

ultra low power **wirelessQ**



QUARTER 2 | SUMMER 2017

China drives
mobile VR

The growing
importance of
Thread

Anatomy of a
SoftDevice

COVER STORY

Wearables lift diabetic health



OPINION

Ståle "Steel" Ytterdal



China powers mobile VR development boom

While China's economic rise might have been built on its high-quality manufacturing capability, today the country is thriving on much more than just being the 'world's factory'. China's engineers are as educated and talented as those in the rest of the world and China's companies now design products that compete with the best that the U.S., Europe, and Japan offer.

And occasionally, China takes the lead in embracing and developing new technology. A case in point is mobile virtual reality (VR)—the offshoot of established VR technology based on PCs and gaming consoles—which leverages the power of the smartphone. Lightweight and inexpensive headsets with built-in optics house mobiles running apps to bring the VR experience to a mass audience. And that audience doesn't come any more enthusiastic than China's consumers.

This passion for mobile VR has its roots in the country's eager adoption of smartphones. While China only comes 26th in the list of countries with the highest smartphone penetration (according to Newzoo's (a mobile sector analyst) Global Mobile Market Report), over 51 percent of the population own a handset. That equates to a staggering 717 million people, dwarfing the U.S.'s 226 million smartphone owners. The Chinese love the devices and everything they support; so naturally, mobile VR has become instantly popular.

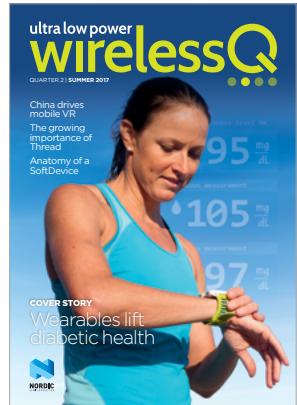
Nordic Semiconductor is playing a significant part in the rise of mobile VR in China. The company's nRF52832 Bluetooth low energy SoC has proved a popular choice for enabling enhancement of the game-play experience by wirelessly connecting handheld remote controls to the smartphone in the headset. Players can play and pause the game from the remote control as well as use the device to trigger game events.

Nordic's flexible SoC makes it easier for developers to code application software while the company's Bluetooth low energy firmware ensures smartphone interoperability, decent bandwidth, and low latency connectivity - which eliminates the video artifacts that can cause motion sickness in competitive systems. The nRF52832 SoC is also compatible with Bluetooth 5's high throughput capability ensuring support for more sophisticated mobile VR applications in the future. An article in this issue (page 14) describes how Xiaomi, Ximmerse, and CyweeMotion Group, are using Nordic's wireless technology to augment their mobile VR applications.

China's wireless design strengths make it a key market for Nordic and it's pleasing to note that the latest addition to the nRF52 Series, the nRF52810 SoC, had its world debut in Shanghai, at the recent CES Asia event. The nRF52810 might be the entry-level device of the nRF52 Series, but it features the same hardware and software architecture of its sister products, a 64MHz, 32-bit ARM Cortex M4 microprocessor, 100dBm link budget 2.4GHz multiprotocol radio boasting the throughput and advertising extension advantages of Bluetooth 5, and much more. This SoC brings the advantages of the nRF52 Series and Bluetooth 5 to even the most cost-constrained, high-volume applications. (See pg8.)

Yours Sincerely,

Ståle "Steel" Ytterdal
Director of Sales & Marketing - Asia



Wireless connectivity could soon deliver non-invasive monitoring for diabetics

ULP Wireless Q is published on behalf of Nordic Semiconductor by Ecritech
www.ecritech.com

Editor

Steven Keeping
e-mail: steven@ecritech.com

Assistant Editor

Andrew Woolls-King
e-mail: andrew@ecritech.com

News Editor

Chris Williams
e-mail: chris@ecritech.com

Art Editor

Tim Plummer
e-mail: production@ecritech.com

Image Editor

Neale Hobday
e-mail: production@ecritech.com

Print & Distribution

Printech Europe



Join online forum:
devzone.nordicsemi.com

Contributors



Page 10

Pär Häkansson is a Product Marketing Manager for Nordic. On page 10 he provides a look into the company's new IoT prototyping tool, the Nordic Thingy:52



Page 16

Sally Ward-Foxton is a freelance journalist specializing in electronics. On page 16 of this issue she looks at the rise of the Thread protocol for smart home applications



Page 20

Caroline Hayes is a U.K.-based technology journalist specializing in semiconductors. Here she examines the IIoT's potential to increase factory efficiency



The Bluetooth® word mark and logos are registered trademarks owned by the Bluetooth SIG, Inc. and any use of such marks by Nordic Semiconductor is under license.

© Nordic Semiconductor 2017

NEWS

The latest developments from Nordic Semiconductor

Nordic Thingy:52 enables rapid IoT prototype development

 Nordic Semiconductor has launched the Nordic Thingy:52, a fully-functional single-board Bluetooth 5-compatible Bluetooth low energy development kit (DK). The DK offers 'out-of-the-box' wireless configuration from smartphone apps and the Cloud.

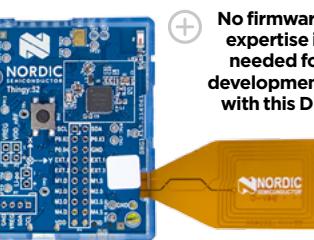
Nordic Thingy:52 enables an app developer with no firmware coding expertise or high-level development tools to quickly design and demonstrate Internet of Things (IoT) devices, and associated mobile and Internet apps. The app developer can configure the DK's embedded application over the provided Bluetooth interface from a mobile.

Based on the company's [nRF52832](#) Bluetooth low energy SoC, Nordic Thingy:52 incorporates: a built-in digital microphone and speaker; nine-



axis movement sensor; ultra low power accelerometer; and pressure, temperature, humidity, air-quality, and color sensors.

Altering parameters such as the air-quality sensor's sample rate, or switching on the color sensor, for example, is simple to achieve via an over-the-air instruction from a mobile or Internet app with no need to interact directly with Nordic Thingy:52's firmware code. More complex IoT applications are equally possible, while the development platform is also



Cloud-platform compatible.

"With Nordic Thingy:52, there is no need for the app developer to go through the complex process of learning how to use high-end Bluetooth low energy development tools for firmware coding, debugging, and compilation," says Pär Håkansson, a Product Marketing Manager with Nordic.

The Nordic Thingy:52 DK is now available through Nordic's global distribution partners and is priced at \$39.

In brief

ANT+ announces SoftDevice revision

The latest production revision of the S212 ANT SoftDevice and the S332 ANT/Bluetooth low energy SoftDevice are now available for licensing and download from ANT. The revisions are compatible with Nordic's nRF5 SDK and can be used with the nRF52 Development Kit and the Dynastream D52 Starter Kit. The revisions include an option to specify a channel offset when opening an ANT channel to give developers better control of performance in multimaster applications.

Healthcare sector to get major IoT lift

The Internet of Things (IoT) has the potential to provide significant financial value for healthcare providers and payers over the next three years, says consulting firm Accenture. The report found 73 percent of healthcare executives say the IoT is poised to create disruptive change within three years, but only 49 percent think their organization's leadership understands what the IoT could mean to their firm. Accenture claims IoT in healthcare's value will top \$163 billion by 2020.

Universal sensor to speed IoT rollout

Researchers from Carnegie Mellon University are working on a 'universal' sensor that can be embedded in home appliances, or stationed in a particular room, to detect a range of inputs with the ability to standardize and share data. According to researchers, 'general purpose sensing' could speed IoT introduction because it would standardize the chips and how they collect, record, and share data. A prototype includes 19 separate sensor channels, including sound, vibration, and motion.

Digital radios enable off-grid, long range smartphone communication

New York-based goTenna has launched its goTenna Mesh and goTenna Pro digital radios, enabling off-grid, long range, peer-to-peer SMS and GPS communication when no cellular signal is available.

The goTenna devices connect with the iOS user's and Android Bluetooth 4.0 (and later) smartphone using Bluetooth low energy wireless connectivity powered by Nordic's [nRF52832](#) SoC. This functionality enables users to share GPS locations, and communicate using SMS, over a range of several kilometers via the goTenna app, without the need for any centralized communications infrastructure.

From the app, users can start a conversation with an



 The goTenna devices enable off-grid communication

individual or group, using the Bluetooth low energy link between the smartphone and goTenna. The goTenna then broadcasts the information publicly to any other goTenna user within range.

The goTenna Mesh is a 1W UHF digital radio designed for general consumer use. The device

automatically relays messages between users, creating a network which gets stronger the more people join it.

The goTenna Pro is designed specifically for mission critical applications such as defense, public safety, and industrial environments. The goTenna Pro transmits at 5W, and is tunable to both UHF and VHF frequencies. The goTenna ad-hoc mesh networking protocol can cognitively sense each frequency to ensure communications always get through, even in rough terrain.

"Nordic was the first company to bring a Bluetooth 4.2 SoC to market, which influenced our decision to use its technology," says Jorge Perdomo, VP of goTenna.

In brief

Nordic posts strong Q1 results

Nordic Semiconductor has reported record high revenue of \$47.3 million during the first quarter of 2017. The result represents growth of 18.2 percent over the same period in 2016. Sales of Bluetooth low energy solutions contributed \$24.3 million towards the result, or 51.4 percent of total revenue during Q1 2017. Proprietary wireless also performed well, delivering revenue of \$21.6 million compared to \$19.3 million in the same period last year. The growth in proprietary wireless came on the back of strong sales in the wireless PC peripherals market.

Smart home sensor market on the rise

ABI Research has forecast there will be 4.5 billion smart home sensor installations worldwide by 2022, fundamentally changing how homes are built, maintained, and managed in the future. The sensors, embedded in a wide range of smart home devices and appliances, will deliver near real-time understanding of even slight changes in home environments. The ability to transform this data into valuable systems and services will be at the heart of smart home adoption and the future housing market, ABI Research claims.

Smart lighting alliance formed

Leading lighting and LED driver manufacturers, Internet of Things (IoT) technology companies, and industry groups have established the IoT-Ready Alliance, dedicated to making installation of IoT technology in lighting fixtures easier. The Alliance is setting industry standards that will enable LED light fixtures to be "IoT-Ready", facilitating a quick and easy installation of advanced IoT sensors. This will also enable building operators to easily upgrade the sensors, ultimately future-proofing their buildings as IoT technology continues to advance.

