to help them live a more balanced life.

From the outset Vinaya realized it was going to require the most advanced System-on-Chip (SoC) available to meet the demands of its wireless application, and having worked with Nordic Semiconductor for a number of years, immediately set its sights on the nRF52832 SoC as the best solution to deliver the processing power, memory capacity, and Bluetooth low energy connectivity required.

Vinaya required the Nordic SoC to act as ZENTA's main controller for filtering and conditioning. The SoC also provides the first level of data manipulation, yet still supports up to five days of continuous biometric sensing and Bluetooth low energy connectivity between recharges of its Li-ion battery.

"The embedded Cortex M4F, the good size memory, together with the very competitive power consumption, and radio performance, make the new nRF52832 a great fit for ZENTA," explains Fabio Pania, Vinaya Founder and Chief Technology Officer. "It allows us to achieve good battery life, small form factor, great RF performance, and the computational power we needed. We planned to use it from the very beginning."

As for the future of wearables, Pania says marketers expectations have been huge and, at times, out of proportion, and although the days of basic fitness trackers that measure every step or heart beat and regurgitate the data back to the user might be numbered, devices that can create real and significant value for their users will thrive.

"Now that wearables are not just a matter of early adopters, people are looking for beautiful, everyday useful devices they can always wear and get a real advantage out of it," explains Pania. "The bar for quality will be raised and I expect to see a lot of new interesting ideas and amazing products coming to the market in the next few years." ∎

For more information about Vinaya and to enquire about 'ZENTA' go to www.vinaya.com

ZENTA builds a profile of the user, providing insights to help them live a more balanced life

According to market research company SuperData Research, by the end of 2016 there will be nearly 56 million VR users worldwide, spending $5.1 billion on hardware, accessories, and software this year alone. The Virtuix Omni gaming platform brings 'active VR' to the home gamer, enabling immersive game play with 360° freedom of movement thanks to a unique platform design, low friction shoes, and up to 16 wearable sensors each powered by a Nordic Semiconductor SoC

The nRF51822 SoC's multiprotocol capability enables the Virtuix Omni to simultaneously support both Bluetooth low energy and proprietary 2.4GHz wireless connectivity. The VR platform uses a proprietary 2.4GHz protocol based on Nordic's Gazell software for low-latency communication between the sensors and the sensor hub, while the hub communicates with Bluetooth 4.0 (or later) mobile devices using Bluetooth low energy or legacy Bluetooth protocols

The base of the platform is a smooth, concave disc, allowing the user to walk, run, and change direction freely when wearing a pair of Virtuix Omni shoes with a proprietary low friction shoe sole. After each stride the user's feet slide back to the center of the platform allowing the action to be repeated to simulate walking or running in the game. The movement of the user's feet is captured by wireless sensors mounted on the top of the shoes

Virtual reality has been widely adopted by the military for training purposes, and is used for risk-free flight, vehicle, and battlefield simulation, medic training, as well as 'virtual' boot camps. It is also used to treat post-traumatic stress disorder amongst returning servicemen and women

While the concept of virtual reality has been around since the 1950s, the actual term as it is widely understood today was coined in 1987 by U.S computer scientist Jaron Lanier, who left arcade game pioneer Atari in 1985 to launch his own company that commercialized VR technologies, including goggles and gloves

Virtuix Omni

This virtual reality (VR) motion gaming platform allows the player's whole body to control the game actions and employs 16 wearable sensors to communicate wirelessly with the sensor hub

The best of Nordic's social networks

Nordic's Facebook and Twitter presence continues to offer a daily feed of the hot news in wireless technology. ULP Wireless Q takes another snapshot

I n the last edition of ULP Wireless Q, the editorial staff dipped into Nordic's Facebook and Twitter feeds. It proved so enlightening that our writers decided a second snapshot of what's trending was worthwhile. But there's no need to rely solely on their quarterly efforts; you can sign-up directly to Nordic's Facebook and Twitter pages to receive almost hourly updates of where the company and its technology are heading. Meanwhile, for those yet to subscribe, here's another selection of the best of Nordic's Facebook and Twitter posts at the time this edition of ULP Wireless Q went to press.

