ultra low power wirelessQ

QUARTER 4 | **WINTER 2017**

COVER STORY

Wireless advances asthma care

Smart home battle begins

Maximizing cellular IoT returns

The benefits of single-chip design

NORDIC SEMICONDUCTOR

OPINION

Thomas Søderholm

Wireless medical devices gaining momentum

The conservatism of the medical sector should not be confused with a lack of vision; healthcare authorities are among the most enthusiastic adopters of technology. But anything new must first pass stringent independent regulation and internal checks to ensure there are no detrimental side effects that could harm patients' health, while confidentiality is upheld, and budgets are maintained.

Bluetooth Low Energy (Bluetooth LE) is passing this scrutiny. Healthcare professionals have quickly grasped how a technology that is interoperable with smartphones can lead to smart medical devices, helping patients manage their conditions between visits to the doctor.

Moreover, opening a wireless pathway between patient and the Cloud enables the compilation of a huge database of anonymous data that can be used by healthcare authorities, drug companies, and medical device makers alike to improve care and the effectiveness of medication.

But it's not just the healthcare professional who appreciates the value of wireless monitoring; a survey by consultant Deloitte (*2016 Survey of U.S. Health Care Consumers*) showed that 70 percent of consumers were open to the use of remote patient monitoring sensors if the need arose.

Some pioneering companies such as Dexcom and Aterica Health have already designed Bluetooth LE-powered products that have either passed stringent U.S. Food and Drug Administration (FDA) certification or are in the late stages of doing so. But there is a development chasm between the vision and commercial realization for other companies wanting to add wirelessly-connected products to their portfolio.

While Nordic Semiconductor numbers Dexcom and Aterica among its valued medical design partners it is just as committed to working with companies with less RF development experience.

That's why, in addition to its established development kits and software development kits for the nRF52 Series Bluetooth LE solutions, Nordic has now introduced a proof-of-concept (PoC) PCB hardware design for medical products. The PoC PCB is based on the nRF52810—the baseline device in the nRF52 Series which offers an excellent cost/performance ratio and Bluetooth 5 capability—and S112 SoftDevice, a lightweight Bluetooth 5 RF protocol software "stack". The PoC PCB significantly accelerates design schedules for medical products such as asthma inhalers. (*See pg14.*)

Bluetooth LE is not only improving the quality of life for chronic disease patients, it is also ensuring allergy suffers remain in good health. Aterica's product is a smart case for auto-injectors, designed to ensure those who react dramatically to things like bee stings never leave their medication at home. Nima's gluten testing product also supplies a convenient alternative to laboratory testing. (*See pg18.*)

Once the healthcare authorities are convinced a technology will benefit patients they embrace it enthusiastically. Bluetooth LE is proving its worth to those authorities and looks set to wirelessly connect medical products for years to come.

Yours Sincerely,

Thomas Søderholm
Director of Business Development

Contributors

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Caroline Hayes is a U.K.-based technology journalist specializing in semiconductors. On page 16 she looks at how Bluetooth Low Energy is accelerating Industry 4.0

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Sebastien Mackaie-Blanchi is an Engineering Manager with Nordic. On page 20 he details the benefits of single-chip integration for advanced wearable applications

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Kalon Huett is an Australia-based freelance journalist. Here he examines the company behind a digital radio enabling off-grid smartphone communication

Designing connected asthma devices is simpler than ever with Nordic's reference design

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NEWS

The latest developments from Nordic Semiconductor

nRF52810 volume production brings Bluetooth 5 to the masses

Nordic Semiconductor's memory-optimized nRF52810 Bluetooth Low Energy (Bluetooth LE) System-on-Chip (SoC) is now available worldwide in volume, allowing designers to get lower-cost, mass-market products to consumers with the key benefits of Bluetooth 5.

The production volume launch of the nRF52810 is accompanied by the introduction of Nordic's latest Bluetooth 5 protocol software, the S112 SoftDevice, and a new version of the nRF5 Software Development Kit.

The nRF52810 SoC, based on Nordic's proven nRF52 Series architecture, has the lowest power consumption in the family and brings the 2 Mbps higher throughput, improved coexistence, and advertising extensions features of Bluetooth 5 to the most cost-sensitive, high-volume applications. In addition, the nRF52810 SoC's Flash-based software architecture brings over-the-air (OTA) application upgrades to products previously excluded by cost constraints.

The nRF52810 is designed for a host of applications including network-connected sensors and beacon building blocks for the IoT

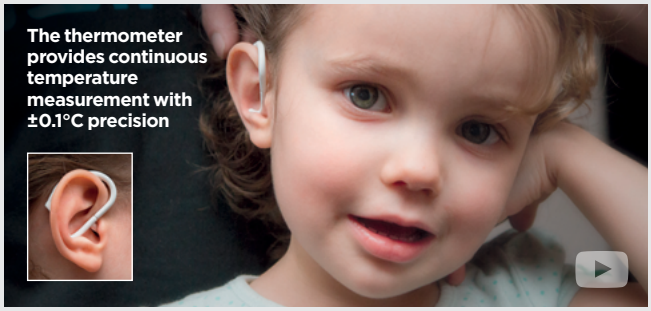
Example target applications include network-connected sensors and beacon building blocks for the IoT, low-cost wearables, wireless mice and keyboards, tablets, toys, disposable medical monitoring devices, and connectivity controllers as companions to much larger microcontrollers.

The S112 SoftDevice is an optimized, lightweight stack designed to complement the nRF52810 SoC's 192 kB Flash/24 kB RAM allocation. The S112 SoftDevice occupies just 100 kB, ensuring ample spare memory for a wide range of mass-market Bluetooth LE applications and robust support for OTA application software upgrades.

Wireless in-ear thermometer offers precise temperature measurement of babies

Germany body sensor company, cosinuss°, has developed a Bluetooth Low Energy connected in-ear thermometer, providing continuous, accurate temperature measurement of babies and children. The "degree°" device employs Nordic's advanced multiprotocol nRF52840 System-on-Chip (SoC).

The thermometer is fitted behind the child's ear with the sensor sitting in the ear canal, providing continuous temperature measurement to ±0.1°C precision. The captured data is stored on the device, and once paired to the user's Bluetooth 4.0 (and later) smartphone or tablet, is automatically synced using Bluetooth LE connectivity.



From the iOS and Android degree° app, parents can monitor a 'fever curve' which plots any changes in temperature over time so the user can see how the child is responding to the effects of treatment, rather than relying on a single-point temperature measurement. The parent can also set a fever alarm, triggering a notification in the event their child's temperature is too high, or rising too quickly.

"For the device we needed a compact chip, with a large memory capacity, and very low power consumption, so the decision to use the nRF52840 was simple," says Dr Johannes Kreuzer, cosinuss° Founder and CEO.

"This is an early and innovative health application based on Nordic's most advanced chip," says Geir Langeland, Director of Sales & Marketing with Nordic.

In brief

Nordic posts all-time record revenue in Q3

Nordic Semiconductor has reported all-time high record revenue of $65.7 million during Q3 2017. The result represents growth of 11.9 percent over the same period in 2016. Sales of Bluetooth Low Energy solutions contributed $47.7 million towards the result, or 72.6 percent of total revenue during the quarter. The result was built on triple digit year-on-year growth in the building and retail sector, as well as continued strong performance in the consumer electronics and healthcare markets.

Beacons market set to soar by 2020

According to a new report by analyst BIS Research, the market for Bluetooth Low Energy beacons will reach its full potential in the next two years. Rapid advancements in wireless technology alongside demand for proximity solutions in retail marketing and healthcare applications will see demand for the technology rise. According to the analyst, the beacons technology market reported revenue of $519.6 million in 2016, but will continue to grow on the back of an increase in IoT spending.

Nordic Thingy:52 wins top award

Against stiff competition, the Nordic Thingy:52 IoT Sensor Kit has won the top prize in the "Development Kit" category of the Annual Creativity in Electronics (ACE) Awards. The awards showcase the industry's most innovative electronics products and were judged by a panel of 15 experts. The Nordic Thingy:52 enables an app developer with no firmware coding expertise to easily design and demonstrate IoT devices, and associated mobile device applications.

In brief

Nordic signs up new Korean distributor

Nordic Semiconductor has signed a new agreement with electronics component distributor, Uniquest, covering the distribution of Nordic's Bluetooth Low Energy, ANT+, IEEE 802.15.4, and 2.4GHz proprietary ultra low power (ULP) wireless connectivity solutions across Korea. The company will not only supply Nordic's complete range of ULP wireless connectivity hardware, firmware, development tools, and reference designs, but also offers firmware design services and technical support expertise.

Wearable injectors market to cash in

The global wearable injectors market is anticipated to reach $11.3 billion by 2025, as a shift towards self-administration and a rising demand for round-the-clock monitoring drives growth, analyst Research and Markets claims. According to the analyst, rising adoption of wearable injectors with integrated Bluetooth connectivity was behind the predicted growth, enabling the sending of alerts to patients, such as injection reminders, providing patients access to therapy data, as well as offering connectivity to the wider healthcare network.

Passive starter kits ease prototyping

Murata has released Passive Starter Kits for the peripheral circuitry to support Nordic Semiconductor's nRF51 and nRF52 Series Bluetooth Low Energy (Bluetooth LE) Systems-on-Chip (SoCs). The kits include the peripheral components required to assemble reference designs and evaluate the SoCs for designs using Bluetooth LE, ANT, and 2.4GHz ultra low-power wireless applications. Both starter kits offer ceramic capacitors, inductors, crystals, and balun in one package simplifying sourcing and accelerating design.

Embedded Studio licensed for Nordic SoC development

Nordic Semiconductor has signed an agreement with Hilden, Germany-based SEGGER Microcontroller to license the use of Embedded Studio. The agreement allows developers to freely use Embedded Studio to develop nRF51 and nRF52 Series Systems-on-Chip (SoCs) applications without any limitations.

Embedded Studio is a complete all-in-one Integrated Development Environment (IDE) for managing, building, testing, and deploying embedded applications. The IDE includes: A powerful Project Manager; Source Code Editor; C/C++ GNU Compiler Collection (GCC) and CLANG/ compilers; an Integrated Debugger with advanced debug information windows and direct J-Link integration; and version control for automatic deployment of finished applications.