Apple HomeKit-compatible sensors keep owners in control

A range of Apple HomeKit-compatible motion, door, window, and flood sensor solutions for the wireless monitoring and control of connected homes has been launched by Polish home automation company, FIBARO.

The Nordic Semiconductor nRF52832 SoC-powered sensors enable Bluetooth low energy wireless connectivity between the sensors and iOS Bluetooth 4.0 (and later) smartphones and tablets running the FIBARO for HomeKit app, or third party HomeKit-compatible apps. From the app, sensor parameters and alerts can be set and monitored, notifying the homeowner in the event of a change of conditions outside of the set parameters.

Incorporating an accelerometer, light, and temperature sensor, the FIBARO Motion Sensor not only detects movement and vibrations, but also measures the light intensity and temperature in a room. The Motion Sensor can also allow users to monitor the length of time someone spends in a room, or if installed at the home's entrance, can count how many people enter or exit the building.

The FIBARO Door/Window

FIBARO sensors notify homeowners of unexpected events



Sensor features an in-built temperature sensor, and wirelessly monitors the opening and closing of windows for security purposes. The sensor can also be integrated with other Apple HomeKit-compatible devices to, for example, prevent air conditioning systems starting if an open window is detected.

The FIBARO Flood Sensor can be used in areas of the home potentially subject to flood. Telescopic probes on the base of the device detect the presence of water and trigger an alarm plus an

alert on the user's smartphone.

"Our sensors were originally based on Z-Wave, but we wanted to reach mass market customers who do not need a dedicated gateway, and only require a smartphone or tablet so we released an additional line of HomeKit enabled products," says FIBARO CEO, Maciej Fielder. "We were attracted to Nordic's Bluetooth low energy solution as it perfectly suited our need for low power consumption, longer battery lifetime, and Apple HomeKit compatibility."

Nordic unveils new S132 SoftDevice and nRF5 SDK for nRF52832 SoC

Nordic Semiconductor has released the latest version of its S132 SoftDevice for the nRF52832 multiprotocol System-on-Chip (SoC). This SoftDevice can support up to 20 concurrent connections in a variety of Bluetooth low energy role combinations to suit almost any application scenario.

In addition to offering a range of connectivity options for different applications, the S132 SoftDevice enables specific tailoring of data bandwidth settings for each link according to its needs. Each link can be setup for low, medium, or high bandwidth options. This is highly advantageous, especially in fitness and wearable applications where multiple links can be in operation simultaneously but performing



The S132 SoftDevice for the nRF52832 SoC can support up to 20 concurrent connections

very different functions.

The S132 v4.0.2 is accompanied by the new **nRF5 SDK v13.0**, which offers full developer support for the S132 SoftDevice and has a range of new and useful features including improved secure device firmware updates, full Eddystone support, and IEEE 802.15.4 MAC support. The S132 and nRF5 SDK are available now.

Wireless motion controller completes 'immersive' virtual reality experience

 Texan virtual reality (VR) company, Merge VR, has launched a Bluetooth low energy universal three-degrees-of-freedom (3DoF) motion controller and accompanying VR goggles, that together are said to deliver a more "immersive" mobile VR experience.

The Moonshot universal motion controller is paired with a user's iOS or Android Bluetooth 4.0 (and later) smartphone—using Bluetooth low energy wireless connectivity provided by Nordic's [nRF52832](#) SoC. The smartphone is then inserted into a mobile VR headset like the Merge VR Goggles, allowing the user to interact with any smartphone-powered app-powered VR



experience with full freedom of movement.

The wireless motion controller is held by the user during play to translate their movements in the real world to movements within

Nordic's SoC adds wireless connectivity between VR headset and motion controller (not shown)

the virtual world, viewed through the Merge VR Goggles. The "marshmallow-soft"

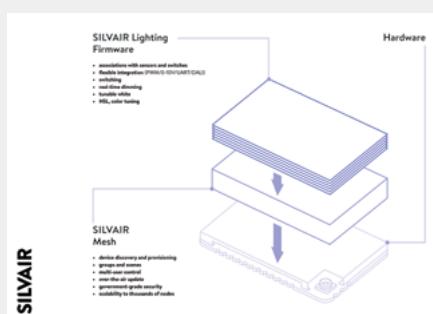
goggles are made from a durable foam, and feature left and right input buttons for interaction in the absence of the wireless controller. Powered by a rechargeable Li-ion battery, the motion controller provides 'all day' game play between recharge, thanks in part to the ultra low power characteristics of the nRF52832 SoC.

"The decision to select the nRF52832 SoC came down to its memory and power consumption, performance, and of course its Bluetooth low energy capabilities," says Franklin Lyons, Merge VR Founder. "The availability of open-source code from the GitHub and Nordic websites was also very important to us."

Wireless smart lighting ecosystem eases management

San Francisco-based Silvair has launched a multiservice smart lighting platform and a Bluetooth low energy-compatible mesh networking software, which claims to optimize the wireless management of commercial smart lighting applications.

The Silvair Platform is a smart-lighting "ecosystem" consisting of a complete set of hardware and software tools that allows installers and property managers to configure, control, and manage commercial lighting systems wirelessly. At its core, the Nordic [nRF52832](#) SoC-powered platform consists of an Internet gateway for routing sensor and fixture data to the Cloud; a secure Cloud service for storing sensor and fixture data as well as configuration back-ups; an intuitive smartphone app for performing ad hoc network configuration adjustments; and a browser-based interface for setting up



Property managers can configure and control lighting systems wirelessly

advanced lighting scenarios and monitoring lighting system performance in real-time.

The Silvair Platform is a fully scalable architecture based on the company's proprietary Bluetooth low energy-compatible Silvair Mesh Stack, enabling low-

latency wireless mesh connectivity in high-density lighting networks typically found in commercial spaces. The stack also allows smart-lighting maker to incorporate Bluetooth low energy mesh connectivity into their products.

"Mesh for lighting is much more complex and challenging than what's typically needed for other IoT applications," says Rafal Han, CEO of Silvair. "We've chosen Nordic's nRF52832 SoC because it is the most powerful and robust Bluetooth low energy solution for Silvair Mesh Stack target applications."

"In addition, the large Flash capacity allows for rapid over-the-air firmware updates, which will be particularly important after adoption of Bluetooth mesh. When that happens, the Silvair Mesh Stack can be updated to become compliant with the standard," adds Han.

Avnet SA joins Nordic network

Nordic Semiconductor has added Avnet South Africa to its existing Avnet EMEA distributor network, and will be launching its first Nordic Tech Tour in South Africa later this year. Avnet South Africa is a national South African electronic component distributor as well as value added services provider. Nordic Tech Tours are designed to help customers get up to speed quickly with Nordic's latest nRF52 Series products and Bluetooth low energy, proprietary 2.4GHz, IEEE 802.15.4, and ANT wireless technologies.

Bluetooth 5 ready module launched

Japan-based electronic component and wireless module manufacturer, Taiyo Yuden, has selected Nordic's nRF52832 Bluetooth low energy System-on-Chip (SoC) for its EYSHSNZWZ Bluetooth low energy module. The Bluetooth 5 ready ultra low power module is designed to help non-expert RF developers of complex space-constrained, wirelessly-connected Bluetooth 5 products reduce time-to-market. The EYSHSNZWZ employs the 3 by 3.2mm wafer level-chip scale package (WL-CSP) variant of Nordic's nRF52832 SoC.

Bluetooth low energy and LoRaWAN module enables long range IoT

 Japan-based Braveridge has unveiled a combination Bluetooth low energy and LoRaWAN module to enable long-range wireless connectivity for Internet of Things (IoT) applications.

The BVMLRS923N52S module provides developers of IoT solutions with proven long-range wireless connectivity between Bluetooth low energy devices in a Local Area Network (LAN) and Low Power Wide Area Networks (LPWANs) operating under the LoRaWAN specification.

LoRaWAN uses unlicensed RF bands to enable low power, wide area communication between remote sensors and gateways.

The multiprotocol module uses Nordic Semiconductor's nRF52832 SoC with Nordic's S132 SoftDevice to both provide Bluetooth low energy wireless connectivity, and to run Braveridge's proprietary

This module can dynamically change modes to provide a bridge between Bluetooth low energy LANs and LoRaWAN networks



LoRaWAN application software. The module also features an integrated LoRaWAN RF chip—supervised by the nRF52832 SoC's embedded ARM Cortex M4F processor—for IoT wireless communication across LPWANs.

As well as providing a bridge between Bluetooth low energy LANs and LoRaWAN networks, the module makes use of the nRF52832 SoC and S132 SoftDevice's support of concurrent Bluetooth low

energy Peripheral and Central modes. The device can simultaneously communicate over the 2.4 GHz (Bluetooth low energy) and 920 MHz (LoRaWAN) unlicensed Industrial, Scientific and Medical (ISM) bands.

Because the LoRaWAN application software is stored in the nRF52832 SoC's 512 kB Flash memory, it can be updated using the chip's over-the-air Device Firmware Update (OTA-DFU) functionality, unlike conventional LoRaWAN modules.

"For our application, the best feature of the S132 SoftDevice is its support for concurrent Peripheral/Central modes," says Yasunari Kohashi, CTO and Vice-President, Braveridge.

"This allows the module to dynamically change modes to facilitate the module's function as a Bluetooth low energy/LoRaWAN bridge."

Sportswatch helps track exercise metrics and daily targets

Smart wearables company, Trasense International, has launched a Bluetooth low energy sportswatch that not only tracks a range of exercise metrics including distance covered, steps taken, and calories burned, but also provides incoming phone call reminders, call rejection, smart alarm, and remote smartphone camera operation.

The HO3 Pro-N sportswatch employs Nordic's nRF52832 SoC to provide the device with Bluetooth low energy wireless connectivity, syncing the exercise data to the user's Bluetooth 4.0 (and later) smartphone or tablet. From the iOS- and Android-compatible Trasense app the user can review their performance and set alarm notifications and daily goals.

Manufactured from stainless steel, the HO3 Pro-N has a stylish analog display that features five LEDs to indicate progress towards a daily goal. When a daily goal is achieved, the watch vibrates and all five LEDs are



This analog watch features five LEDs to indicate progress towards a daily goal

illuminated. The user can also press the function button on the watch at any time to check their progress towards their goal, or to trigger the 'find my phone' and 'one button SOS' panic alarm functions. When the user receives an incoming call on their smartphone the device vibrates three times, and when the alarm is triggered it vibrates six times.