Magnus defends chess title

Following hot on the heels of "MAGNUS", the documentary about Magnus Carlsen, the Nordic-sponsored World Chess Champion (see *ULP WQ Autumn 2013 pg6*), comes news of the Norwegian's FIDE World Chess Championship progress. While Calrsen is focusing on his match against Sergey Karjakin of Russia, his father Henrik is blogging on Nordic's website about Carlsen's progress. The match is proving to be very competitive and the best-of-12-games contest is set to go the distance but everyone at Nordic is hoping that Carlsen will prevail. http://www.nordicsemi.com/About-us/Magnus-Carlsen-Sponsorship/The-official-blog-of-Magnus-Carlsen

■ Mesh technology is coming to Bluetooth low energy wireless soon and Nordic's engineers are developing tools and techniques to enable customers to get a

Mesh networking is coming to and Nordic's engineers are using social media to blog about the company's development tools

head-start when it's adopted. Mesh networking will make Bluetooth low energy better suited to some smart home and industrial applications. The company's Facebook page directed followers to a blog on Nordic's DevZone by the company's David Edwin. The blog describes in easy-to-follow steps how to get started with PC software for mesh applications and mesh Device Firmware Updates (DFU). https://devzone.nordicsemi.com/blogs/1044/get-started-on-pc-software-for-mesh-and-mesh-dfu

■ Nordic's Product Marketing Manager, John Leonard, plays host to a tour of Nordic's Electronica 2016 stand in a video hosted on the Facebook page. In the video, Leonard points out highlights such as a Nordic nRF51832 SoC-powered Arduino Primo single board computer connecting to the Internet via IPv6; Google's Physical Web, a beacon technology that allows

the devices to broadcast a URL that provides consumers with contextual information and options to find out more or even purchase products; and Nordic's nRFready Smart Remote 3, a complete Bluetooth low energy reference design. https://www.facebook.com/nordicsemiconductor/videos/1644176122274828/

■ Elsewhere, the Facebook page hosted a video that demonstrated how an nRF51822 SoC-powered BBC micro:bit can be used to control a model buggy. The micro:bit is a versatile yet simple single board computer that is designed to engage schoolchildren in coding. It has been rolled out in the U.K. and is under consideration for deployment to Norwegian schoolchildren. The micro:bit's onboard accelerometer detects which way the user is tilting the board, and the Bluetooth low energy link wirelessly connects to send the information to

the buggy to drive it in the direction the board is aimed. The buggy is easy to make and code. https://www.facebook.com/nordicsemiconductor/videos/1623669907658783

@NordicTweets

Meanwhile on @NordicTweets congratulations went out to Nordic customer Gooee which won the Connected Lighting Innovation of the Year title at the LUX Awards 2016. The Gooee smart lighting and IoT sensor platform employs a Wireless Interface Module (WIM) with an embedded Nordic nRF51822 SoC to control and monitor each LED light via its power supply. https://twitter.com/gooee/status/802038039581257728

■ Nordic Retweeted an interesting article by Daryl Plummer of analyst Gartner which was published by Forbes. In the article Plummer outlined Gartner's top 10 strategic predictions for 2017 which included: by 2020, 100 million consumers will be using augmented reality; 30 percent of browsing sessions will be done using voice search; and by 2020 the IoT will save consumers and businesses $1 trillion a year in maintenance services and consumables. bit.ly/2fTkpmO

■ Finally, @NordicTweets Retweeted how crowdfunding platform Kickstarter has launched a new way for start-ups to communicate with potential backers. Dubbed "Kickstarter Live" the platform promises to bring live video and "real-time community engagement". Pioneering companies have already hosted cooking shows and performed plays, in addition to more traditional product demonstrations, to connect with backers. http://tinyurl.com/zaesyp7

Here we've only scratched the surface of the postings that occur daily on Nordic's social media. If you want much more, head over to https://www.facebook.com/nordicsemiconductor *and* https://mobile.twitter.com/nordictweets *to see what's hot.* ■

Bluetooth SIG award winner is also a high flyer outside of work

Hi, I'm Leif-Alexandre Aschehoug and I work as an R&D Engineer developing the software architecture that underpins Nordic's Bluetooth low energy software development kits (SDKs).

I am also Chair of the Bluetooth Special Interest Group (SIG) Sports & Fitness Working Group where I'm responsible for handling the development and rollout schedule of next-generation specifications, as well as actively participating in their technical development.

For the latter I was delighted to recently discover I had been awarded a Bluetooth SIG Key Contributor Award for my work on what's called the 'Object Transfer Specifications' which makes it easier to manage (create, delete, list) the bulk transfer of data between devices.