Developers can freely use Embedded Studio to develop applications based on Nordic's nRF51 and nRF52 SoCs

Nordic delivers a complete software solution for its nRF51 and nRF52 Series SoCs but until now these have relied on the use of either commercial IDEs for development or manual set-up of open-source IDEs.

Now, with support for the Embedded Studio IDE added to the latest release of the nRF5 Software Development Kit (SDK), developers using the nRF5 SDK gain free access to a commercial IDE with full support for nRF51 and nRF52 Series SoCs.

"The powerful Nordic nRF SoC family is now complemented by the best cross-platform IDE, Embedded Studio, which will help software engineers to be even more efficient in their daily development processes," says Ivo Geilenbruegge, CEO at SEGGER.

"Adding Embedded Studio is an important step in making our solutions easier to use," says Pål Kastnes, a Technical Marketing Manager with Nordic Semiconductor.

"Embedded Studio includes all the features needed to develop applications on the nRF51 and nRF52 Series SoCs and features an intuitive user interface, easing project starts."

Alibaba reduces wireless design costs

Alibaba Cloud IoT, a unit of e-commerce giant Alibaba's subsidiary company Alibaba Cloud, has released Alibaba Cloud Link. The product provides developers with a secure Internet of Things (IoT) platform for Cloud computing, artificial intelligence, content delivery, and Cloud integration for home and industrial automation, and smart city applications.

The Alibaba Cloud Link employs Nordic's nRF52832 Bluetooth Low Energy (Bluetooth LE) System-on-Chip (SoC) and nRF5 Software Development Kit (SDK), and allows developers to connect devices, manage device data, and develop IoT applications at low cost.

To date the company has launched three distinct Alibaba Cloud Links; the 'Alibaba Cloud Home Link', 'Alibaba Cloud City Link', and 'Alibaba Cloud Industry Link'. The Alibaba Cloud Home Link is intended for smart home applications. The Alibaba Cloud City Link enables independent software vendors and system integrators to build a range of secure, linked smart city applications. The Alibaba Cloud Industry Link allows manufacturing enterprises to achieve interoperability and coordination of their digital equipment assets online.

The Alibaba Cloud Link reduces the cost of Bluetooth LE-based application development via the nRF5 SDK-based Ali_SDK. The nRF5 SDK is the first SDK to receive formal Ali Cloud Link Certification. The Ali_SDK provides a complete and secure end-to-end solution for developing and commissioning Bluetooth LE solutions, including broadcast customization, connection management, authentication, and Over-The-Air Device Firmware Upgrades (OTA-DFU).

The Alibaba Cloud Link allows developers to efficiently develop IoT applications at low cost

Suunto open environment offers rapid prototyping of motion sensing solutions

Finnish smartwatch manufacturer, Suunto, has released Movesense, an open environment for developers of wireless motion sensing solutions across a range of markets including sports, activity tracking, health, logistics, and gaming.

Employing Nordic's nRF52832 System-on-Chip (SoC), the Movesense platform comprises a versatile, programmable multifunction sensor that incorporates nine-axis motion (accelerometer, gyroscope, and magnetometer), as well as temperature, heart rate, and electrocardiography (ECG) sensing. A smart connector attaches the sensor to clothing or integrates it into apparel, offering an embedded solution with an individual ID that can be used for performing context-specific applications. A soft module with electrodes for integrating heart rate sensing into clothes is also available.

The Movesense platform includes a programmable multifunction nine-axis motion sensor

Application Programming Interface (API) and software libraries allow developers to build applications using the sensor and develop associated iOS and Android mobile apps. The nRF52832 SoC provides the Bluetooth Low Energy wireless connectivity to mobile devices.

"Most development platforms are just circuit boards and it's difficult to build commercial solutions based on them," says Olli-Pekka Ojanen, Suunto Program Manager. "Movesense allows developers to skip the hardware design—which can take years, is expensive, and requires a team of experts from different fields—and instead focus their application expertise on developing a commercial product."

The shock- and water-resistant Movesense sensor weighs only 10 g, and is powered by a replaceable CR 2025 Li-ion battery.

QuickLogic and Nordic partner on audio reference design

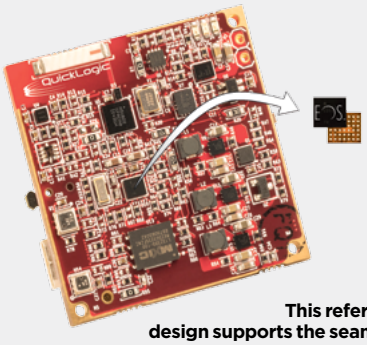
QuickLogic has released its 'EOS S3 Sensor Processing Platform Alexa BLE Wearable Reference Design', the first commercial product to support Voice-over-Bluetooth Low Energy (Bluetooth LE) with Amazon Alexa.

QuickLogic's Alexa reference design combines the company's EOS S3 Sensor Processing SoC—which features an ARM Cortex M4F-powered multicore sensor processing System-on-Chip (SoC) enabling sensor applications on smartphones, wearables, hearables and IoT devices—with Nordic's nRF51822 multiprotocol Bluetooth Low Energy SoC.

The reference design enables connectivity to the Alexa App on a Bluetooth 4.0 (and later) smartphone using a custom Bluetooth LE Audio Profile via the nRF51822 SoC. Enabled by the QuickLogic EOS S3 SoC's hardware integrated Low Power Sound Detector (LPSD), the chip consumes just 640 µW of power (in a typical use case) for 'always-on' listening and wake-word detection. When the voice prompt is recognized, the audio stream is compressed and transmitted over the Bluetooth LE link to the smartphone.

The smartphone then decompresses the audio data and sends it to the Alexa Voice Service (AVS) Cloud server. This results in the AVS server's response being played over the smartphone speaker. A scheduled update will provide the option to have the response also played on a wearable device.

The reference design supports the seamless transmission of Voice-over-Bluetooth LE, via a custom application developed by QuickLogic using Nordic's nRF5 development tools. The application is stored in the nRF51822 SoC's Flash memory, and buffers the voice data while the Bluetooth LE SoC wakes up.



This reference design supports the seamless transmission of Voice-over-Bluetooth LE

In brief

Bluetooth 5 boosts IoT growth

According to analyst, Research and Markets, annual shipments of Bluetooth Low Energy chipsets for Internet of Things (IoT) markets will increase by 524 percent between 2016 and 2022. Growth will be driven by the expanded network range, throughput, and capacity of Bluetooth 5, mesh network capability, as well as a large and growing developer community. Wireless sensor network markets such as industrial sensors, smart homes, and building automation will increase three times faster than other IoT markets over this period.

Speakers drive smart home boom

Market research firm Forrester Research projects that the installed base of smart home devices in the U.S. will grow at a five-year compound annual growth rate (CAGR) of 42 percent, powered by the smart speakers category. The report forecasts that smart home devices are expected to grow tenfold between 2017 and 2022, at which point one in five U.S. households will have at least one smart home device. The growth is expected to be driven by smart speakers and the devices, such as smart bulbs and smart thermostats, that they can control.

Fujitsu beacon family targets indoor navigation and asset management

Japan-based Fujitsu Component Limited, has released a portfolio of beacons for indoor navigation, asset management, and advertising applications, employing Nordic's Bluetooth Low Energy nRF51822 System-on-Chip (SoC).

The family of beacons comprises the FUJITSU Component Beacon, compliant with Apple iBeacon and Google Eddystone formats for basic advertising applications; and the FUJITSU Sensor Embedded Beacon. The latter is available in three models, all offering an embedded accelerometer and temperature sensor to track the beacons' exact movements and to provide the user with environmental feedback.

The beacons can be easily attached to a specific location or object to provide contextually relevant 'microlocation' based content to a user's Bluetooth 4.0 (and later) smartphone or tablet. The ultra low power operating characteristics of the Nordic SoC can extend the beacons' CR2450 coin cell battery life to more than two years.

The beacons can be attached to a specific location or object to provide contextually relevant 'microlocation' based content

Fujitsu Component Limited provides users with a smartphone or tablet application and Windows-based tool for beacon programming and simple text-based command configuration. Setting and advertising data can be updated via over-the-air (OTA) functionality.

"The nRF51822 SoC controls the wireless connectivity, sensors, LED, and battery management in the beacons," says Fujitsu Component Limited Director of Global Marketing, Takashi Arita. "We selected the Nordic SoC because of the ARM processor, great radio characteristics, low power consumption, easy control, and its overall flexibility."

Shimane Fujitsu Limited is employing Fujitsu Component beacons to resolve issues with its pre-shipping repair process in its laptop PC and tablet assembly facility in Shimane, Japan.

For real-time visualization of the process a beacon is attached to each product needing repair that is sent to the repair line, enabling all line workers to be aware of each product's location in the process, how long it has been there, and its shipping deadline. According to the company this has led to a reduction of extra transportation costs by 30 percent.

Bluetooth Low Energy door lock eliminates need for keys

Danish company Poly-Control Aps has unveiled its Danalock V3 door lock, a smart door lock that can be retrofitted to existing manual door locks to provide a complete smart door entry and security solution.

The smart lock features Nordic's nRF52832 System-on-Chip (SoC) for Bluetooth Low Energy (Bluetooth LE) connectivity with Bluetooth 4.0 (and later) iOS and Android smartphones. The low latency response of Bluetooth LE technology ensures rapid response to unlocking signals, while the compact smart lock incorporates AES-256 security to protect against breaches.

Danalock V3 eliminates the need to carry door keys or replace a door lock when keys are lost or stolen, and users can configure and control the smart lock via the smartphone companion app. Users can grant temporary or permanent lock access by sending an email or SMS to another person, and subsequently receive notifications whenever the lock is used.

The smart lock's four CR123A extra long-life batteries last for approximately 9000 cycles, or one year, based on average use. Poly-Control Aps' open Application Programming Interface allows developers to build custom applications for Danalock V3 and create their own iOS and Android mobile apps.

"The Danalock V3 is the smartest, smallest, safest, fastest, and strongest smart lock available," says Hans Overgaard, Poly-Control Co-founder and CEO. "We used the nRF52832 SoC in the Danalock V3 because of its functionality, price, and performance."

This smart lock eliminates the need to carry door keys or replace a door lock when keys are lost or stolen

ULP WIRELESS TRENDS

The latest developments in technology

A digital ingestion tracking system will record dosage information and when a pill is taken

U.S. FDA approves digital tracking pill

The U.S. Food and Drug Administration (FDA) has approved the first drug in the U.S. with a digital ingestion tracking system. The 'Abilify MyCite' aripiprazole anti-psychotic tablets treat schizophrenia and depression, and digitally record medication delivery.