The water resistant HO3-Pro-N employs a rechargeable 100mAh Li-Poly battery that provides up to 50 days standby time between recharges, thanks in part to the ultra low power consumption of the nRF52832 SoC.

"One of the key reasons we selected the nRF52832 SoC was its multiprotocol support which dramatically reduced the time we had to spend during the development process," says Shawn Hsu, Trasense Assistant to the CEO. "The ability to perform over-the-air firmware updates has also saved us a lot of time in software development."

ULP WIRELESS TRENDS

The latest developments in technology



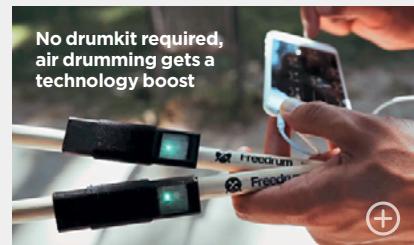
A glove that could rapidly detect the presence of a nerve agent could improve defense and food security

Biosensor glove can detect deadly nerve agents with touch of finger

Researchers at the University of California, San Diego, have developed a biosensor glove that can rapidly detect nerve agents with the touch of a finger, providing real time sample results to a smartphone using Bluetooth low energy wireless connectivity. The so-called 'lab-on-a-glove' could help improve both defense and food security by accurately and quickly detecting the presence of organophosphate nerve agents and pesticides.

The glove biosensor carries out the sampling and electrochemical biosensing steps on different fingers, with the thumb used for collecting the nerve-agent residues and the index finger containing an enzyme that reacts with organophosphate compounds. The researchers created stretchable inks to print the collection and sensing elements.

In operation, a user would swipe the thumb of the glove on a surface for testing, then touch the thumb and index fingers together, creating an electrochemical signal that is sent to a ring worn on the index finger. The ring in turn is connected to a reusable Bluetooth low energy device on the back of the user's hand, that relays real-time results via the wireless link to a smartphone. Testing showed that the glove could detect organophosphate pesticides on various surfaces, including glass, wood, and plastic, as well as on produce.



Smart sensors power virtual drumkit

Swedish start-up, Freedrum, has taken the concept of "air-drumming" to a new level with the launch of its Bluetooth low energy wireless smart drumsticks. The Freedrum sensors are attached to a regular pair of drumsticks, or can be placed on the user's feet to simulate kick drums, and are then paired to the user's smartphone or tablet. Freedrum primarily supports iOS with Garageband, but works with any program or app that supports Bluetooth MIDI.

Freedrum's integrated sensors detect movement and force, and interprets these as a hit on a drum. Six hit areas can be customized through the MIDI standard to give the experience of playing behind a full drumkit. The sensor data is relayed as a MIDI signal via Bluetooth low energy wireless to compatible apps on the user's smartphone or tablet, which then plays the actual sound. The Freedrum device is powered by a rechargeable Li-Poly battery, that can provide up to seven hours of play.

Freedrum was successfully funded on Kickstarter and will begin shipping in November this year.

LPWAN and cellular vie for bigger slice of IoT market segments

The emergence of Low Power Wide Area Network (LPWAN) and Machine-to-Machine (M2M) cellular technologies are set to provide increasing competition to short range wireless technologies in certain Internet of Things (IoT) market segments, analyst ABI Research claims.

According to the analyst, Bluetooth low energy, Wi-Fi, and IEEE 802.15.4, that have been making inroads into nascent IoT markets, will have to battle LPWAN and cellular solutions for future market share, particularly in the transportation and logistics, utilities and energy management, smart cities and smart buildings, industrial automation, and smart agriculture markets.

The IoT will represent 15 percent of Wi-Fi,



27 percent of Bluetooth low energy, and over 60 percent of IEEE 802.15.4 device shipments by 2022, as these technologies continue to evolve and target emerging opportunities ranging from wearables and

healthcare to beacons, smart home, building and industrial automation, the analyst claims. LPWAN and legacy M2M cellular technologies, meanwhile, are set to ship nearly 575 million chipsets by 2022, growing faster than any short-range connectivity solution across IoT verticals.

"LPWAN technologies ... comprise a very competitive and rapidly evolving IoT landscape," says Andrew Zignani, Senior Analyst at ABI Research. "These technologies are specifically designed for IoT and are arguably much better matches for outdoor, larger-scale IoT applications due to their abilities to target greater coverage areas, their ease of deployment, and their greater scalability."

New nRF52 SoC extends Bluetooth 5's accessibility

The nRF52810 SoC adds a baseline chip to Nordic's nRF52 Series bringing Bluetooth 5's advantages to even cost-constrained, high-volume wireless applications

Such is the range of Bluetooth low energy applications that even a chip as capable as Nordic's mainstream [nRF52832](#) System-on-Chip (SoC) can't satisfy every demand. Recently the company added the [nRF52840](#) SoC to its portfolio to satisfy the most demanding and complex Bluetooth low energy applications (see [ULP WQ Spring 2017 pg8](#)) and that has now been followed by the baseline nRF52810 SoC.

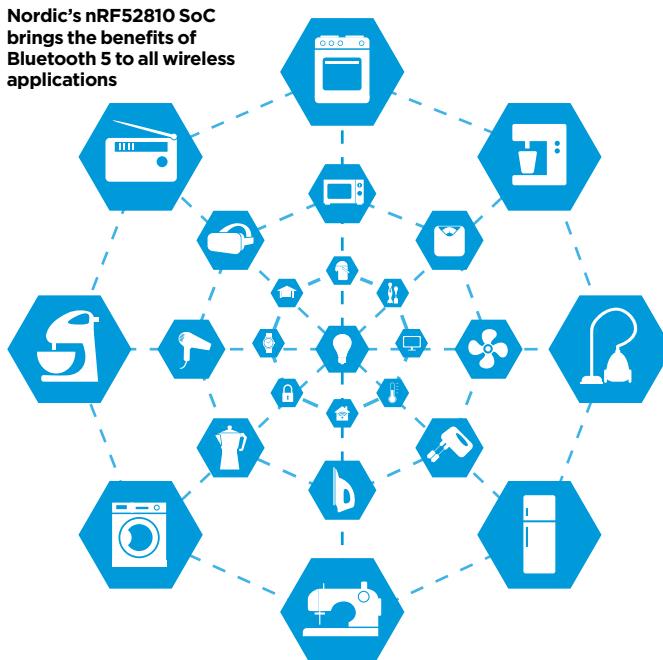
The [nRF52810](#) SoC allows developers of low-cost, high-volume applications—for example, network-connected sensors and beacon building blocks for the IoT, toys, and disposable medical monitoring devices—to benefit from the throughput and increased broadcast capacity capabilities of Bluetooth 5.

Thanks to Bluetooth 5, the SoC can deliver Bluetooth low energy wireless connectivity with up to two times the raw data bandwidth (2Mbps) compared with the Bluetooth low energy implementation of Bluetooth 4.2, and advertising packet payload size of up to 251 bytes.

"Any wirelessly-connected device significantly benefits from the throughout and broadcast capacity benefits that Bluetooth 5 offers," explains Geir Langeland, Nordic Semiconductor's Director of Sales & Marketing. "The billions of interconnected sensors making up the future IoT will not only require decent throughput, efficient data transfer, and security, but they will also need to be inexpensive to purchase, install, and maintain."

"Previously it was difficult for developers to justify the expense of one of the early Bluetooth 5 SoCs for such high-volume, lower-level applications. The nRF52810 SoC not only solves that problem

Nordic's nRF52810 SoC brings the benefits of Bluetooth 5 to all wireless applications



"Previously it was difficult for developers to justify the expense of one of the early Bluetooth 5 SoCs for high-volume, lower-level applications. The nRF52810 SoC solves that problem"

but also opens up many new Bluetooth 5/Bluetooth low energy applications."

Proven architecture

While the nRF52810 doesn't offer all the capabilities of its sister products in the nRF52 Series, it is still a powerful and sophisticated Bluetooth low energy single-chip solution which shares the proven hardware and software architecture of the more powerful SoCs. The nRF52810 SoC features a 64MHz, 32-bit ARM Cortex M4 MCU, providing similar computational power and RF performance to the nRF52832 SoC but with reduced radio energy consumption of Tx 4.6mA (0dBm) and Rx 4.6mA (1Mbps) peak currents.

The nRF52810 features the

same 100dBm link budget (96dBm receive sensitivity (at 1Mbps), 4dBm (maximum) output power), 2.4GHz multiprotocol (Bluetooth low energy, ANT+, and 2.4GHz proprietary) 2Mbps PHY radio as the nRF52832 SoC.

In addition, the nRF52810 SoC integrates 196kB Flash and 24kB RAM and a subset of the peripherals from the nRF52832 SoC. The memory allocation is ample to run application code typical of high-volume, low cost applications, and over-the-air application code updates are also supported. The SoC comes in either a 6 by 6mm 48-pin QFN package with 32 GPIOs, or a 5 by 5mm 32-pin QFN with 16 GPIOs.

The nRF52810 SoC is supplied with the latest version of Nordic's S132 SoftDevice, a Bluetooth



5-compliant RF protocol software 'stack' offering up to 20 concurrent links in a combination of Bluetooth low energy roles. The nRF52 Series' software architecture separates the protocol stack from the application software, allowing developers to quickly build, test, and verify application code with no risk of corrupting the stack.

Applications for the nRF52810 SoC can be built using the nRF52 Development Kit (DK). The basis of the nRF52 DK is the nRF52832 SoC; as such, the DK provides a simple migration path from the nRF52810 SoC to the pin-compatible nRF52832 SoC should future applications require it.

While the nRF52810 SoC's embedded ARM M4 processor powers a Bluetooth low energy single-chip solution for virtually all lower-level applications, the SoC's price makes it attractive to developers looking for a capable 'connectivity chip' which can be teamed with a separate microprocessor. This is an advantage in applications where a microprocessor has already been designed-in to a product and a developer just wishes to add wireless capability or if a developer is familiar with a non-ARM microprocessor integrated development environment (IDE) and wishes to reuse proven code.