One of the things I really like about my job is the diversity, which really helps to keep things varied and interesting. It also means I have a lot of contact with many different organizations as well as people working both inside and out of Nordic Semiconductor.

Although at times juggling the commitments of several roles can be challenging (you can't let one team down because you happen to be a member of

Leif is a fully qualified private plane pilot, and has gained the additional training and qualification to fly seaplanes

another), it does have its rewards. These include the opportunity to travel through my job and discover quite a few countries and cultures I might not have had the opportunity to experience otherwise.

The price to pay for this, however, is that you have to make the most of your travel time. This, for me, includes using uninterrupted time on long-haul flights to write software. In fact, on my way to a number of Bluetooth SIG Interoperable Prototype (IOP) Test and Unplug Fest (UPF) events, the prototype that I hadn't had time to get working before I boarded the plane was 'suddenly' working

by the time I landed at my destination.

Outside of work one of the things I like doing is flying. Since 2001, when I was living in France, I've been a fully-qualified private

plane pilot and have flown around France a couple of times, as well from France to Scotland (although the initial destination was Norway, but that's another story), Berlin, and even the North Cape in northern Norway. Nowadays in Trondheim I mostly fly day trips down to Ålesund over the Geiranger Fjord, for example, and sometimes take out one of my two current Værnes Flying Club's veteran 1953 planes (a Piper Cub and a Saab Safir).

I also have a seaplane qualification and fly the Cessna 185 operated by the Trondheim Flyklubb out from Selbu lake.

On the ground I am a keen fencer too. I started as a child, stopped for a while, and then picked it up again as a university student and have continued ever since.

I've mostly practiced with foil (flexible and rectangular in cross-section), but when I came to Norway I had to switch over to épée (the largest and heaviest weapon used in fencing) since this is the only one used here.

But then eight years ago I was living in Paris and never dreamed that I would end up moving to Trondheim; but here I am. So you never really know where life will take you I guess, but you can make the most of wherever you end up. ∎

Personal Profile

NAME:
Leif-Alexandre Aschehoug

JOB TITLE:
Senior R&D Engineer

JOINED NORDIC:
October 2008

BASED:
Trondheim, Norway

INTERESTS INCLUDE:
Flying, fencing, skiing, travelling, cooking

"On my way to a number of Bluetooth SIG events, the prototype that I hadn't had time to get working before I boarded the plane was 'suddenly working' by the time I landed"

nRF52840
BLUETOOTH 5 READY

SMART WEARABLES FOR SECURITY

CONNECTED HOMES AND ADVANCED WEARABLES

ADVANCED NOTIFICATION WEARABLES

SMART WEARABLES FOR PAYMENT

Front Door
OPEN

Turn Lights on

SMS: 9 am meeting cancelled

65°F

$ 4.00 Coffee
PAID

⊕   nRF52840   +   ❋ Bluetooth® 5
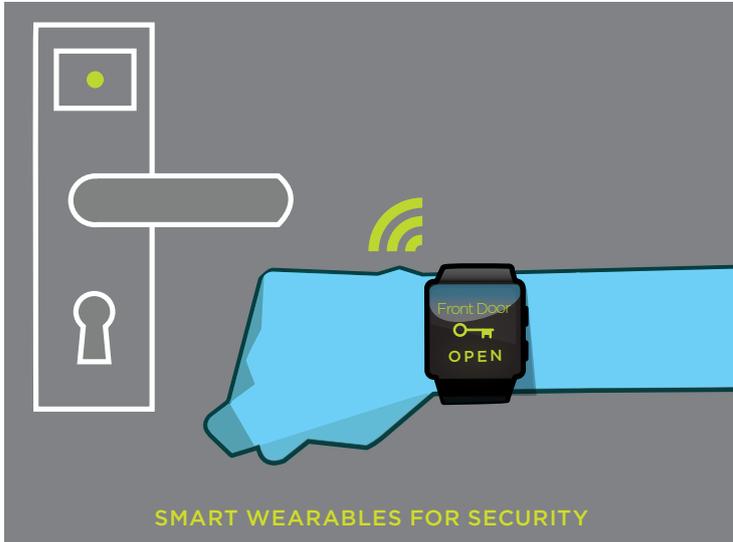
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