The tablets feature a sensor the size of a grain of sand made of silicon, copper, and magnesium. When the sensor comes into contact with stomach acid a few minutes after ingestion, an electrical signal is activated, sending a message from the pill's sensor to a wearable patch worn on the patient's left rib cage.

The patch then sends data, for example dosage and when the pill was taken, via Bluetooth Low Energy to a smartphone app, allowing patients and caregivers to track the ingestion of the medication. Patients can permit caregivers and doctors access to the information through a web-based portal. The patch must be replaced every seven days, while the sensor passes naturally through the patient's body.

"Being able to track ingestion of medications prescribed for mental illness may be useful for some patients," says Dr Mitchell Mathis, director of the Division of Psychiatry Products in the FDA's Center for Drug Evaluation and Research. "The FDA supports the development and use of new technology in prescription drugs and is committed to working with companies to understand how technology might benefit patients and prescribers."

The biocompatible microsensor monitors if food in transit is kept cool enough

Microsensors monitor food condition

New microsensors could provide a link between food products and the Internet of Things, according to researchers from Swiss University, ETH Zurich. ETH has developed an ultra-thin temperature sensor that is both biocompatible and biodegradable.

The researchers constructed the microsensors by encapsulating an electrical filament made of magnesium, silicon dioxide, and nitride in a polymer.

An external micro-battery using ultra-thin, biodegradable zinc cables forms the power supply. On the same non-biodegradable chip a microprocessor and transmitter send temperature data via Bluetooth Low Energy to an external computer. This makes it possible to monitor, for example, the temperature of a product over a range of 10 to 20 meters.

The researchers noted that, for example, "fish from Japan could be fitted with tiny temperature sensors, allowing them to be continuously monitored to ensure they are always at a cool enough temperature".

Wearables reinforce security of voice-based authentication

A security-token necklace, ear buds, or eyeglasses developed at the University of Michigan (U-M) could eliminate vulnerabilities in voice authentication. Voice assistants have become commonplace, but sound is an "open channel" and can be easily spoofed by impersonators and hackers.

"Increasingly, voice is being used as a security feature but it actually has huge holes in it," says Kang Shin, a professor of electrical engineering and computer science at U-M. "If a system is using only your voice signature, it can be very dangerous. We believe you have to have a second channel to authenticate the owner of the voice."

The solution that Shin and colleagues developed is called VAuth, a wearable device

Voice authentication is not completely secure

that can take the form of a necklace, ear buds or a small attachment to eyeglasses. VAuth continuously registers speech-induced vibrations on the user's body and pairs them with the sound of that person's voice to create a unique and secure signature.

Speaking creates vibrations that can be detected on the skin of a person's face, throat or chest. The system works by leveraging the consistency between signals from the accelerometer in the wearable product and the microphone in the electronic device. Voice authentication is only possible when the user is wearing the security token.

The team has built a prototype using an off-the-shelf accelerometer, which measures motion, and a Bluetooth Low Energy transmitter, which sends the vibration signal to the microphone in the user's device.

"VAuth is the first serious attempt to secure voice-based services, ensuring that your voice assistant will only listen to your commands instead of others," says Shin.

Nordic first to deliver concurrent Thread and Bluetooth 5 connectivity

The newly Thread-certified nRF52840 System-on-Chip eliminates the need to disconnect from a Thread network before accessing a Bluetooth 5 network

Several RF protocols are competing for the smart home consumer and even the best-informed analyst is unsure which will dominate. Bluetooth Low Energy (Bluetooth LE) smartphone interoperability, the addition of mesh networking (*see* ULP WQ *Autumn 2017, pg10*), and Bluetooth 5 enhanced throughput and range have placed the protocol at the forefront, but competitive technologies have their merits. (*See pg9.*)

Nordic Semiconductor's nRF51 and nRF52 Series offer support for multiple protocols, but recently, the newly launched high-end nRF52840 SoC (available in volume soon) added an IEEE802.15.4 PHY to the chip family's Bluetooth 5, ANT+, and 2.4-GHz proprietary protocol support. The new PHY allows the nRF52840 SoC to run the OpenThread stack. (OpenThread is the first open-source Thread-certified implementation of the Thread networking protocol, released by Nest Labs.)

"We see Thread as one of the leading wireless technologies currently emerging in the home IoT space," comments Geir Langeland, Nordic Semiconductor's Director of Sales & Marketing. "That's why we've directed our ultra low power wireless R&D expertise towards contributing to the development of the OpenThread stack."

"Nordic Semiconductor has been a long and active participant in the Thread Group and is making meaningful contributions towards helping Thread deliver on its potential," says Grant Erickson, President of the Thread Group.

The nRF52840 is the only multiprotocol SoC on the market offering certified concurrent support for smart home applications using Thread and Bluetooth 5

"Nordic sees Thread as one of the leading wireless technologies currently emerging in the home IoT space"

Unique to the market

Now the nRF52840 SoC has achieved Thread 1.1 certification to add to its previous Bluetooth 5-certification (including meeting the requirements for both Bluetooth 5 wireless' range and throughput enhancements).

"The expeditious path of the nRF52840's Thread certification is testament to the benefits of OpenThread's open-source approach, portability, and optimized footprint," said Jonathan Hui, Technical Lead and Original Architect of OpenThread at Nest, in a statement.

Notably, the nRF52840 SoC passed Thread certification testing while the device maintained Bluetooth 5 connectivity to a central device – demonstrating the chip's capability to support applications that concurrently access Thread and Bluetooth 5 networks. This means the device becomes the only multiprotocol SoC on the market that offers this concurrent Thread and Bluetooth 5 support.

Concurrent Bluetooth LE and Thread operation is ensured by the nRF52840 SoC's 'Dynamic Multiprotocol' feature. Previously, Nordic's nRF5 Software Development Kit (SDK) for Thread implemented a switching solution for multiprotocol support of Bluetooth LE and Thread. A switched solution operates by disabling the operational protocol before activating the other protocol. The technique is simple to implement but is unable to support concurrent protocol operation.

The latest release of Nordic's nRF5 SDK for Thread (version 0.10.0) addresses that downside by introducing Dynamic Multiprotocol using Nordic's S140 v5 SoftDevice (Bluetooth LE RF protocol stack) and the OpenThread protocol stack.

Dynamic Multiprotocol ensures the radio hardware's operational time is shared between the protocols.

Nordic's firmware automatically looks after the time-sharing between protocols. The developer is freed-up to code the Bluetooth LE functionality of a multiprotocol application as if it was solely leveraging Bluetooth LE, and then the Thread part of the multiprotocol application in the same way. Any wireless sensor or product that uses the nRF52840 SoC can now not only quickly and easily gain Thread certification, but will also be interoperable with (and be commissioned, controlled, or managed by) a Bluetooth v4.0 (and later) wireless device, benefiting from both technologies at the same time.

"In operation, the nRF52840 can effectively work as a bridge between Thread and Bluetooth 5 networks, and can communicate with, for example, both a smartphone over Bluetooth 5, and a Thread wireless sensor, enabling data to be exchanged between them without going via the Cloud," explains Pär Håkansson, a Product Marketing Manager at Nordic Semiconductor.

According to Håkansson, Nordic's R&D teams have engineered the network-switching process to be so quick and seamless that developers can consider it as effectively simultaneous when designing their applications. ■

Smart home technologies battle for market share

Ahead of the smart home boom, competing wireless protocols are vying for both brand awareness and loyalty from developers and consumers alike

Marketers have long wrestled with the imprecise concept of 'brand strength', attempting to gauge factors including awareness, leadership, uniqueness, and consumer loyalty to measure the health of their brand.

Last year, for example, Canadian market research analyst, Lux Insights, conducted the Bluetooth brand equity study, surveying consumers between the ages of 18 and 70 with a three-pronged aim: Identifying how consumer perception of Bluetooth technology has changed in recent years; benchmarking Bluetooth against competing wireless technologies; and identifying opportunities for growth.

According to the research, 92 percent of respondents were aware of the wireless technology, while better still, 78 percent of those people were actually using it. Only Wi-Fi polled better, while competing technologies such as Thread, Near Field Communication (NFC), ANT, Z-Wave, zigbee, and AllJoyn trailed by some distance when it came to consumer mindshare.

While the current landscape for Bluetooth technology is encouraging—predictably outperforming alternative wireless technologies in its traditional stronghold market segments of wearables, audio equipment, and automotive—more informing is the road ahead. According to the research, the biggest opportunities for Bluetooth technology lie in home automation, location-based services, personal monitoring and tracking, and remote access control.

Consumers see the future power of Bluetooth wireless formed by the additional control and insight it can offer them, be that via location awareness applications, personal health and wellness data monitoring, and notably in-home automation control.

Several low power wireless protocols are going head-to-head in the burgeoning home automation market

According to analyst statista, the home automation market will be worth $52.45 billion by 2022, which explains why several low power wireless protocols are going head-to-head for dominance in this relatively nascent sector. The real growth still lies ahead.

Bluetooth has one key advantage - its omnipresence in smartphones. The smartphone with its rich user interface is almost certainly the easiest way today for consumers to interact with home automation devices, and Bluetooth's interoperability with smartphones means it will likely always have a strong hold in this market, even if it's in parallel with one, or multiple other, protocols.

While Lux Insights' research indicates consumer awareness of Thread, Z-Wave, and zigbee is currently nowhere near that of either Wi-Fi or Bluetooth, each has vociferous evangelists in the home automation space, and the emergence of Thread is particularly notable. According to the research while only seven percent of respondents were currently aware of Thread, a third of that seven percent have used, or are using, Thread-based solutions. Moreover, the technology rates highly in terms of constant improvement, security, and future potential.

Complementary protocols

Thread's rise has added a further alternative to a crowded market, and which protocol (or more likely complementary protocols) smart home solution developers ultimately converge on is both unclear and fluid. This situation has formed part of Nordic Semiconductor's own product strategy. For example, late last year Nordic unveiled its advanced nRF52840 System-on-Chip (SoC), which not only offers Bluetooth 5 and ANT support, but also IEEE 802.15.4, the foundation technology behind both Thread and zigbee. The Bluetooth 5-certified SoC was Thread-certified in September 2017, providing developers with access to a powerful, single-chip Thread and Bluetooth Low Energy (Bluetooth LE) wireless connectivity solution.