"While the headlines will be about the nRF52810 SoC bringing the throughput and increased broadcast capability of Bluetooth 5 to lower-level applications, there is much more to the new version of the Bluetooth standard and the new SoC than that," explains John Leonard, a Product Marketing Manager with Nordic. "Faster throughput shortens the time the SoC is on air and a new coexistence algorithm reduces interference and the need to resend packets. Both these features help to extend battery life and lower maintenance." ■



China smart city embraces resonant wireless charging

Shenzhen in China is the first major city to roll-out resonant wireless charging as part of an overhaul of communication and information technology

Imagine the convenience if all your mobile devices—smartphone, tablet, fitness band—start to charge when brought close to a café table, even if they remain in your backpack. This is the promise of resonant wireless charging, a [technology](#) from the AirFuel Alliance that transfers power even when devices aren't perfectly aligned with, or even particularly close to, the charging transmitter. (See ULP WQ, Autumn 2015, pg14.)

The technology is beginning to fulfil this promise as the first commercial devices equipped with AirFuel resonant wireless charging start to reach the market. Public familiarity is also on the rise with a 2016 consumer survey, sponsored by analyst IHS Markit, concluding that eight out of ten consumers in the U.S. had heard of wireless charging, and one in four had used the technology to recharge a smartphone battery. According to the alliance, AirFuel has already enabled more than 4,000 resonant-based public charging spots throughout the world. Now the technology has received another significant boost in a city-wide deployment as part of a "smart city" initiative in Shenzhen, China.

City-wide overhaul

Shenzhen's initiative includes a public wireless charging infrastructure that adds charging transmitters onto the underside of existing furniture surfaces. Resonant wireless charging is part of a city-wide overhaul that integrates communication, information, and IoT in an ecosystem glued together with ubiquitous wireless connectivity. Offices and hotels are the first to receive charging stations and AirFuel Resonant infrastructure



Dell's new 2-in-1 portable computer is the first to incorporate AirFuel-certified wireless charging technology

"Resonant wireless charging is beginning to fulfill its early promise"

will expand to include more public places such as restaurants, malls, airports, and subway stations for use by the city's population of 12 million. Shenzhen's adoption of city-wide wireless charging demonstrates to other cities how ubiquitous wireless charging complements ubiquitous wireless connectivity to improve the productivity, health, and leisure time of citizens.

AirFuel Resonant uses coupled magnetic resonance technology, which has some advantages over the competing inductive technology. These advantages include a single

charging transmitter which can simultaneously charge multiple devices across a wide surface area, elimination of the requirement to precisely align the device to be charged with the charging transmitter, and charging that occurs even if an object is placed between the device to be charged and the charging transmitter.

Power transmitting units (PTUs) are equipped with Bluetooth low energy wireless connectivity which connects to a Bluetooth 4.0 (or later) smartphone or tablet (the power receiving unit (PRU)) to control power levels, identify

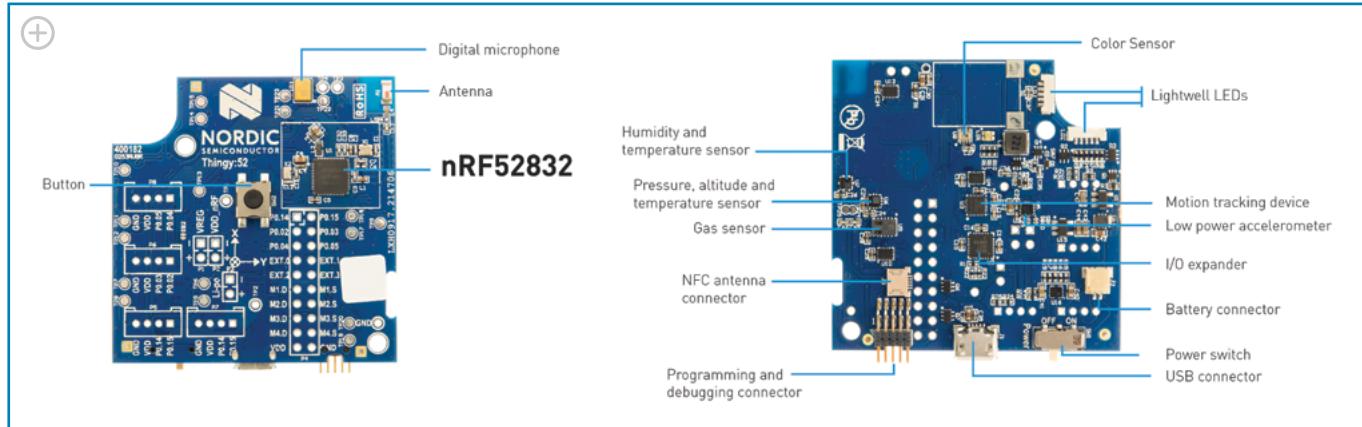
loads, and protect non-compliant devices. Several companies, including LG, Samsung, Motorola, and Nokia, are already selling smartphones and tablets with AirFuel Alliance's inductive wireless charging technology. Manufacturers look set to [incorporate](#) both resonant and inductive technologies into their products for maximum consumer convenience (Samsung, for example, has already implemented more than one wireless charging standard into a single phone.) Moves are afoot to incorporate both technologies into a single certification process. (See ULP WQ Spring 2016, pg17.)

Dell, for example, introduced the Latitude 7285 2-in-1, featuring AirFuel-certified technology, at CES 2017 in Las Vegas. The portable computer charges automatically when placed on an AirFuel-compatible charging surface. Although slower than plugging in to a power point, the 30 W of power transmitted through resonant wireless charging is sufficient for a handy top-up between full charges.

AirFuel Alliance member companies have already established a far-reaching ecosystem to support wireless charging. Nordic Semiconductor, for example, offers the nRF5 Software Development Kit (SDK) for AirFuel. The [SDK](#) can be used with both the nRF51 Series and nRF52 Series SoCs and supports the development of AirFuel Alliance-compliant wireless charging applications. The SDK includes examples for both PTUs and PRUs. ■



Nordic Thingy:52 plays host to a wide array of built-in sensors



App developers provided easy IoT access with Nordic prototyping tool

IoT hardware and firmware is tricky to develop and configure. Nordic Thingy:52 eliminates the challenge and allows smartphone app developers to focus on their strengths



By Pär Häkansson,
Product Marketing
Manager, Nordic
Semiconductor

Nordic has taken huge strides forward in simplifying Bluetooth low energy development with hardware reference designs to ensure good radio performance, innovative software architecture which separates the RF protocol stack from application code, and development kits which include software examples of the most common applications.

However, wireless product development is still far from trivial; that makes it expensive, time consuming, and more difficult for an engineer to justify building a proof-of-concept prototype to demonstrate his or her Internet of Things (IoT) idea. And even if suitable hardware is constructed and tested, some firmware expertise is needed to configure the prototype to complete even the simplest tasks.

Now, Nordic has released a prototyping tool that sweeps away all that complexity. The Nordic Thingy:52 is a self-contained platform housed in a 60 by 60-mm plastic and rubber case, with an nRF52832 System-on-Chip (SoC)

at its heart, and sporting a Li-ion battery chargeable from a USB port. (See this issue page 3.) The nRF52832 SoC boasts a powerful ARM Cortex M4F microprocessor, lots of Flash and RAM, a suite of peripherals, and a sophisticated power management system. It runs Nordic's S132 SoftDevice, a Bluetooth 4.2 qualified RF software protocol stack for advanced wireless applications.

Better yet, Nordic Thingy:52 is equipped with a family of the most popular wireless sensors, including a built-in digital microphone and speaker, nine-axis movement sensor, ultra low power wake up accelerometer, and pressure, temperature, humidity, air-quality, and color sensors. Many of the sensors are connected to switches allowing them to be turned off to save power. And if the developer is handy with a soldering iron, the Nordic Thingy:52's capabilities can also be extended by adding connectors for daughter boards.

Quick configuration

But although what's under the hood is important, a developer doesn't need to be overly concerned with the hardware and firmware specs because Nordic Thingy:52 operates as an IoT "black box", looking after all the

Bluetooth low energy connectivity and application code supervision without direct user intervention.

A developer can get straight down to rapidly configuring Nordic Thingy:52 in order to demonstrate IoT applications to interested parties. Nordic Thingy:52 can even form the basis of a hardware prototype, eliminating the need to assemble and solder RF circuits and antennas.

The unit is supplied with iOS and Android Bluetooth low energy connectivity apps which allow the developer to configure everything on the Nordic Thingy:52 from a smartphone or PC – without ever having to go near the nRF52832 SoC's firmware.

From the supplied and easy-to-use Bluetooth application programming interface (API), developers can quickly develop IoT devices for a range of applications using Nordic Thingy:52. Altering parameters such as the air-quality sensor's sample rate, switching on the color sensor, or changing the operating parameters when Nordic Thingy:52 is employed as a beacon, for example, is simple to achieve via an over-the-air instruction from a smartphone or Internet app with no need to interact directly with Nordic

Thingy:52's firmware code.

More complex IoT applications are also simple to implement. For example, a developer could demonstrate a smart light applications by connecting Nordic Thingy:52 to a Bluetooth low energy hub controlling lights such as Philips' Hue products. Alternatively, a Nordic Thingy:52 attached to a door could send a message to the hub to turn on room lights if it senses the door is opened and ambient light is low.

Nordic Thingy:52 can also be easily configured to connect to a Cloud server via the smartphone app. For example, the device could be configured to change its LED's color in response to voice commands directed at a personal assistant such as Amazon's Alexa. The voice command triggers Alexa to contact a Cloud platform which in turn instructs an inexpensive Internet-connected router to wirelessly forward the command to reconfigure Nordic Thingy:52.

Nordic Thingy:52 is the first prototyping device that allows developers to demonstrate Bluetooth low energy applications without interacting with hardware or firmware. This opens up the technology to a huge new group of developers keen to put their IoT ideas into action. ■

Non-invasive monitoring next step for diabetes sufferers

Wireless technology will play a key role in a new generation of blood-glucose monitoring which aims to consign uncomfortable finger pricking to history

Glucose is a type of sugar used to power muscles and organs. But continuously high blood-glucose levels can lead to cardiovascular disease, kidney damage, and sight deterioration.

In healthy people, hormones from the pancreas maintain an optimum level of glucose in the blood. Diabetics aren't so lucky. The disease robs them of the body's natural blood-glucose management and requires them to constantly monitor blood glucose levels and administer control using medication, diet, and exercise.

