ultra low power
wireless
QUARTER 2 | SUMMER 2016

COVER STORY
Building the BBC micro:bit
Eddystone strengthens beacon security
What’s next for semiconductors?

SPECIAL SUPPLEMENT
A decade of ultra low power wireless 2006 to 2016
Internet of Things promises to democratize connectivity

The success of a company depends on things like skilled staff, visionary management, investment in R&D, and of course, products that people want, plus a little luck. I’m not suggesting that Nordic Semiconductor is perfect, like other companies we’ve made some wrong turns, but over the last decade we have got many of those success factors about right. That’s propelled the company from a healthy, niche supplier of proprietary ultra low power (ULP) wireless technology to the forefront of the Bluetooth low energy segment.

To coincide with the tenth anniversary of ULP Wireless Q, first published back in June 2006 (just as Nordic was teaming up with Nokia and other enterprising firms to form an alliance to develop a smartphone-friendly form of ULP wireless called Wibree, the predecessor of Bluetooth low energy) this edition includes a special eight-page anniversary supplement looking back over that decade.

But in an increasingly competitive world there’s little time for reminiscence and today the company is charting a course to become an important player in the Internet of Things (IoT) sector. We’re looking beyond the hype that talks about connecting 10, 20 or even 50 billion ‘things’ to the cellular network, the conventional Internet and each other, to come up with answers to the formidable engineering problems that need to be solved before the IoT becomes reality. Such is the magnitude of the challenge that it will require a collaborative effort between many companies spanning several technology sectors including semiconductors, network infrastructure, and Cloud computing platforms. Nordic hopes to play a significant role.

That’s not to say the company is only focused on the big projects. One of the promises of the IoT is that it promises to democratize connectivity far beyond even that achieved by today’s Internet. Soon, for just a few dollars, even the most inexperienced maker or hobbyist will be able to make their project ‘smart’ by adding a Bluetooth low energy wireless connection. This is not a dream; in this issue (see page 16), for example, you can read about the Arduino Primo, the latest single-board computer from the world’s largest open-source ecosystem. The company says the Primo is the first Arduino product to allow makers and hobbyists to take advantage of the embryonic IoT. The Primo is powered by Nordic’s nRF51822 Bluetooth low energy solution which can also support IPv6.

Today, Nordic Bluetooth low energy chips are found in hundreds of millions of products around the world. If our engineers’ talents are nurtured and we continue to enjoy a share of good fortune, it’s possible that when we take a glance back from June 2026 we’ll see a good share of the 50 billion things making up the IoT being powered by one of our devices.

Yours Sincerely,

Geir Langeland
Director of Sales & Marketing

Contributors

Yamazaki Mitsuo is Nordic’s Regional Sales Manager in Japan. Here he looks at how the nRF52 Series SoC is powering a new generation of RF modules

Sally Ward-Foxton is an electronics freelance journalist. On page 10 she speaks to the man behind the BBC micro:bit and finds out why Nordic’s chip lies at the heart of the device

Caroline Hayes is a tech writer specializing in semiconductors. In this issue she explores the state of play in wireless charging, finding an industry undergoing rapid change
New Arduino base board offers native Bluetooth low energy

Open source prototyping platform developer, Arduino, is to use Nordic Semiconductor’s nRF52832 Bluetooth low energy System-on-Chip (SoC) in its new Internet of Things (IoT) programmable single board computer: the Arduino Primo.

For the first time the low cost single board computer—or base board—features native Bluetooth low energy wireless connectivity alongside Near Field Comms (NFC), Wi-Fi, and infrared (IR) technologies. Previously users were required to add shields to the board to enable Bluetooth low energy technology.

In addition to being able to wirelessly connect to a wide array of Bluetooth low energy sensors, the Arduino Primo can act as a fully functional TCP / IP Internet processor has the computational overhead to supervise and control the Arduino Primo’s on-board accelerometer, temperature, humidity, and pressure sensors. For all but the most advanced projects, programming will be done via the established and easy-to-use Arduino Integrated Development Environment (IDE) programming interface.

As well as controlling the Bluetooth low energy RF protocol software stack and application code, the nRF52832’s ARM Cortex-M4 processor has the computational

Soccer sensors track player performance for post-game analysis

U.S. wearable sports technology company, Zepp Labs, has launched a new wearable soccer sensor that monitors a range of in-game player attributes to provide coaches and players with a tool to analyze and improve performance post game.

The Zepp Soccer sensors are strapped to a player’s calves, and record running and sprint distance, passing, and preferred foot metrics, employing Nordic Semiconductor’s nRF52832 System-on-Chip (SoC) to sync the data via a Bluetooth low energy wireless link to compatible iOS or Android smartphones.

The Zepp Soccer sensors place a high demand on the Nordic SoC, as the application is required to support more than 30 sensors and provide sufficient bandwidth between the sensors and a smartphone to cope with, for example, more than 100x the data generated by a heart rate monitor.

Zepp Labs also required low power consumption in both ‘active’ and ‘standby’ modes to achieve up to 15 hours of game time between recharges.

From a smartphone running the Zepp Soccer app, a coach or ‘host’ can also record game time and capture individual player video. The app will then generate a report for post-game review.

“Wa needed a Bluetooth Smart solution with a powerful CPU, excellent Floating Point and DSP performance, to perform the data manipulation, as well as large RAM capacity to buffer all the information being gathered by the sensors,” explains Dong Li, Zepp Labs Hardware Director.

“But we also needed to minimize power consumption. For those reasons the nRF52832 Bluetooth Smart SoC was the logical choice.”