Nordic is the first company to market with a multiprotocol solution offering concurrent operation for Bluetooth LE and Thread, ideal for developers targeting the smart home—including those working on mesh networked products—where multiple protocols could prevail.

"We are expanding our addressable market adding Thread [and] focusing on advanced mesh for smart home and industrial enterprise networks," Nordic's Director of Strategy and Investor Relations, Thomas Embla Bonnerud told attendees at the recent Q3 Investor Presentation. "We believe [the nRF52840 SoC's] multiprotocol support gives us a competitive edge and value add. It is valuable for legacy support, but also for people who want to build heterogenous ecosystems, who want to take advantage of multiple different protocols in the same network."

Which protocols will dominate remains unclear, but what's more certain is that home automation will remain at the front line of the battle for low power wireless technology domination. ■

The Lux Insights report is available from www.bluetooth.com.

The value of information

New cellular IoT modems will be optimized for a carrier model by buffering and analyzing data at the node, but not at the expense of battery life. By Peder Rand

Peder Rand is Product Manager for Cellular IoT with Nordic Semiconductor

The mature IoT will see local area network (LAN) technologies such as Bluetooth Low Energy (Bluetooth LE) and Thread, and Low Power Wide Area Networks (LPWAN) based on cellular IoT working in harmony.

One scenario illustrating this synergy imagines dozens of mesh-connected Bluetooth LE or Thread nodes embedded in smart lights illuminating a parking lot. The nodes will monitor their surroundings and then transmit information about traffic density, power consumption, and the temperature of the LEDs (which affects their life span) to one or more cellular IoT modems.

In turn, the modems will aggregate the data and forward to the Cloud via the cellular network - enabling a remote parking lot manager to decide where lights can be dimmed because no one is around, and which need servicing during the next maintenance round.

However, while Bluetooth LE or Thread LANs and LPWANs based on cellular IoT will technically play nicely together, different data-usage models will apply. This in turn impacts the choice of cellular IoT technology.

Specifically, data sent across a Bluetooth LE mesh is free (discounting the cost of the energy required to transmit the packets), while that sent using modems wirelessly connected to a cellular network will be metered and subject to carrier fees.

Information not data

When data is metered, it becomes very important to optimize transmission efficiency. It's one thing for a consumer to foot the occasional bill for streaming Netflix videos to their smartphone, but quite another for the parking lot company to continually pay charges for dozens or even hundreds of cellular IoT nodes sending data about smart lights 24 hours a day.

The right choice of cellular IoT technology will keep parking lot lights on and data charges low

The solution is to ensure the cellular IoT modem is smart enough to send valuable information rather than kilobytes of trivial raw data. For example, when considering the parking lot lighting example, most of the time most of the lights will be working well. There seems little point constantly reporting that fact. Rather, the raw data from the Bluetooth LE LAN sensors could be buffered and then analyzed by the cellular modem for exceptions to normal performance.

For example, if the modem receives a signal from light "41B" indicating that the LEDs are running 20°C over normal operating temperature, it would be useful for the device to compute that the elevated temperature will cause LED failure within 72 hours and then pass that information to the parking lot owner.

"When data is metered, it becomes very important to send useful information rather than raw data"

Such information is valuable because the light can then be fixed before failure, preventing costly situations such as motorists colliding in the dark and then seeking damages via an insurance claim against the lot owner.

In a second example, the parking lot manager might want information about the power consumption of the lights—even if they are all working normally—to estimate the size of his or her electricity bill.

Instead of constantly sending raw data about each light's instantaneous power consumption, a smart cellular modem could, for example, buffer the data, compute the power consumption for a 24-hour period, and then send that information in one short burst across the cellular network – again limiting data charges.

Integrated development

Like their Bluetooth LE and Thread counterparts, LTE-M (for M2M) and Narrow Band-IoT (NB-IoT) modems will include microprocessors to look after the RF communications and run application-specific software.

Moreover, in order to facilitate development of intelligent software to run on end-devices, it is crucial the modems are supported by a good software framework and development environment. The application development platform needs to be tightly integrated with the modem and its functionality to enable the modem to work in concert with the application to reduce energy consumption while maintaining the required performance.

Expect to see new LTE-M and NB-IoT products leveraging such technology, to meet the power consumption/computational performance trade-off while meeting the demands of the subscription usage model adopted by cellular carriers.

Nordic is a leader in Bluetooth LE and embraces Thread with its nRF52 Series Systems-on-Chip (SoCs) and is now applying its RF and ultra low power expertise to its forthcoming nRF91 Series cellular IoT products.

The nRF91 Series is based on the 3rd Generation Partnership Project's (3GPP) LTE-M and NB-IoT specifications (*see* ULP WQ *Autumn 2016, pg8*) and will allow Nordic to offer customers a seamless LAN/LPWAN wireless IoT solution. Nordic is backing cellular IoT because of the clear advantages it brings over competing proprietary technologies. (*See* ULP WQ *Spring 2017, pg10.*) ■

NFC protects Bluetooth Low Energy from hackers' attacks

Bluetooth Low Energy is generally a secure protocol, but it can be vulnerable during initial connection set-up. ULP WQ reports

As Bluetooth Low Energy (Bluetooth LE) becomes more widely used, so the traffic it carries increases in value. Today, for example, the data gathered by sophisticated wearables reveals much about users' daily habits. And tomorrow, when Bluetooth LE will be carrying payment details or medical data, the value of the information will be greater still. And value attracts hackers.

Recent versions of Bluetooth LE include good security features, but the final strength of the wireless link is determined in part by the chip maker. Some lesser chip makers can leave vulnerabilities in their firmware. In contrast, Nordic Semiconductor, considers security a top priority. For example, the company's nRF52840 System-on-Chip (SoC), an advanced Bluetooth 5-certified device, incorporates an ARM TrustZone CryptoCell-310 Cryptographic module and AES 128-bit hardware accelerator. These features support a wide range of asymmetric, symmetric, and hashing cryptographic services for secure applications.

But even the best-designed Bluetooth LE solutions face some threats from a determined hacker, and one of the biggest can occur during device initial set-up or "commissioning".

An asymmetric encryption scheme—whereby the private key used to decrypt security information is never passed over the air—closes one vulnerability by eliminating the possibility for an eavesdropper to access the critical information needed to break into the link. Such a scheme, called "secure connections" was introduced with Bluetooth 4.2. Specifically, that revision of the specification included an algorithm that generated a private key using an 'Elliptic Curve Diffie–Hellman' (ECDH) key exchange method making it almost impossible to intercept.

Bluetooth Low Energy technology is generally secure but extra protection is needed against determined hackers

"NFC makes it very difficult for a would-be hacker to intercept the authentication process without revealing their intent"

However, another common threat to Bluetooth LE happens when devices are subject to a "man-in-the-middle" attack.

This time the solution is to move authentication away from the usual Bluetooth LE channels to an "out-of-band" (OOB) channel which remains unknown to the prospective hacker. OOB commissioning was introduced as part of Bluetooth 4.0 (which introduced Bluetooth LE) together with a "just works" (unsecured) pairing method and the passkey method. The challenge of OOB is implementing the OOB channel without complicating the connectivity solution or making things more difficult for the end user.

NFC for OOB

Engineers at the Norwegian University of Science and Technology in Trondheim, Norway, recently conducted research into the best methods for authentication using an OOB channel. The researchers found that Near Field Communication (NFC) offered the best balance of security and user-friendliness for implementing the OOB channel.

NFC devices exchange information in the 13.56 MHz ISM band at rates ranging from 106 to 424 kbps. Bidirectional interaction is established by bringing the devices within 4 to 10 cm of each other. The NFC link can then be used as the OOB channel to start the pairing process and look after the authentication. Once commissioning is complete, communication switches to the secure Bluetooth LE link.

The key to NFC's success as an OOB channel is its very short range which makes it difficult for a would-be hacker to intercept the authentication process without revealing their intent. NFC OOB commissioning also prevents unwanted devices connecting without the user's permission. A further advantage is that the user doesn't need to enter or verify a passkey, simplifying the commissioning process.

Nordic's nRF52 Series SoCs incorporate an NFC-A tag to facilitate authentication using an OOB channel. Many smartphones incorporate NFC and commissioning is as simple as touching the Nordic SoC-powered device and the mobile together. Gateways—'edge' devices which connect Bluetooth LE sensors to the Internet of Things (IoT)—are also adopting NFC for commissioning purposes. Because NFC commissioning doesn't require passkey entry or verification, it is also suitable for the increasing number of Bluetooth LE sensors designed without a user interface. ■

Ultra low power wireless connectivity solutions

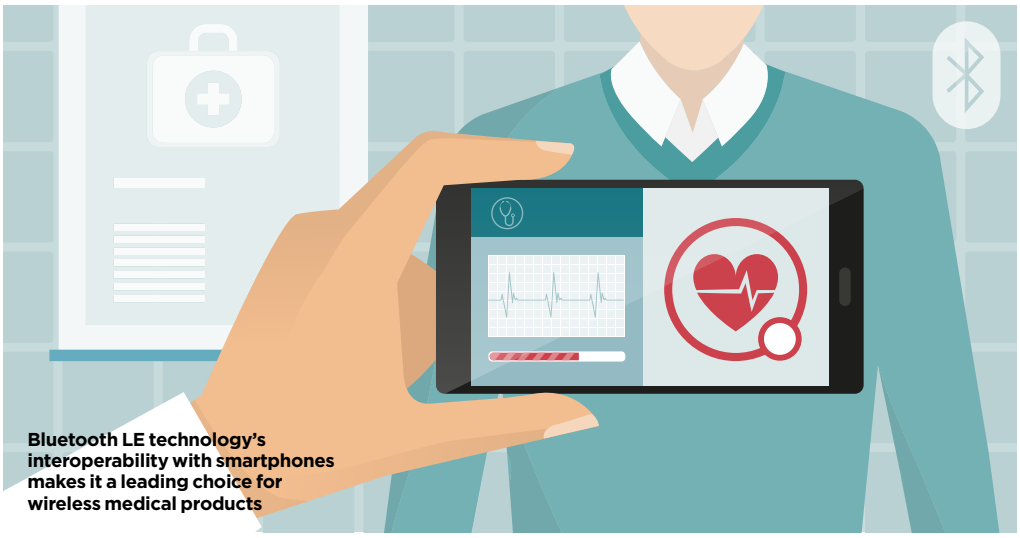
Find the chip you need using this latest listing of every Nordic product