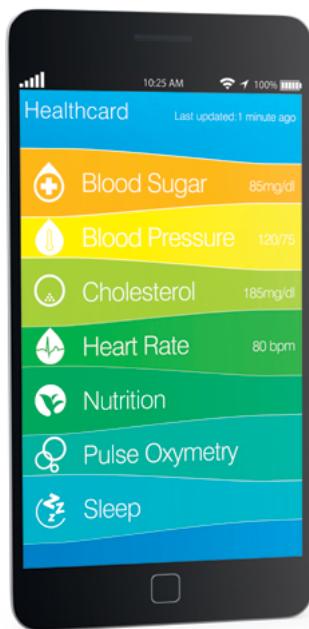
Diabetes is on the rise and, according to the International Diabetes Federation (IDF), cost health-care authorities a staggering \$673 billion in 2015. It's a major pandemic that wireless technology can help manage.

Testing, testing

Diabetics typically measure blood-glucose levels using meters with test strips containing an enzyme that reacts to glucose in a blood sample. Results are accurate, but the downside is the constant finger-pricking which is both uncomfortable and carries the risk of infection.

Other technology has further eased diabetic management. For example, wirelessly-connected continuous glucose monitors (CGMs) are becoming more common. The CGM sends data to a paired smartphone and triggers alarms when blood glucose exceeds set thresholds. The disadvantage of CGMs is that the technology is still invasive.

Non-invasive blood glucose measurement promises to eliminate the drawbacks of finger-pricking and CGMs. The problem is that it's proving very difficult to commercialize with some companies working on



The next-generation of wearables will use powerful Bluetooth low energy SoCs to monitor a wide range of health metrics including blood glucose



the technology for four decades without payback. And there are several possible techniques with no clear leader. A 2012 study listed ten non-invasive blood glucose measurements including several forms of spectroscopy, transdermal, and ultrasound, but noted that none had yet resulted in a commercial product.

Wearables makers are spending millions on non-invasive blood-glucose measurement and tend to favor spectroscopy because it uses similar optical sensors to those already proven for heart-rate measurement. By shining a light through the skin the wearables makers hope to detect signs of glucose using the optical sensors. The major challenge is that the glucose signal is tiny and tends to be swamped by ambient light. To achieve sufficient sensitivity, prototypes use large, heavy sensors weighing several hundred grams that only work well in dim ambient light.

"Non-invasive blood glucose measurement promises to eliminate the drawbacks of finger-pricking, but it's proving very difficult to commercialize"

Other companies have chosen not to crack the non-invasive glucose measurement problem directly, rather to introduce an app that correlates the conventional wirelessly-transmitted data from a wearable against independent blood readings so users can track the effect of exercise on their blood glucose. However, while this will help to improve management and reduce the frequency of finger pricking as confidence in the effects of an exercise routine increases, it doesn't eliminate the problem entirely.

Today's wearables, such as the bong 3 HR from Chinese smart

wearables company, [bong](#), rely on technology such as Nordic's [nRF52832](#) SoC because it offers a single-chip solution for Bluetooth low energy wireless connectivity to smartphones, tablets, and PCs. And the chip's embedded 64MHz, 32-bit ARM Cortex M4F microprocessor handles the complex algorithms required to compute real-time metrics such as calories burned, heart rate, baseline heart rate measurement, and heart rate alerts.

However, adding blood glucose functionality to a wearable that already supports exercise metrics demands even more from the Bluetooth low energy SoC. Nordic's recently-released [nRF52840](#) SoC builds on the success of the nRF52832 but offers greater performance, including 1MB Flash and 256KB RAM to support demanding application software, and Bluetooth 5's range, throughput, power saving, and security enhancements. (See [ULP WQ Spring 2017 pg8](#).) The SoC has been specifically designed for the most demanding Bluetooth low energy applications such as next-generation wearables.

Manufacturing (and getting approval for) a medical-grade, non-invasive blood-glucose monitoring wearable is likely to challenge even the world's largest electronics company and could therefore still be some years from market. But in the next few years expect to see "lifestyle-advice only" wearables—powered by SoCs like Nordic's nRF52840—providing a guide to blood glucose levels with around +/- 20 percent accuracy - at least enabling diabetics to identify trends, troughs, and peaks. While finger-pricking will be around for a while, next generation wearables promise to significantly reduce its frequency. ■

Ultra low power wireless connectivity solutions

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

ICs	Operating Band	Wireless Protocol	IC Type	On-Chip				Peripherals								Applications				Ref. Designs	Dev Tools	WLCSP Wafer-level chip-scale package option																	
				CPU	FPU	DSP	Memory	MPU	PA	Balun	Oscillators	NFC/Tag	2-Wire	ADC	AES	Analog Comparator	I2S	PDM	PWM	Real Time Clock	ARM CryptoCell	TRNG	SPI	QSPI	Temperature Sensor	UART	USB	PC Peripherals	Sports & Fitness	Gaming	Cellphone Accessories	Consumer Electronics	Automation	Healthcare	Toys	Wearables	Smart Home	Beacon	Wireless Charging
nRF52 Series 																																							
nRF52840	   802.15.4 2.4 GHz	2.4GHz	                                                                                         <img alt="●" data-bbox="2330 34																																				

China delivers mobile virtual reality from dream to consumer

Mobile VR stands at the crossroads between a niche fad and the next blockbuster consumer tech with the China market deciding which way it goes. ULP WQ reports

Virtual reality may be currently enjoying its greatest surge of popularity in its fifty-or-so year history, but for the doubters who have seen the technology repeatedly fail to bridge the gap between gimmick and game-changer, there is convincing still to do.

Why virtual reality—or ‘VR’ as it’s universally known—has thus far failed to win over consumers is down to no single reason. But the gulf between a manufactured and pixelated digital reality, and the nuance and subtlety of actual reality, has been a factor. To put it another way, VR has been too much virtual and not enough real.

This though, might finally be about to change. VR developers have gone a long way to bridging the reality gap. And China—a market with the perfect blend of financial and technological muscle fuelled by a consumer base with an innate cultural willingness to embrace technology—is backing it.

IT market analyst, IDC, recently predicted that the VR market in China would expand by an astronomical 441 percent in 2017, which is remarkable but even more so when Q3 2016 already saw VR shipments leap 367 percent over Q2. Among the key factors driving VR growth in China, IDC claims, are the arrival of major players, explosive growth for head-mounted smartphone-based units, better content, as well as the emergence of numerous independent start-ups launching mobile VR solutions with the backing of chipmakers.

The smartphone is king

The other clear influence driving China’s increasing uptake of mobile VR is the country’s all-encompassing love affair with the smartphone itself. According to



China's all-encompassing love affair with the smartphone is driving increasing uptake of mobile VR

Hong Kong-based Ståle “Steel” Ytterdal, Nordic Semiconductor’s Director of Sales & Marketing – Asia, while enthusiasm for the PC never really took off in China, it has been quite a different story with the smartphone.

“Everything in China revolves around the smartphone,” says Ytterdal. “So when mobile VR arrived China immediately embraced it, and the country has taken it much further, much faster than the rest of the world.”

Given the scale of the potential market for mobile VR in China, it is hardly surprising that consumer appetite for the technology has been matched by developers in rapidly bringing solutions to market; led, predictably enough, by the smartphone makers themselves.

“There are at least ten big smartphone brand names in China, and they see mobile VR is going to be big,” says Ytterdal.

“The VR market will be driven by the big companies, but they don’t necessarily have the knowledge of how to make VR solutions, so they are partnering with third party companies and start-ups specializing in mobile VR to access the necessary expertise.”

Beijing-based Xiaomi, the world’s fourth largest smartphone manufacturer, is a case in point. Late last year Xiaomi launched its Mi VR headset and wireless motion controller, following up on its already successful Mi VR Play that was released in August 2016. Within eight hours of the Mi VR Play launch announcement, more than a million people registered to become beta testers. Mobile VR is clearly a market Xiaomi sees as a Trojan horse for boosting smartphone sales.

The new Mi VR headset is designed to work with several smartphones across the Xiaomi range, at a price point that

extends the reach of high-quality mobile VR to price-conscious consumers. The headset is accompanied by a wireless motion controller. This makes the most of the smartphone’s Bluetooth low energy interoperability by wirelessly transmitting data about the user’s movements in the real world so that they can be mimicked by movements of the virtual player within the smartphone VR app.

The technology to do this without the motion-sickness effects associated with systems exhibiting excessive latency (a key reason for the slow take-up of mobile VR so far) is sophisticated and demands an extremely capable wireless System-on-Chip (SoC). Xiaomi’s [remote control](#) makes the most of Nordic’s nRF52832 SoC—one of the most powerful single-chip Bluetooth low energy solutions in the world—to incorporate a nine-axis



Inertial Measurement Unit (IMU) with three-degrees-of-freedom motion tracking, that is held by the user during play to enhance the VR experience.

Xiaomi has also developed a VR Software Development Kit (SDK) for the wireless motion controller, allowing third-party developers to design new interactive modes in their own applications or games, and interested parties are not in short supply. Xiaomi claims as many as 250 third-party developers have already expressed an interest in working on new content for the company's Mi VR store.

Guangzhou-based, Ximmerse, is another firm eager to partake in China's blossoming mobile VR market, and has also embraced the benefits of a sophisticated

[motion controller](#). The startup, launched in 2015, recently announced the launch of Ximflip, a three-degrees-of-freedom (3DoF) motion controller, and Ximneon, a six-degrees-of-freedom (6DoF) mobile VR kit with positional tracking.

The Ximneon 6DoF mobile VR kit not only includes Nordic nRF52832 SoC-powered motion controllers incorporating magnetometer, accelerometer, gyroscope, and touchpad sensors, but provides a further level of VR sophistication with the inclusion of an external stereo camera. The camera tracks the user's movements within its line of sight and 120° field of vision via a VR headset-mounted LED marker. The camera tracks the LEDs on the headset marker to

locate the user's position in 3D space, relaying the data back to the user's smartphone via a home Wi-Fi network.

Taiwan's CyweeMotion Group, meanwhile, has launched a VR [remote module](#), designed to help OEMs develop wireless controllers for Android mobile applications. The VRRM01 remote module incorporates a nine-axis motion sensor combining a three-axis gyroscope, three-axis accelerometer, and three-axis magnetometer to track the user's hand motions using the company's proprietary, advanced 'sensor fusion' algorithm. The algorithm is powered by the nRF52832 SoC's ARM Cortex M4F microprocessor.

The company's sensor fusion algorithm generates "flicker-free"

motion tracking at up to 100 Hz for a fast-response VR experience free of motion-sickness.

VR comes of age

If a willing consumer base and an able community of manufacturers and developers might provide two key ingredients for mobile VR success, does this guarantee the latest incarnation of VR will prove more successful and sustained than previous false dawns seen since the 1990s? Perhaps not in itself, says Ytterdal, but the missing ingredient then was always the electronics, and that gap has finally been overcome.