ICs	Operating Band	Wireless Protocol					IC Type			On-Chip						Peripherals																						Applications													Ref. Designs	Dev Tools	WLCSP Wafer-level chip-scale package option
		Bluetooth 5	Bluetooth LE	ANT	802.15.4	2.4GHz Proprietary	System-on-Chip	Connectivity	Transceiver	CPU	FPU	DSP	Memory	MPU	PA	On-chip Balun	Oscillators	NFC-A tag	2-Wire	ADC	AES	Analog Comparator	I2S	PDM	PWM	Real Time Clock	ARM CryptoCell	TRNG	SPI	QSPI	Temperature Sensor	UART	USB	PC Peripherals	Sports & Fitness	Gaming / VR + AR	Mesh Networks	Consumer Electronics	Automation	Healthcare	Toys	Wearables	Smart Home	Beacon	Wireless Charging	Automotive Graded			
nRF52 Series																																																			
nRF52840	2.4GHz	●	●	●	●	●	●			Cortex M4F	●	●	256kB RAM 1MB Flash	●	●	●	32MHz / 32kHz Crystal 64MHz / 32kHz RC	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	Single Board Dev Kit, Power Profiler Kit	●
nRF52832	2.4GHz	●	●	●		●	●			Cortex M4F	●	●	64kB or 32kB RAM 512kB or 256kB Flash	●		●	32MHz / 32kHz Crystal 64MHz / 32kHz RC	●	●	●	●	●	●	●	●	●	●		●	●		●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		PC Desktop, Smart Remote, Smartphone Demo Apps	Single Board Dev Kit, Power Profiler Kit, Nordic Thingy:52	●
nRF52810	2.4GHz	●	●	●		●	●			Cortex M4		●	24kB RAM 192kB Flash	●		●	32MHz / 32kHz Crystal 64MHz / 32kHz RC		●	●	●	●		●	●	●		●	●		●	●		●	●	●		●	●	●	●	●	●	●				-	Single Board Dev Kit, Power Profiler Kit	●
nRF51 Series																																																		
nRF51822	2.4GHz		●			●	●			Cortex M0			32kB or 16kB RAM 128kB or 256kB Flash	●			16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●		●	●	●	●	●	●	●	●	●	●	●	●			PC Desktop, Smart Remote, Smartphone Demo Apps, Beacon	Single Board Dev Kit, Dongle	●
nRF51422	2.4GHz		●	●		●	●			Cortex M0			32kB or 16kB RAM 128kB or 256kB Flash	●			16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●		●	●	●		●	●	●	●	●	●	●				Smartphone Demo Apps	Single Board Dev Kit, Dongle	●
nRF51824	2.4GHz		●			●	●			Cortex M0			16kB RAM and 256kB Flash	●			16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●			●	●		●	●		●	●						●					●	●	●			Smartphone Demo Apps	Single Board Dev Kit, Dongle	
nRF8000 Series																																																		
nRF8001	2.4GHz		●					●		-			-				16MHz / 32kHz Crystal 32kHz RC												●		●			●	●	●		●	●	●	●							PC Desktop, Smart Remote, Smartphone Demo Apps	nRFgo Dev Kit, Prog. Kit	
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	

Simplifying Bluetooth Low Energy medical device design

A new Nordic Proof-of-Concept PCB makes it less complicated for developers to bring the benefits of wireless connectivity to medical devices. By Thomas Søderholm

Thomas Søderholm is Director of Business Development with Nordic Semiconductor



Bluetooth LE technology's interoperability with smartphones makes it a leading choice for wireless medical products

Pioneering medical product companies are already improving the lives of diabetes-, allergy-, and asthma-sufferers by equipping their products with Bluetooth Low Energy (Bluetooth LE) technology. For example, Canadian company, Aterica Health, has developed Veta Smart Case, a Bluetooth LE-connected carrier for Epipen auto-injectors. San Diego, CA-based Dexcom meanwhile, recently received U.S. Food and Drug Administration (FDA) approval for its G5 Mobile Continuous Glucose Monitoring (CGM) System which includes a Bluetooth LE component to transmit glucose levels from a monitor mounted on the patient's skin to a companion app on a smartphone or smartwatch.

These wirelessly-connected medical products assist patients by reminding them when to take medication, warning when medicine approaches its expiry date, and notifying if vital medicine is left behind when leaving home. In addition, wirelessly connecting the product to the IoT (via a smartphone gateway) establishes a bidirectional link along which not only can data be transmitted to remote family and healthcare professionals but also information returned in the form of guidance for the patient, or software enhancements and security patches for the product.

Wireless connectivity also brings medical economic benefits. By helping patients adhere to a medication regime, money is saved due to a reduction in the complications that could otherwise occur without proper treatment of the primary illness. Another significant benefit is in the value of data that becomes available from the Cloud to help medical equipment manufacturers understand how, when, and where devices and medication are used – leading to better products.

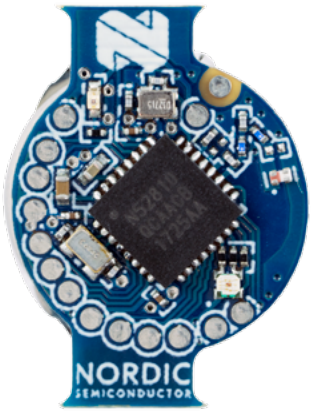
"By helping patients adhere to a medication regime, money is saved due to a reduction in the complications that could occur without proper treatment of the primary illness"

However, RF engineering is a challenging discipline requiring skilled practitioners who are in short supply, making it difficult for many medical product makers to enter the market.

Simplifying design

But now, Nordic Semiconductor has introduced a proof-of-concept (PoC) printed circuit board (PCB) that simplifies the design process. The PoC PCB employs the company's nRF52810 Bluetooth LE solution and S112 SoftDevice (Bluetooth LE RF protocol software 'stack'). The product is an extremely flexible, mature, and reliable Bluetooth 5-certified solution optimized for low power and high performance in a tiny footprint.

Nordic's nRF52810 Bluetooth LE SoC—the baseline device in its nRF52 Series which offers an excellent cost/performance ratio and Bluetooth 5 capability—features a 100-dBm link budget



Nordic's PoC PCB is based on the company's baseline nRF52810 and S112 SoftDevice making it an ideal reference design for inexpensive, disposal medical products

2.4-GHz multiprotocol radio, 64-MHz, 32-bit ARM Cortex M4 MCU, 196-kB Flash, and 24-kB RAM. Notably, the memory allocation is ample to run the application code typical of high-volume, low-cost applications such as those required for medical devices. Like all Nordic's nRF51 and nRF52 Series SoCs, the nRF52810 supports Over-the-Air Device Firmware Updates (OTA-DFUs), allowing the software of devices in the field to be upgraded using just the radio link. The nRF52810 SoC (*see* ULP WQ *Summer 2017, pg8*) is supplied with the latest version of Nordic's S112 SoftDevice, a lightweight Bluetooth 5-certified stack.

The nRF52 series also brings other features crucial to medical product development, notably "out-of-band" (OOB) pairing via Near Field Communication (NFC), which enables Bluetooth LE pairing to be established by simply touching an NFC-equipped smartphone to the

medical device with no other interaction required from the user. Second, once the medical device is paired with the smartphone, sensitive medical data is secured by protecting the Bluetooth LE link with 128-bit AES encryption.

While the S112 SoftDevice supervises the communication link, some application code is typically required to optimize the software for the target product. For example, if the target application is an asthma inhaler, some coding will be required to, for instance, monitor how often and when the device is used.

Among Bluetooth LE vendors, Nordic has a unique advantage during application code development. The company's software architecture separates the Bluetooth LE stack (the SoftDevice) from the application code thereby removing the complexity of integrating the application software with the stack. Without this separation, it can be all too easy for the RF stack to be corrupted during software compilation – extending the development and debugging process. Nordic's SoftDevices are delivered as tested and verified binary files and the company's development tools look after interfacing the application code to the SoftDevice during compilation.

Nordic also supplies a Development Kit (DK) and Software Development Kit (SDK) which eases the design process. The DK includes the target nRF51 or nRF52 Series SoC and the SDK makes it simple to interface the SoC to the developer's preferred ARM integrated development environment (IDE). Notably, the SDK also includes simple application code examples which the developer can use to accelerate the coding of their own application.

Combining advantages

Nordic has brought together the key advantages of its nRF52 Series SoCs, Bluetooth LE SoftDevices, unique software architecture, reference designs, and application code development environment in the new PoC PCB – a product that's specifically designed to simplify the process of adding wireless connectivity to medical products.

The PoC PCB is based on the nRF52810 SoC and S112 SoftDevice (enabling Bluetooth 5-certified Peripheral device operation), is assembled on a 13.5-mm diameter circuit board and includes matching circuits, antenna, and coin-cell battery. The PoC and the necessary design files are available from Nordic on demand. The file includes a short description and 'walk through', circuit board schematics, and bill of materials (BOM). This is everything a designer needs to develop their own design based on the PoC.

Dexcom's G5 Mobile Continuous Glucose Monitoring (CGM) System wirelessly transmits blood glucose data from monitor to smartphone using Bluetooth LE technology

The product comes preloaded with the SoftDevice and an Eddystone Bluetooth LE beacon application example. The nRF52810 SoC can be programmed with the developer's own application through OTA-DFU. Because the nRF52810 with S112 SoftDevice form a cost-effective Bluetooth 5/Bluetooth LE solution, the Nordic medical PoC PCB is particularly suitable for inexpensive, disposable drug delivery products such as asthma inhalers. According to a report from analyst Market Research Future, the market for 'smart' (wireless) asthma inhalers will be worth $1.6 billion alone by 2022.

An inhaler equipped with Nordic's Bluetooth LE technology would enable medication management (for example, providing an automatic medication diary), notifications to remote family members and healthcare staff, and usage statistics. With permission, the data could also be automatically sent to the manufacturer via the Internet to allow it to improve the performance of future products.