"The reason it has taken so long for VR to succeed is down to the technology, but it's now here to stay," says Ytterdal. "Finally, we have the technology that makes mobile VR more comfortable to use. You have better displays, high data throughput and lower latency wireless connectivity, longer battery lifetime, and more powerful smartphones. All these things come together to make the difference."

While gaming has been identified as the genesis for VR's latest rise to prominence, it is quickly being joined by other applications that had previously not considered the technology worthy of embracing.

"Gaming started VR and continues to make it thrive, but you can also see the technology moving into different market segments," continues Ytterdal. "For example, travel agencies are starting to use VR and are seeing a huge increase in the number of people making travel decisions because they used VR to visualise their holiday experience before they stepped on a plane."

"Oil companies are also using VR to do repairs on oil platforms. And the medical sector is another starting to embrace VR. Each sector is using the gaming segment's experience to learn about what they can actually do with mobile VR, and once the technology becomes even better and more affordable you will start to see people take this technology and using it somewhere that hasn't been considered previously."

"This is just beginning. Prepare to see an explosion very soon." ■

"When mobile VR arrived China immediately embraced it, and the country has taken it much further, much faster than the rest of the world"

The new Mi VR headset is designed to work with several smartphones across the Xiaomi range



Thread protocol extends smart home influence

As the connected home gathers pace, a dedicated open-standard communication protocol is required. Sally Ward-Foxton explains



Sally Ward-Foxton
is a freelance
journalist specializing
in electronics

As more home automation IoT devices come onto the market, effective and efficient interoperability has never been more important. Many of today's commercial protocols are proprietary, meaning only devices from a single vendor will interoperate. Worse yet, proprietary protocol set-up is tricky, efficiency is compromised, and security isn't as strong as it could be. And many proprietary systems connect to the Internet via a single point such as a home Wi-Fi router, which means the entire network is broken if the router goes down.

Open-standard communication protocols address the drawbacks of proprietary protocols. Established technology such as Bluetooth low energy and zigbee

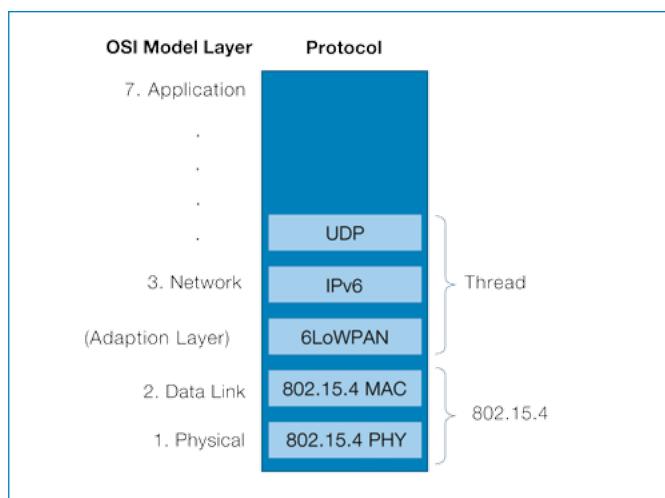
are popular, and now Thread is attracting a lot of attention among smart-home sensor makers.

Thread is emerging as a low-power, easy-to-use, secure solution for the smart home. It has the backing of Google following its acquisition of Nest, the company famous for its smart home thermostat, at the beginning of 2014. Since then Google has used Nest's Thread protocol as the basis for its smart home connectivity offering.

Google then set up the [Thread Group](#), which now includes companies such as Samsung, ARM, and Qualcomm, to develop and maintain Thread as an open-standard protocol for low power wireless home automation networks. The first Thread standard was released in July 2015 offering scalability and reliability combined with security features such as smartphone-grade authentication and AES encryption.



Figure 1: Thread defines the transport and network layers (including IPv6 and User Datagram Protocol (UDP)), with 6LoWPAN forming the adaptation layer for the IEEE 802.15.4 PHY and MAC



Combining WPANs and IPv6

Thread, like some of its smart home counterparts including zigbee and Wireless HART, is built on the IEEE 802.15.4 standard which helps underpin its low power consumption. The Institute of Electrical and Electronic Engineers (IEEE) has developed and maintained this physical layer (PHY) and media access control (MAC) standard since 2003. It is designed for low power, low data rate wireless personal area networks (WPANs), allowing for up to 250kbit/s data rates, but the rate can be lowered for reduced power consumption. Useable range is around 10m.

A 6LoWPAN (IPv6 over low power WPAN) adaption layer bridges the gap between the IEEE 802.15.4 PHY and MAC (primarily designed for transmission of lightweight packets across the home network) and the Thread upper layers and application (which handle the larger packets and IP address headers of the IPv6 protocol). (See figure 1.)

By supporting Internet Protocol (IP), Thread devices can communicate with all other



IP-addressable devices on the Internet of Things (IoT) without relying on an expensive and complex gateway. Instead, Thread networks employ relatively inexpensive ‘border routers’ in place of complex gateway devices to relay the short-range WPAN signals to the Internet proper. IP support also means Thread devices can take advantage of existing, proven security- and transport-protocols that already service other IPv6 devices.

Thread networks

A second key advantage of Thread is its mesh network support for up to 250 devices. Mesh networks can self-heal by re-routing packets when individual nodes go down - building in redundancy. A mesh topology also enables scalability - more nodes can easily be added, extending the network's reach.

However, not all Thread devices are able to operate as mesh nodes. End devices (for example, the smart home's thermostats) are only able to transmit data and check for messages via their parent router. Such sensors spend most of

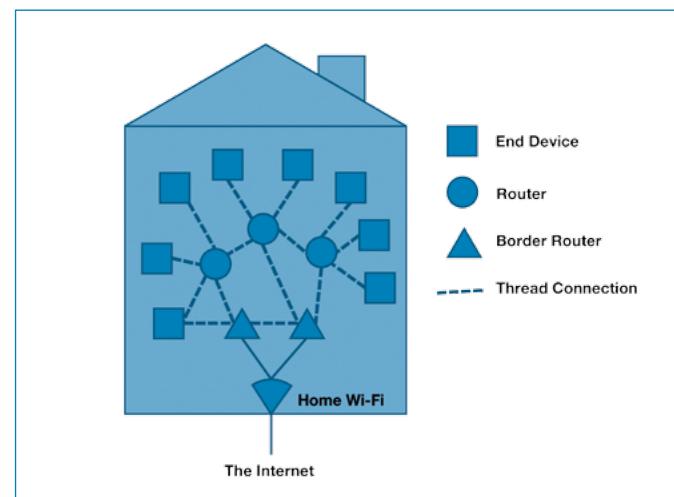
the time in sleep mode, and by limiting the network functionality and duty cycle of end devices, efficiency (and battery life) is improved.

Routers play the key role in Thread mesh networking by relaying traffic and facilitating the commission of new devices. New devices need authorization from the user via a smartphone or tablet for security, but such authorization only takes a few steps. The first device to join the network becomes the lead router and makes decisions within the network. Other devices can then join the network as either router eligible devices or end devices, with router eligible devices able to become routers if needed. Unlike end devices, routers are not designed to sleep so inevitably use more battery power.

protocol is available on GitHub and is both operating system and platform agnostic with a radio abstraction layer supported on multiple platforms. The idea is to give more developers access to Thread technology to encourage them to incorporate the protocol into new products. However, companies must join the Thread Group to gain the intellectual property rights to the protocol. Products must also be approved by the group before they can be marketed as “Thread-certified”.

Thread is gaining momentum with wireless chip vendors. For example, Nordic Semiconductor, an established supplier of Bluetooth low energy, ANT+, and 2.4GHz proprietary solutions, has added IEEE 802.15.4 PHY and MAC support to its [nRF52840](#) System-on-Chip. For developers

Figure 2: Thread builds mesh networks based on routers and end devices such as thermostats and security cameras



Border routers provide bridges between the Thread network and exterior networks (in most cases, the Internet). Border routers can be specific Thread gateway devices or other devices that can communicate via both Thread and other protocols, such as home Wi-Fi gateways that have built-in Thread functionality. If one border router in the network fails, then another can take over. (See figure 2).

Thread in Products

Last year, home automation firm Nest released an open-source implementation of Thread, called OpenThread. The networking

wishing to use the nRF52840 SoC's IEEE 802.15.4 capability for Thread devices, Nordic supplies a Software Development Kit ([SDK](#)), employing OpenThread, for product development.

Given Thread's key advantages in the smart home space, and the possibility of relatively straightforward software upgrades of IEEE 802.15.4-based products to enable them to use the Thread protocol, initiatives like OpenThread promise to result in rapid Thread adoption. When this happens, home automation devices such as smart thermostats will truly become an integral part of the IoT. ■



IoT Test Center gives bright future to smart lighting

With a little help from Nordic Semiconductor, U.S.-based smart-lighting company Gooee is intent on revolutionizing the industry on a scale previously unseen

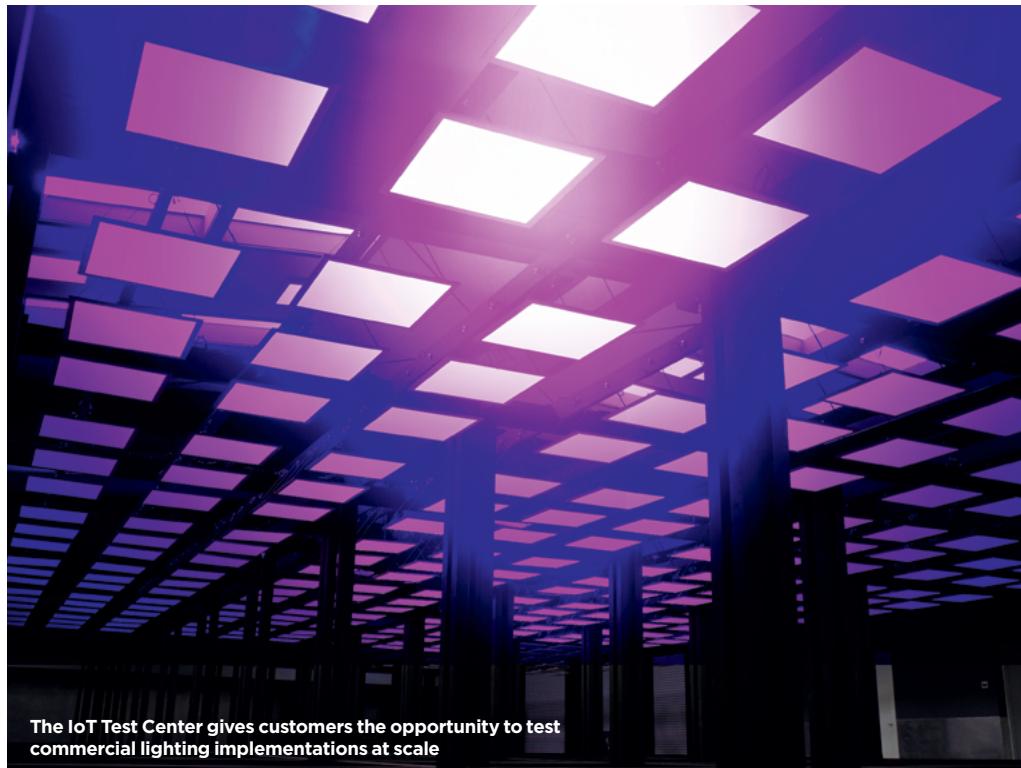
With an average 361 days of sunshine each year, St Petersburg, Florida, may have earned its nickname of the “Sunshine City”, but there is an agreeable irony that while it is sunlight the city may be best known for, it is also rapidly winning a reputation as the smart lighting capital of the world.