The quiet revolution

A quiet revolution is underway in connected medical products. Because of the tough regulatory environment, it has taken time for these products to reach the market but there are many innovations nearing commercialization. Bluetooth LE is ideally suited for transmitting small amounts of data from power-constrained devices and is appearing in applications ranging from connecting a stethoscope to a smartphone app to simultaneously monitoring the blood pressure of dozens of seniors in a care home and forwarding the data to the Cloud to determine when to administer hypertension medication. And Bluetooth LE wireless' ubiquity in smartphones and tablets cements its position as the pre-eminent wireless connectivity technology for medical products.

Designing wireless products can be daunting and many medical product companies may not have the in-house RF skills to take advantage of the technology. However, by partnering with a Bluetooth LE vendor like Nordic, developers with little RF design experience gain access to proven hardware, protocol firmware, reference designs, development tools, and technical expertise that ease the path to prototypes and then volume production of commercial devices. ■

Wirelessly-connected medical products promise to improve patients' quality of life

Connectivity comes to the heart of the industrial machine

Diagnostic information from wireless sensors integrated into the moving parts of factory equipment promises to accelerate Industry 4.0. Caroline Hayes reports

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

Bluetooth Low Energy is helping power Industry 4.0, the revolution that will see today's factories transformed into the smart facilities of tomorrow

When people refer to the Internet of Things (IoT), they imagine a network of 'smart' devices that make life more comfortable and convenient. A typical example is a healthcare product that can track how many calories have been ingested and then burned through exercise, with a reassuring graph of the wearer's heart rate. Another example is the smart home where specific music tracks can play on command, lights can be turned off in unoccupied rooms, and temperature can be remotely adjusted to suit the occupant.

But the IoT is moving into the industrial arena too, with networks that can collect data to monitor and control production lines, inventory, and energy use for sustainable, reliable manufacturing (*See* ULP WQ *Summer 2017, pg20*). As part of the Industrial IoT (IIoT) these models rely on devices (or nodes) such as thermostats, or optical sensors at the edges of the network, receiving and sending data that a central system can analyze and act upon to, for example, optimize a process.

Today, sensors are typically positioned on the outside of equipment where access is easier, but what if the sensors were embedded into the machine's actual moving components when it was manufactured or serviced? The data gathered from an embedded sensor would offer far more detailed information about what was happening inside the machine, practically in real time, dramatically enhancing how well a process was controlled and improving machine maintenance. But even with today's compact, power-frugal, and inexpensive wireless sensors, is it really possible to integrate the device into the very fabric of a machine and then expect it to reliably transmit information for months or even years? A team of researchers at Dresden University of Technology (TU Dresden), Germany, have been finding out.

Material gain

The TU Dresden team has been experimenting with wireless sensors embedded into the fiber-reinforced material used to make industrial brake discs, turning the discs into rotating IoT nodes.

The brake discs are critical for safety applications in industrial equipment. An example is in elevators, where the discs are used to control the speed of the ascending car, protect against unintended movement, and maintain the car's position when it stops at each floor. In addition to difficult access, measuring specific system parameters, such as vibration or wear, traditionally requires the addition of expensive hardware, such as torque shafts. Embedded wireless sensors can do away with all that.

During the experiments, a Nordic Semiconductor nRF51 Series Bluetooth LE System-on-Chip (SoC), paired with MEMS-based sensors to measure acceleration in the x, y and z axes, three-axis gyroscopes, magnetic field sensors, and temperature sensors, were combined with a power supply to monitor the condition of the electromagnetic braking system. An important consideration was that the integration of the electronic components would not affect the mechanical performance of the brake disc material, which has to operate reliably and safely in harsh, dirty industrial environments at high temperatures.

Sven Grunwald and Bernard Bäker from TU Dresden developed a low-cost method to embed the wireless sensors into the fiber-reinforced material to measure three parameters: Brake disc wear, the condition of the system in which it was used, and air gap detection between the disc and the brake-activating magnetic anchor.

The data from the wireless sensors can also be used to remotely report on the status of the brake and identify the best time for maintenance or repairs while minimizing disruption.

Integration cuts costs

The "always-on" nature of the IoT demands low power consumption to extend battery life. Nordic's ultra low power wireless SoCs feature microampere average current consumption leading to years of battery life (depending on the application), an important consideration in an application where the battery can't be replaced and hence must last the lifetime of the host product.

The Nordic nRF51 Series SoC employed by the university team used a Bluetooth LE RF protocol "stack" certified to the Bluetooth 4.2 standard. This version of the standard supports a channel dedicated to IPv6 communication. With some additional software and an IoT

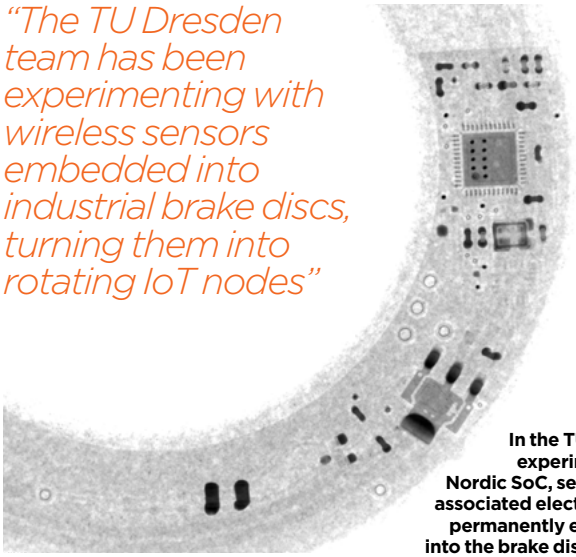
router, the sensor could send data directly to a Cloud without human intervention.

The system described by Grunwald and Bäker is also upgradeable to Bluetooth 5 (using Nordic's nRF52 Series SoCs). This version of the Bluetooth LE standard increases the range of wireless connectivity, or doubles the bandwidth achievable compared to Bluetooth 4.2 without any power consumption penalty. (*See* ULP WQ *Spring 2017, pg16*). Nordic has also released a Software Development Kit (SDK) that enables designers to take advantage of the recently-released Bluetooth mesh standard - making it much easier to integrate multiple embedded industrial wireless sensors into a network, enhancing the robustness of the system. This is again an important factor when there is no possibility of replacing a faulty sensor. (*See* ULP WQ *Autumn 2017, pg8*.)

Nordic's nRF51 SoC integrates the 2.4GHz radio with an ARM Cortex M0 processor, 256 kB/128 kB Flash and 32 kB/16 kB RAM, plus a power management systems. This high level of integration reduces the component count in the embedded system to minimize the bill of materials, simplifies design and assembly, saves space, and increases reliability. The SoC provides bidirectional Bluetooth LE wireless connectivity between the brake's embedded sensors and host system, or a wireless router (and then the Cloud). Updates can be seamlessly implemented using the SoC's over-the-air device firmware update (OTA-DFU) capability.

After verifying that the electronics' integration into the composite material did not affect its properties, the brake components were tested. Grunwald and Bäker concluded: "The integration of electronic, IoT-enabled systems, based on a low-cost [Bluetooth LE] SoC and the required sensor electronics into a composite material is [successful]," despite the mechanical stresses and high temperature operation of the brake disc. They reported: "Defect-free integration of the measurement unit, as well as typical end applications, such as shock detection, speed measurement, and temperature monitoring, were [also] successfully realized."

"The TU Dresden team has been experimenting with wireless sensors embedded into industrial brake discs, turning them into rotating IoT nodes"



In the TU Dresden experiments, the Nordic SoC, sensors, and associated electronics are permanently embedded into the brake disc material

Grunwald and Bäker concluded that their system had proven itself capable of "monitoring performance parameters and condition monitoring of the brake disc, as well as fulfilling predictive maintenance tasks within the field of electric drives, according to Industry 4.0 ['smart factory']".

The idea can be extended to other machine components. "It is important to mention that [the experimental] applications represent only a small excerpt of possible and useful applications," noted Grunwald and Bäker.

Vision becomes reality

John Leonard, a Product Marketing Manager with Nordic, has speculated on the new business models that the IIoT can support. (*See* ULP WQ *Spring 2016, pg10*). He envisages business models where rather than constantly fighting a battle with unplanned repairs of broken-down machinery, companies can reduce costs by planned maintenance where wear has been reported by wireless sensors. In addition, Cloud servers could use sensor data in algorithms to predict high and low periods of demand, with the system's operation adjusted accordingly to save energy.

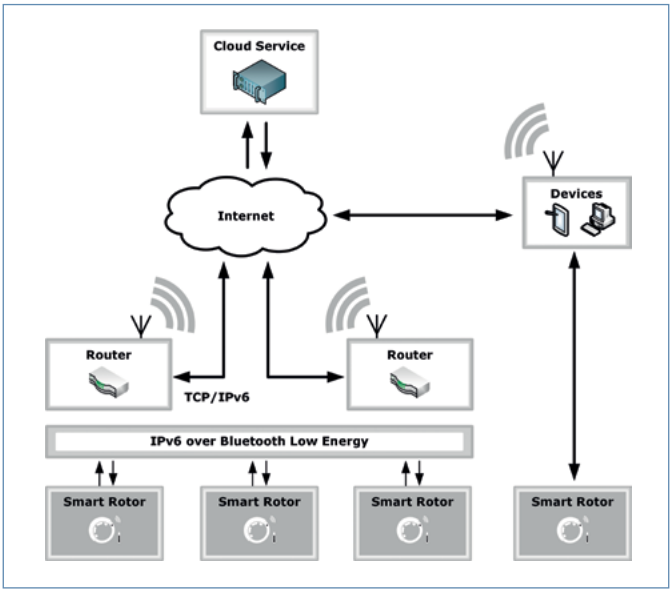
The German research shows these models can be refined by moving the sensors into the very heart of the machine, and in doing so, designers can accelerate the advent of the smart factory. With cost-effective wireless SoCs and sensors embedded directly into components and connected via a mesh network to the Cloud, powerful servers can, for example, determine the location of underused equipment and process bottlenecks to adjust the speed of the process accordingly. In addition, every part of an automated factory can be monitored for wear and tear to pinpoint maintenance needs, slashing production stoppages due to equipment failure.

This vision of the smart factory is rapidly turning into reality, according to consultant PwC. In a recent report (*Industry 4.0: Building the digital enterprise*) the company explains that Industry 4.0 investments are already significant and global industrial products companies will invest $907 billion per year through to 2020. PwC suggests: "The major focus of this investment will be on digital technologies like sensors or connectivity devices, [as well as on software and applications like manufacturing execution systems]."