St Petersburg is home to Gooee, a smart lighting company focused on delivering enterprise-wide Internet of Things (IoT) solutions to the global lighting sector.

The city is also home to Gooee’s new state-of-the-art IoT Test Center, a purpose-built facility spanning 1300 square meters—equivalent in floor area to seven tennis courts—designed to provide both Gooee and its customers with commercial scale testing of the company’s IoT smart lighting ecosystem.

Gooee’s smart lighting platform captures and displays smart lighting installation data, environmental information such as room temperature and ambient light levels, human activity such as motion and motion direction, as well as LED lighting performance. Designed for LED lighting manufacturers, the platform significantly simplifies installation complexity, at the same time reducing energy consumption and maintenance costs for end users by monitoring every LED light in an installation, providing the opportunity for predictive maintenance, and enabling lifetime tracking of each individual LED’s performance.

The company began fabricating the Test Center in November 2016, rapidly building



The IoT Test Center gives customers the opportunity to test commercial lighting implementations at scale

it out over the following three months, before commencing full automation testing in February of this year.

According to Gooee Chief Technology Officer and Co-Founder, Simon Coombes, while the IoT Test Center was originally conceived as a tool to test the capabilities of the company’s mesh networking software stack within its own ecosystem, the benefits of the facility for Gooee customers was equally apparent.

Where lighting brand owners and end users might traditionally have trialed their products on a small scale in a test sphere, the IoT Test Center now gives customers adopting Gooee’s platform the opportunity to fully test

commercial smart lighting at scale, in real world scenarios, before committing time and money to further development and deployment.

“Every customer we have had pass through the facility has been impressed by the scale on which we are testing,” says Coombes. “The level of performance analysis in terms of debugging and stability tracking gives our customers reassurance that we have a full picture of their system.

“We track a wide number of data points, such as latency at the local, networking, and Cloud level, network stability versus node count, network join time, data bandwidth, and sensor data streaming – it’s an extensive list.

“We have developed a suite of robots to simulate motion and activity,” continues Coombes, “allowing fully automated testing over prolonged periods, giving us a rich set of data to analyze. Data is also stored in the Cloud for analysis between product releases and various scenarios we design.”

Future-proofed

Launched in 2016, the Gooee [platform](#) originally employed Nordic Semiconductor’s nRF51822 Systems-on-Chip (SoCs) for its Wireless Interface Module (WIM) to control and monitor each LED light via its power supply. The WIMs also provide Bluetooth low energy beacon functionality for consumer engagement, and send



data securely to a Gooee wireless enterprise gateway, and the Cloud, via a provisional release of Bluetooth mesh networking technology. In late 2016, Gooee decided to migrate their platform to Nordic's [nRF52832](#) SoC, which at launch was the world's most powerful single-chip Bluetooth low energy solution, not only for future-proofing, but also for the performance improvements it delivered.

A mesh networking stack for smart lighting is not only highly complex, but the performance requirements are also extremely challenging. The nRF52832 SoC's powerful 64 MHz, 32-bit ARM Cortex M4F processor, 512 kB Flash memory, and 64kB RAM, not only allows it to handle the complex algorithms and processes involved, but also provides for rapid over-the-air

firmware updates, which will be particularly important after the formal adoption of the Bluetooth mesh specification anticipated later this year.

"We saw a massive opportunity to gain performance improvements and technology future-proofing by moving to the nRF52832 SoC and in late 2016 we hit a perfect time in development to migrate," says Coombes. "We now have all hardware upgraded, which is currently being re-certified, and the response from our customer base on this decision has been extremely positive."

Bright future

More broadly, Coombes sees the future of lighting as a sector with an almost unparalleled opportunity for development,

improvement, and innovation, a future in which he hopes Gooee will play a significant part.

"The fundamental technology is over 100 years old which means for new buildings and lighting installations there is an opportunity for enormous installation, energy, and maintenance cost savings," says Coombes. "Smart Lighting is a really exciting sector to be working in and we see a lot of innovation happening, including technology in complementary fields such as sensing.

"In terms of mesh networking, we felt from the beginning that due to wide variance in lighting environments that exist across new builds and retrofits, a low-powered mesh network was going to be critical. When we first engaged with Nordic three years ago, there was a shared

vision of what was needed technology- and solution-wise, and we have had a great partnership ever since."

Which is not to say, adds Coombes, that the smart lighting sector—and the IoT more broadly—is without its challenges.

With the rapid nature of technology evolution across both hardware and software it's clear, he says, that a lot of lighting brand owners are struggling to keep up with the technology, resource requirements, and generally what is needed to bring a smart solution to market. Which is where Gooee, its full-stack ecosystem, and new IoT Test Center, really come to the fore. The future is looking bright for the company and the Sunshine City it calls home. ■

"Gooee's purpose-built smart-lighting test center spans the equivalent floor area of seven tennis courts"



Gooee's platform simplifies smart lighting installations, and reduces energy costs

IoT extends its reach into the industrial landscape

The Industrial Internet of Things (IIoT) promises to increase efficiency in a range of industries from agriculture to manufacturing. Caroline Hayes takes a closer look



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

Intelligent, connected consumer devices in cars, home appliances, and healthcare equipment make up the Internet of Things (IoT). The Industrial Internet of Things (IIoT)—a subset of the IoT which increases efficiency and improves health & safety—adds ‘big data’ analytics and machine learning to create reliable, efficient, plant and automation systems in factories, utilities, mining, and agriculture.

IIoT offers a plant operator visibility and remote control to improve management and efficiency. By building a huge database of plant performance and failure modes, engineers can develop predictive maintenance algorithms that enable connected devices to [issue an alert](#) if a maintenance check is required, for example, or highlight a potential failure before the event occurs. This can prevent costly, extended downtime periods.

The data gathered from sensors can also be used to track assets within the supply chain, with real-time updates of location and movement to improve efficiency. As well as increasing profitability, better supply-chain management contributes to improved energy consumption efficiencies.

According to a recent report by consultants, Accenture Technology, the IIoT has been heralded primarily as a way to improve operational efficiency. “Operational efficiency is a key attraction for manufacturers to invest in the IIoT, and early adopters are focused on these benefits,” explained Paul



The IIoT will make industrial facilities both more efficient and safer places to work

Daugherty, Accenture’s CTO, in the report. “By introducing automation and more flexible production techniques, for instance, manufacturers could boost their productivity by as much as 30 percent. However, the Accenture report also notes that the IIoT should also be seen as a tool for finding growth in unexpected opportunities.

The role of Bluetooth

Key to finding these opportunities is using the IIoT to power many new applications. For example, oil companies could remotely monitor the condition of a pipeline along its entire length and use the data to identify any changes triggering an alert for a maintenance team to check a specific location. This preventative action will ensure efficient, uninterrupted operation, and save on maintenance travel time and costs.

While reliability is important for the IoT, it is critical for the IIoT. A lack of communication or downtime in a factory is expensive, and in utilities, oil, and mining, for example, could have

“While reliability is important for the IoT, it is critical for the IIoT”

disastrous safety consequences. Security is also important in the IIoT, not only because the data being transferred could be sensitive, but because any unauthorised access could interrupt, or paralyze, vital utility or medical services.

Bluetooth low energy is a proven foundation technology for the IoT and meets the exacting demands of the IIoT. And the recent introduction of Bluetooth 5 brings new benefits to IIoT applications. For example, Bluetooth 5 offers a 2-Mbps data rate, ensuring faster data transfer, more rapid firmware updates, and longer battery life because transmission times for a given amount of data are slashed. The new version of Bluetooth also extends the range by a factor of four allowing for practical and scalable wireless deployments over large industrial facilities. (See [ULP WQ Spring 2017, pg16](#).)

Like previous versions of the technology, Bluetooth 5 adheres to U.S. federal security regulations, ensuring all Bluetooth devices are capable of meeting and exceeding strict government security standards to prevent hacking.

Nordic Semiconductor’s [nRF52840](#) System on Chip (SoC) supports the throughput, range, and security benefits of Bluetooth 5, while its 64-MHz, 32-bit ARM Cortex-M4F microprocessor and generous Flash and RAM allocation enables it to support advanced IIoT wireless sensor applications. The SoC also supports IEEE 802.15.4, ANT+, and proprietary RF software protocols. A Preview Development Kit (PDK) eases and accelerates development of IIoT applications with the nRF52840 SoC.

While precise numbers are difficult to estimate, it’s safe to say the IIoT will boost the global economy by hundreds of billions of dollars over the next decade. But perhaps more importantly, it will enable industry to become safer, more sustainable, and more energy efficient. ■

Anatomy of a SoftDevice

Nordic Semiconductor's RF protocol software stacks are an essential component of the company's award-winning suite of wireless connectivity solutions

Nordic's nRF51 and nRF52 Series Systems-on-Chip (SoCs) comprise highly-integrated hardware and sophisticated software. This software typically comprises two elements: the RF protocol and the application program. The application program is typically written by the customer using Nordic supplied development tools, and ensures the wireless product is optimized for a specific implementation. The RF protocol software is commonly referred to as a "stack" - layers of software forming a single protocol that ensures the transceiver communicates using a defined set of priorities and rules. (See [ULP WQ Autumn 2014, pg9.](#))

Nordic has brought together one of the world's largest and most experienced teams to develop its own Bluetooth low energy RF protocol software. This software team works closely with the company's hardware group to ensure the protocol is highly optimized for the nRF51 and nRF52 Series SoCs. The performance of the SoC is highly dependent on the protocol's smooth and efficient operation.