Bluetooth LE, initially targeted at consumer peripherals, has rapidly adapted with security, IP connectivity, range/throughput, and mesh networking enhancements to become a foundation technology of the IIoT. In turn, the technology is helping power Industry 4.0, the revolution that will see today's manufacturing facilities transformed into the highly-efficient, highly-sustainable smart factories of tomorrow.

*For more information on Sven Grunwald and Bernard Bäker's IIoT work at TU Dresden see their recent report entitled "*Integrated measurement units and sensor systems for harsh industrial applications*". Available from www.tu-dresden.de.* ■

Data from the Bluetooth Low Energy SoCs embedded in brake discs can be sent to the Cloud via routers using IPv6 over Bluetooth LE



Wireless tech overcomes challenge of gluten-free living

Food allergies range from asymptomatic to life-threatening. For some, gluten is the culprit. Now Nordic-powered technology is addressing the problem. ULP WQ reports

Food allergies may have originally been a response to civilization. For example, Celiac Disease (CD)—a genetically inherited autoimmune reaction to eating the gluten protein predominantly found in wheat, barley, and rye—is thought to have first become a problem when humans introduced grains into the diet, after a long existence as hunter-gatherers. This may also explain allergies to milk and eggs; both products of domesticated animals.

Approximately two percent of the population in Europe and one percent of the U.S. has been diagnosed with CD. It's an unpleasant ailment; over time, the immune reaction to gluten causes intestinal inflammation, destroying the lining of the small intestine so that nutrients can no longer be properly absorbed.

However, technology is coming to the rescue of the gluten-wary. San Francisco, CA, company Nima recently released a small portable device that provides practically instantaneous testing of foods for the presence of gluten, meaning consumers don't have to rely on the claims of a food manufacturer or restaurant, which Nima claims can be inaccurate in as many as one in three instances.

Adopting and maintaining a gluten-free diet is not as simple as it seems

"Studying labels is not a guarantee that the food is gluten-free, wheat lurks in food from soy sauce to caramel coloring"

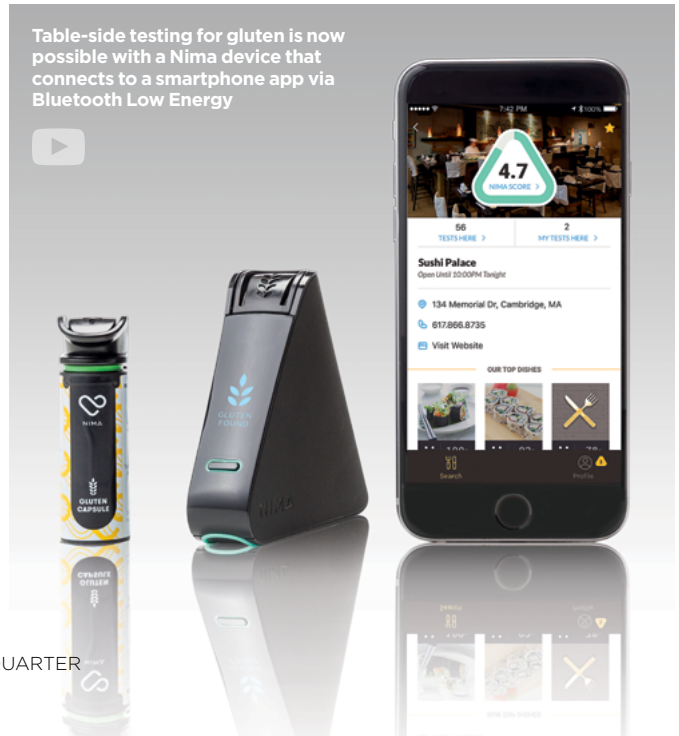


Table-side testing for gluten is now possible with a Nima device that connects to a smartphone app via Bluetooth Low Energy

Arduously avoiding gluten

Awareness of CD seems to be growing as "gluten-free" products, restaurant menus, and online communities increase. CD sufferers often explain that removing gluten from their diet restores energy levels, which follows as nutrient absorption improves when intestinal inflammation declines. Advocacy for gluten-free food is then inspired by those who feel noticeably better and tell others. Unfortunately, adopting and maintaining a gluten-free diet is not as simple as it seems. For example, eating at a restaurant places sufferers' well-being in the hands of strangers. For some, even the tiny amount of gluten resulting from cross-contamination of utensils can cause severe reactions. Fortunately, restaurants are beginning to take food allergies seriously, stopping the flow of the busy dinner hour to change out every utensil for a gluten-free dish.

Progress is also being made elsewhere. In 2013, the U.S. Food and Drug Administration (FDA) formally defined the term "gluten-free" as food containing

no more than 20 mg/kg of gluten. Those with CD find it easier to control the condition when food is identified in this way (since a trace of gluten can set back any progress made in healing the small intestine). However, studying labels for wheat is not a guarantee that the food is gluten-free. Wheat is pervasive, lurking in food from soy sauce to caramel coloring. Moreover, labelling food as gluten-free requires expensive and time-consuming lab testing, discouraging some. And for individuals, such a process is so onerous as to be almost impractical.

Nima's device, also called Nima, allows immediate, table-side gluten testing, delivering results in less than three minutes. A pea-sized portion of the suspect foodstuff is put in a chamber with a disposable capsule inside. Screwing the lid onto the capsule both grinds the sample into small particles and releases a solution. The solution breaks molecular bonds, freeing any gluten protein for testing with a strip that's already inside the capsule.

A solution with 20 ppm (based on the FDA 20 mg/kg threshold) or more of gluten yields a "Gluten Present" message from the Nima's electronics and processing algorithm with a claimed accuracy rate of 99 percent. Results are visible (and stored) on the Nima machine and sent to the user's smartphone.

Nima's test results and restaurant gluten-free food ratings can be shared with an online community of users

Nima employs Nordic Semiconductor's nRF51822 Bluetooth Low Energy (Bluetooth LE) System-on-Chip (SoC) to wirelessly transmit results to Nima's smartphone app.

The nRF51822 is built around a 32-bit ARM Cortex M0 CPU, 2.4GHz multiprotocol radio, and 256kB/128kB Flash and 32kB/16kB RAM.

Nima's test results can be shared, if desired, with an online community of Nima-users. The Nima community has access to a gluten-free food-rating system for local restaurants on the Nima smartphone app. However, a smartphone is not required for Nima to work. Test results are visible on the Nima device and stored there for later download. Nima is also working on a peanut sensing version for people with nut allergies, expected in 2018.

Nima employs a 300mAh rechargeable Li-ion polymer battery that can achieve more than 30 tests between recharge—or six months in sleep mode—thanks in part to the ultra-low power consumption of the Nordic SoC.

"When we looked at our wireless connectivity options for Nima we opted for Bluetooth LE because of the simplicity of the protocol, the low power consumption, and the compatibility with a wide range of devices and smartphones," says Scott Sundvor, Nima Chief Product Officer and Co-Founder. "Specifically, we went with Nordic's nRF51822 SoC because of the combination of the ARM Cortex M0 CPU with the 2.4 GHz radio in one small package."

Those suffering from food allergies may have hope in research for disrupting the autoimmune response to certain foods. Until then, the good news is that manufacturers and individuals alike now have a lower-cost, more convenient alternative to gluten testing which provides a stepping-stone to enjoying a more normal life for those with allergies. ■

Powerful wireless SoCs meet advanced wearable demands

Systems-on-Chip are now sophisticated enough to support complex Bluetooth Low Energy applications. Sebastien Mackaie-Blanchi explains

Sebastien Mackaie-Blanchi is a Hong Kong-based FAE & Customer Engineering Manager - APAC with Nordic Semiconductor

While single-chip Bluetooth Low Energy (Bluetooth LE) Systems-on-Chip (SoCs) have been available since Nordic launched the nRF51 Series in 2012, until recently they lacked the computing power for the most complex wearable applications. This situation forced developers to increase solution complexity and extend design schedules by specifying a two-chip Bluetooth LE solution comprising a connectivity chip (essentially the radio) teamed with a supervisory microprocessor.

That changed with Nordic's 2015 launch of the nRF52832 (and more recently the nRF52840) which combines a higher performance microprocessor, with a higher sensitivity radio, and greater RAM and Flash memory capacity to support more advanced RF software protocols ("stacks") and sophisticated application code. These nRF52 Series SoCs free developers to design complex applications without having to resort to two-chip designs.

Single-chip solutions bring other advantages, including: Less PCB area; lower bill-of-material (BOM); elimination of the power- and performance-sapping interface between separate connectivity chip and microprocessor; simplification of software architecture by elimination of code split between the two chips; simpler software development due to the requirement for a single toolchain, and debug of just one coding language.

Since its launch as a hallmark element of Bluetooth 4.0 back in 2010, Bluetooth LE applications have rapidly increased in complexity as the technology extends far beyond the original target sectors.

Processor power

For example, a typical high-end wearable supports routine features such as activity monitoring, calorie consumption, sleep pattern monitoring, as well as more focused analytics such as heart rate variability (measurement of the time between heart beats), skin temperature, and muscle oxygen levels. Information comes from accelerometers, gyroscopes, and pulse oximeters every tens or hundreds of milliseconds.

Such sensors require the Bluetooth LE SoC's processor to be capable of rapid Digital Signal Processing (DSP) and Floating-Point (FP) arithmetic to deal with this constant stream of data and transform it into accurate and precise activity, sleep, and heart rate data. DSP transforms the analog sensors' signals into the digital domain while FP arithmetic uses a formulaic representation of real numbers to accommodate a much wider range of values. A number is typically represented by a fixed number of significant digits and scaled using an exponent in a fixed base. Such DSP and FP arithmetic are common challenges for developers of high-end wearables.

COURTESY: WEARPAI TECHNOLOGY

Sophisticated wearables require higher processor performance

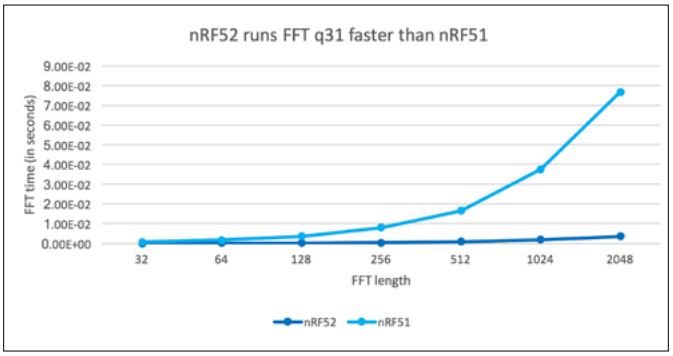
Nordic's nRF52832 and nRF52840 SoCs' ARM M4F microprocessors are perfectly adapted for DSP and FP arithmetic. For example, Figure 1 compares how much more rapidly the 64 MHz, 32-bit ARM M4F-powered nRF52832 SoC performs a software-based floating-point operation (Fast Fourier Transform (FFT) q31) compared with a 16-MHz, 32-bit ARM M0-powered nRF51822. (FFT is a commonly employed algorithm used to convert a discrete time-domain signal into an equivalent frequency-domain signal. q31 is a common data format used for FFT calculations.)

It's important to note that comparing an ARM M0 to an M4F microprocessor isn't just about the clock speed, FP, and DSP capabilities. The structure of the microprocessors is different with the ARM M4F based on Harvard architecture contrasted with the M0's Von Neumann; making it impossible to make a direct comparison. For example, if the respective microprocessors are running filters and polynomial-based computations the M4F's Harvard architecture is inherently faster no matter what the chip clock speed.

However, rapid processor clocking will maximize the performance of the ARM M4F microprocessor. In the nRF52832 SoC the device runs at 64 MHz (compared to the nRF51822 SoC's 16 MHz clock speed). Code execution at this clock speed requires the resources of the nRF52832 SoC's larger instruction cache to ensure the embedded Flash memory access doesn't create a bottleneck.

In addition to an efficient microprocessor, a Bluetooth LE SoC for complex applications demands enough RAM and Flash memory to support an RF stack and application software, and, crucially, over-the-air device firmware updates (OTA-DFU). Previously, designers leaned towards a two-chip approach because it offered not only flexibility in the choice of microprocessor but also the memory configuration. Today, the nRF52 Series SoCs embed up to 1 MB Flash and 256 kB RAM so separate memory chips are not required. ■

Figure 1: Nordic's ARM M4F-powered nRF52832 SoC completes FFT q31 calculation more rapidly than the ARM M0 used by the nRF51822 SoC



Off-grid, networked digital radios complement cellular systems

Nordic has helped customer goTenna develop digital radios that enable long-range SMS and GPS transmission when no cellular signal is available. Kalon Huett explains

Kalon Huett is an Australia-based freelance journalist

Anyone who has experienced the frustration of trying to reach friends when cellular communication is congested at a busy music festival, or even non-existent when in a remote location such as a national park, would immediately recognize the value of goTenna's Nordic Semiconductor-powered technology. The Brooklyn, NY-based company's system lets smartphone users send text messages and GPS locations over long distances—hopping via anonymous users' goTenna radios over a mesh network—when no cellular signal is available.

The 'goTenna Mesh' and 'goTenna Pro' digital radios support "100 percent off-grid, long range, peer-to-peer SMS and GPS communication" between users' iOS and Android Bluetooth 4.0 (and later) smartphones. From the smartphone-hosted companion app, users can start a 'chat' with an individual or group, using the Nordic-powered Bluetooth Low Energy (Bluetooth LE) link between their smartphone and goTenna device.

Key to the system's success is the growing strength of the connection as more users join the private network. By using a reconfigurable network protocol, messages automatically (and securely) hop through other goTenna units in the area, extending the message range between individuals engaged in the conversation to several kilometers. For example, the 1W UHF goTenna Mesh product, designed for general consumer use, offers off-grid connectivity anywhere in the world. In addition, the device can operate for up to 24 hours between recharges.

A second product, the goTenna Pro, transmits at 5W, is tunable to both UHF and VHF frequencies, achieves an operational battery life of more than 60 hours between recharges, and has been designed specifically for mission-critical applications such as defense, public safety, and industrial environments.

Inside the goTenna products, the nRF52832 Bluetooth LE System-on-Chip's (SoC) ARM M4F processor looks after the Bluetooth 4.2 RF protocol while the goTenna's complex *ad hoc* mesh networking protocol is controlled by a separate ARM processor. The networking protocol selects the best frequency to avoid interference and boost range, even in rough terrain.

"Following a positive experience the first time around, we felt confident working with Nordic again on our next models"

When cellular communication is non-existent smartphone SMS communications can be sent over long distances using a goTenna digital radio

Optimal user experience

According to Jorge Perdomo, Co-Founder and Vice President of goTenna, a key reason for choosing Nordic technology was because it allowed the company to optimize and future proof its devices. "Using the smartphone as our core user platform allows us to simplify our hardware greatly while also providing natural user experiences," he says. "That makes it essential for the Bluetooth Low Energy link between the mobile and the goTenna radio to be reliable, robust, and designed to consume minimal power.

"We have had previous experience working with Nordic because it makes the most power-efficient chip we could find. But while power consumption remains highly important, when we considered a chip for future devices we wanted to move to Bluetooth 4.2 because it supported our higher throughput requirement. We selected Nordic again because it was the first company to bring a Bluetooth 4.2 SoC to market."

According to Perdomo, another factor in the move to partner with Nordic was the robustness of the SoftDevice (Nordic's Bluetooth LE RF protocol software) and the flexibility of the company's Software Development Kit (SDK). "The SoftDevice and SDK accelerated our development because we could skip some of the lower level configurations that can often cause issues and rapidly progress to our application-specific software development," he says.

"We are already seeing an immediate benefit from Bluetooth 4.2 during over-the-air device firmware update [OTA-DFU] transmission times, which are down from eight minutes to close to one minute. This creates a much better experience for our customers."

In addition to the ultra low power capabilities, RF performance, SoftDevice reliability, and development tools, Perdomo identified Nordic's supportive approach as key to the partnership.

"Following a positive experience developing our V1 digital radio, we felt confident working with Nordic again. We have always enjoyed quality support from Nordic, even when implementations have proved challenging," says Perdomo.

Thanks to goTenna Mesh and goTenna Pro, the challenge of off-grid, long-range, multipoint smartphone communication has been solved. ■

Suunto Spartan Ultra Sportswatch

This Bluetooth Low Energy multisport GPS watch supports more than 80 different sports and monitors a wide range of performance metrics

According to analyst, Statista, sportswatch shipments reached 21.2 million units in 2016, projected to rise to 22.3 million units by 2021. The Suunto Spartan Ultra multisport watch provides GPS tracking and route navigation, heart rate measurement, and peak training effect data, with both racing and interval modes for dozens of individual sports

Suunto Spartan Ultra offers a color touch screen, 100-meter water resistance, and up to 26 hours of battery life in training mode. Featuring 80 pre-set sport modes and rich sport-specific metrics, Spartan Ultra also features a compass and barometric altitude measurement

Post-workout activity data can be synced to Suunto's Movescount app on the user's smartphone or tablet, using Bluetooth Low Energy wireless connectivity provided by Nordic's nRF51822 System-on-Chip. From the app users can track their distance, speed, calories burned, and view their training history, as well as explore new routes

The world record for the longest distance ever swum without flippers in open sea, belongs to Croatian Veljko Rogosic, who covered 225km across the Adriatic Sea in a time of 50 hours and 10 minutes, losing 16kg en route. Rogosic was also the first person to swim from Europe to Africa, covering the 171km between Sicily and Tunisia at the age of 67

Swimming can be dated back to the Stone Age, with cave paintings found in Egypt depicting prehistoric man learning to swim in order to cross rivers and lakes. It didn't become an organized sport until the early 19th century, when the National Swimming Society of Great Britain began to hold competitions

PEOPLE & PLACES

Ximena Patricia Bravo

Planner by day, live music fan at night

Hi, I'm Ximena Patricia Bravo (my name is Spanish and comes from Chile where I was born before emigrating to Norway with my family when I was eight) and I'm a Senior Business Planner based in Nordic's Sales & Marketing headquarters in Oslo.

I joined Nordic's Customer Service department in 2008 having worked previously in Customer Services at Norway's national telecoms company Telenor. After being interviewed in the morning, I was offered a job at Nordic in the afternoon and started working for the company two days later: it was obvious to me that the company was going places and it has never stopped growing in the 10 years since.

Because Nordic sells to customers through distributors, these were my customers, along with Nordic sales and fulfilment staff around the world who we consider to be our 'internal' customers. My main role involved placing and managing distributor orders, confirming lead-times, invoicing, and liaising with Nordic's foundry partners.

In November this year, I was officially promoted to my new role as Senior Business Planner. My main responsibility today is to ensure Nordic can supply its global distributor network with the right volume and the right mix of Nordic chip products at any one time. This requires a certain degree of forecasting through careful analysis of inventories and likely future demand. It can often be a challenge to predict when new projects will peak in demand or maybe even be cancelled.

I have to translate the forecasting into quarterly projection numbers that are then reported and discussed with both Nordic supply chain and senior management. It's a careful balancing act to get it right, but luckily for me I love working with numbers and using them to identify and solve potential problems, so I find my job never gets dull.

Outside of work I love to travel all over the world, as much as I can. Last year this included a two week road trip in Florida, and in May this year another two week road trip through Mexico which was a lot of fun, especially since I am fluent in Spanish and could therefore speak to the locals with ease.

Because I am from the West Coast of Norway that's renowned for its beautiful mountains and fjords, I also enjoy going mountain hiking which can take anywhere from two to eight hours to go up and down covering a distance of up to 20km.

I try to do that at least once a year other than winter, when it's too cold and the only thing any self-respecting Norwegian can do if they don't want to hide indoors in the warm all the time is go skiing – which I've just rediscovered my love for by finally buying (instead of borrowing) my own set of skis.

Other than that, I love watching sports events, especially football and all kinds of winter sports. And I love going to see live music at concerts. I enjoy all kinds of music including rock, R&B, hip-hop, and heavy metal. I'm pretty sure that at heavy metal concerts I'm the only chip production forecaster in Norway head-banging in the mosh pit! ■

When not forecasting inventory levels, Bravo can be found skiing or mountain hiking

Personal Profile

NAME:
Ximena Patricia Bravo

JOB TITLE:
Senior Business Planner

JOINED NORDIC:
Sep 2008

BASED:
Oslo, Norway

INTERESTS INCLUDE:
Travel, concerts, skiing, hiking, watching sports

"My job is to ensure that Nordic Semiconductor can supply its global distributor network with the right volume and right mix of Nordic chip products at any one time"

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