Nordic's RF protocol software forms part of the company's "SoftDevice", so named because although it comprises just binary code, the software can effectively be viewed as an extra 'device' on the SoC with known interfaces and predictable operation.

The rest of the SoftDevice comprises the SoC Library (an Application Programming Interface (API) enabling coexistence with the application) and the SoftDevice Manager (an API for enabling and disabling the SoftDevice, among other tasks).

A SoftDevice is a qualified, pre-compiled, and linked protocol stack downloadable as a binary file from Nordic's website. The software is event-driven, provides run time isolation



Nordic's SoftDevices are proven, secure RF protocol software stacks

and determinism, and allows applications to implement standard Bluetooth low energy profiles as well as proprietary implementations.

In addition, a SoftDevice provides a mechanism for enabling the number of Central or Peripheral roles the application can concurrently run and supports per-connection bandwidth configuration by giving the application control over the connection interval and the

length of the connection event.

Software separation

Nordic's nRF51 and nRF52 Series are based on a software architecture that enforces a clear separation between the SoftDevice and the developer's application code. This separation simplifies development by eliminating the tedium of application code integration as part of a vendor-imposed development framework. (See

figure 1.) The SoftDevice resides in a specifically allocated area of Flash memory on the SoC (and can be updated in the field using the SoC's wireless link). Different SoftDevices are available to meet varying Bluetooth low energy use scenarios and each employs a prioritized interrupt scheme (first critical low-level protocol tasks, then critical application tasks, secondary protocol tasks, and secondary application tasks) to maintain good protocol and application performance.

The SoftDevice API is available to applications as a high-level programming language interface, for example a C header file. The API gives the application complete compiler and linker independence from the SoftDevice implementation. During application development, compiling, testing, and verification, the SoftDevice remains untouched and uncorrupted; critical dependencies for efficient and reliable RF protocol software operation are maintained and unpredictable behavior is minimized. And because the prequalified SoftDevice is unchanged, it requires no Bluetooth requalification when development is complete.

The latest Bluetooth low energy [SoftDevices](#) for Nordic's nRF51 and nRF52 Series are the S130 (nRF51 Series), S132 (nRF52810 and nRF52832), and S140 (nRF52840).

The S130 is a Bluetooth 4.2 concurrent multirole (Central/Peripheral/Broadcaster/Observer) Bluetooth low energy SoftDevice; the S132 is a Bluetooth 4.2 concurrent multirole Bluetooth low energy SoftDevice, and the S140 is a Bluetooth 5-ready concurrent multirole Bluetooth low energy SoftDevice.

ANT SoftDevices are available from Nordic's design partner ANT Wireless. ■

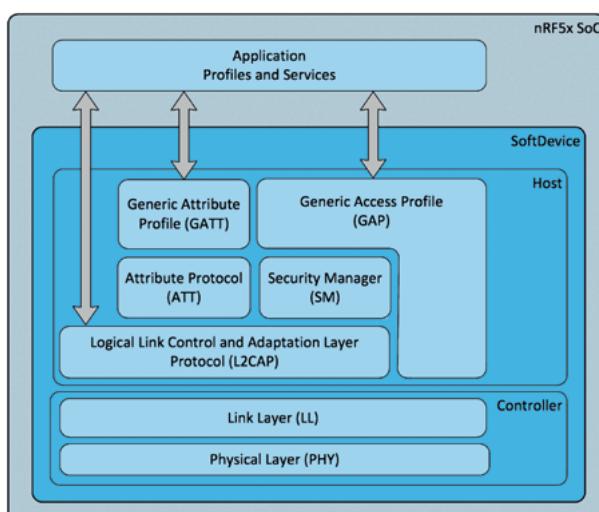


Figure 1: Nordic's SoftDevice (Bluetooth low energy version shown) and customer application code remain separated during development



Zepp Play Soccer Sensor

This Bluetooth low energy wearable soccer sensor measures a wide data set of player performance attributes for post-game analysis by coaching staff

The hardest-working professional footballers regularly run 12 km during a match, but the record for the furthest distance covered in 90 minutes is held by England's former captain, David Beckham. During a [World Cup qualifier](#) between England and Greece in 2001, Beckham ran an energy-sapping 16.1 km on the way to a 2-2 draw

According to the sport's governing body, FIFA, more than 265 million people across 207 countries play soccer around the world, while 3.9 billion people tuned in to watch the most recent World Cup in 2014, easily making the sport both the most widely played and followed activity on the planet

Over the next five years the sports analytics market is predicted to grow at a compound annual growth rate of more than 40 percent, to reach an aggregate of \$3.97 billion by 2022. According to analyst WiseGuyReports.com, sports analytics will receive a major boost from wearable devices and sensors. The Nordic Semiconductor-powered [Zepp Play Soccer](#) sensor not only tracks player statistics, but also uses auto-clip technology to create video highlights providing a wide range of performance insights for coaching staff and players alike

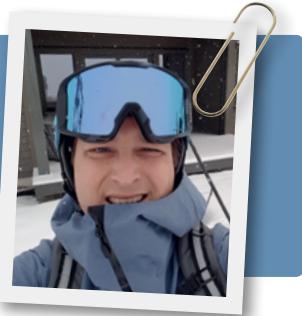
Zepp Play Soccer places a high demand on the Nordic [nRF52832](#) Bluetooth low energy SoC. The application is required to support more than 30 sensors and provide sufficient bandwidth between sensors and smartphone to cope with more than 100x the data generated by a heart rate monitor

The Zepp Play Soccer sensors are strapped to a player's calves during a game, and record running and sprint distance, passing, and preferred foot metrics, automatically synching to a smartphone via Bluetooth low energy wireless connectivity after the game. Powered by a 125mAh Li-ion battery, the sensors can record up to 15 hours of game time between recharge



PEOPLE & PLACES

Peder Rand



Nordic's first Product Manager for cellular IoT enjoys both work and play

Hi, I'm Peder Rand and I'm Nordic's first Product Manager for Cellular IoT. I joined Nordic in January this year having previously worked at TI for many years specializing in the same kind of ultra-low power wireless technologies as Nordic, but as a competitor.

My main job right now is to engage with both existing and potential customers to make sure that Nordic gets the right cellular IoT products to market when they are launched.

This is a tricky balance to get right because not only does Nordic not currently have any actual [cellular IoT](#) products on the market, cellular is a complex ecosystem within which cellular IoT itself is a brand new, emerging segment.

Although this has put me on a steep learning curve, the depth of relationship Nordic has built with its customers over many years has led to a level of trust and collaboration I've not seen before when introducing new technologies.

This means the focus can very quickly move to the specifics of how cellular IoT will allow both existing and emerging applications to wirelessly connect to the Cloud directly via a cellular network instead of a



When not at work, Rand loves to explore the Norwegian fjords

gateway or gateway device (such as a smartphone). And these conversations get interesting when customers realize the Nordic solution will support this in a highly power-optimized way at a commercially viable cost that supports widespread use in everyday devices.

Before long, when almost everything we use around us is 'online', 'intelligent', and almost 'instant', children growing up today will wonder how their parents and grandparents ever coped without the labor-saving, chores-eliminating simplicity and automated ease of things that just 'work' all by themselves. And I feel privileged to be playing an

Personal Profile

NAME:
Peder Rand
JOB TITLE:
**Product Manager –
Cellular IoT**
JOINED NORDIC:
January 2017
BASED:
Oslo, Norway
INTERESTS INCLUDE:
**Skiing, boating,
socializing, cooking**

active part in helping to make this happen.

And while I'd love to be able to give away more details on what the fantastic

products Nordic's R&D team are developing to enable this future vision, all I can say at this stage is one of the major focus points is ensuring they will be very easy for customers to integrate, with potential for genuine 'connectivity anywhere' functionality.

But giving away even that could get me in trouble with senior management so swiftly changing subject: outside of work I really like to ski – both cross country and slalom.

It's a great activity for spending time with your family and enjoying the outdoors, even when the winter is at its most brutal here in Norway.

When I'm not skiing, I like to spend time on the water in my boat exploring the small islands of the fjords in southern Norway. It's not a long season—typically a few good weekends in the summer if you get lucky—but it's a truly magnificent outdoor experience that I always cherish.

Finally, I also thoroughly enjoy socializing with friends, and especially when that involves sitting down to share a meal that I have a cooked for them or they for me, and best of all - after having been out for a good, long ski in the cold during the day. It's one of the finest Norwegian luxuries. ■

"Nordic Semiconductor's cellular IoT products will be very easy for customers to integrate, and have the potential for genuine 'connectivity anywhere' functionality"



Subscribe to ULP Wireless Quarter:

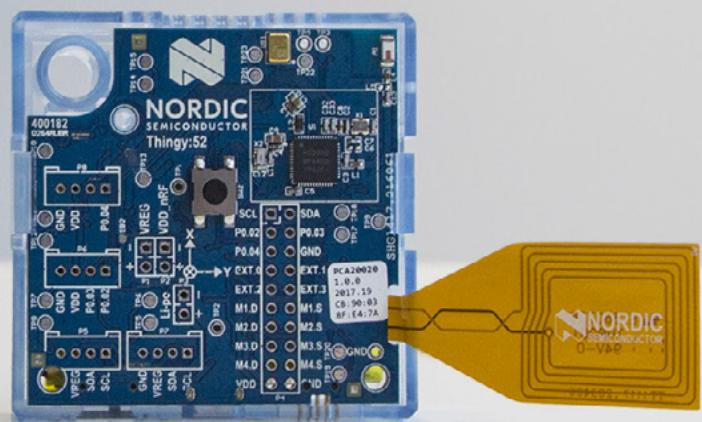
To subscribe (or unsubscribe) to *ULP Wireless Q* please login to (or create) your Nordic [MyPage account](#) at www.nordicsemi.com

BACK ISSUES: A complete archive of all previous *ULP Wireless Q* issues are available for you to download in PDF format at: www.nordicsemi.com/News/ULP-Wireless-Quarter



Nordic Thingy:52

IoT Sensor Kit



Designed to create IoT
demos and prototypes

› For more info go to nordicsemi.com/thingy