Bluetooth sector set for huge lift

Analyst Beige Market Intelligence, claims the Bluetooth low energy market will be worth $3 billion by 2021, driven by major expansion in the industrial Internet of Things (IoT) sector, and high demand from Asia Pacific. The report claims the region will contribute more than 50 percent of the revenue in the Bluetooth low energy market and identifies Nordic Semiconductor as a key vendor.

Close to 4 billion Bluetooth chips are likely to be shipped worldwide in 2021.

Flexible security solution unveiled

Experimental physicists at Saarland University in Germany have developed an outdoor security solution that issues a warning if someone has attempted to cross over a flexible cable. The cable contains a linear array of highly sensitive magnetic-field sensors that are capable of detecting the smallest changes in the ambient magnetic field at distances of up to several meters, issuing a message via Bluetooth technology to a smartphone or tablet.
In brief

Bluetooth device boom coming

Market Intelligence firm ABI Research, predicts annual Bluetooth device shipments will reach 5 billion by 2021, with Bluetooth low energy delivering the strongest growth, driven by new opportunities in mesh networking and IPv6, as well as improvements in efficiency, range, and size reductions.

Monitoring heart rate

China-based Shenzhen DO Intelligence Technology Co has selected Nordic’s nRF51822 Bluetooth Smart System-on-Chip for its “ID 107” real-time dynamic heart rate monitor wearable. The multifunction wristband is equipped with a photoelectric diode and a green LED on the underside of the bracelet. Heart rate data is calculated based on a proprietary algorithm and wirelessly synced to the user’s smartphone via Bluetooth low energy, allowing them to determine the level of effort maintained during exercise.

Energy costs fuel smart home lift

The global smart home market is predicted to grow from $46.97 billion in 2015 to $121.73 billion by 2022, as advancements in the Internet of Things (IoT) sector drive consumer adoption, analyst MarketsandMarkets claims. It said increasing consumer demand for convenience, safety, and security, as well as a rising need for energy saving would see manufacturers expand their smart home product portfolios. The lighting control market is expected to grow at the highest rate during the forecast period.

A million schoolchildren receive Nordic-powered BBC micro:bit

Britain’s public broadcaster, the BBC, is delivering up to one million free codeable computers called micro:bits to every 11-12 year old school child in the U.K., each driven by a Nordic Semiconductor nRF51822 Bluetooth low energy System-on-Chip (SoC).

Announced at a launch event hosted at the London Stock Exchange, the BBC said the project aimed to encourage the next generation to take an interest in technology. Following the nationwide rollout, the micro:bit hardware and much of the software will be open-sourced, and the micro:bit made available to buy from a range of retailers.

Nordic Semiconductor is an official BBC micro:bit partner, and the nRF1822 SoC sits at the heart of the micro:bit, integrating the computer’s ‘brain’—a 32-bit ARM Cortex M0 microprocessor—where the school child-created software code runs, and that also allows the micro:bit to wirelessly communicate with other micro:bits, and wirelessly sync to smartphones and computers.

Nordic pioneered the development of ultra low power wireless in the early 2000s, and later became a key contributor in the creation and evolution of Bluetooth low energy technology. Since then Nordic has worked to make ultra low power wireless connectivty simple, and open to the widest number of people, including those from a non-electronics background.

“The ability to code is now as important as math skills and can unlock new career opportunities,” says Simon Segars, CEO of ARM. “I can easily imagine a new wave of entrepreneurs looking back and citing (the BBC micro:bit launch) as the day their passion for technology began.”

Smoke and motion detectors provide networked protection from fire and theft

Norwegian safety connected device company, sfty, has released a wireless, smartphone app-controlled combined smoke- and motion-detector. The unit is designed for use in multi-dwelling units and apartments to protect the owner against fire and theft, as well as provide temperature and relative humidity data.

The sfty Sense device employs Nordic Semiconductor’s multiprotocol nRF51822 System-on-Chip (SoC) to deliver communication across a 2.4 GHz low power mesh network while simultaneously providing smartphone connectivity.

From the app, users can create a social network of friends, family, and neighbors who are notified via the app on their own mobile device in the event of a sfty Sense detector alarm being triggered. The user can also manage their safety devices from the app to turn on and off the burglar alarm, as well as notify their network if they are in need of assistance.

The device employs a home Wi-Fi network via a standard router to communicate with the sfty Cloud for configuration, status reports, and signaling, while the low power mesh network is used for signaling between devices to trigger or cancel smoke or motion alarms in the individual home, or trigger building-wide smoke alarms.

“With the impending announcement of Bluetooth Smart Mesh, the support for Bluetooth in smartphones will allow direct interaction between the user’s mobile and our devices when they are at home,” says Espen Schrøder, COO of sfty. “This capability is something that competing standards are not in a position to provide for the foreseeable future.”
IoT platform enables end-to-end wireless monitoring and control

Swedish industrial Internet of Things (IoT) system provider, Free2move, has unveiled its 2Connect building management and industrial automation IoT platform, a complete IoT architecture comprising sensors and actuators, wireless gateways and middleware, analytics, and presentation.

The platform incorporates Cloud services for automating and connecting ‘things’ with building and industrial automation applications and services. The fundamental part of 2Connect is the Celebes scalable wireless gateway which employs Nordic Semiconductor’s nrF52832 multiprotocol System-on-Chip (SoC) to enable either or both Bluetooth low energy and the company’s own legacy Free2move Radio Air Protocol (FRAP)—wireless connectivity to a range of IoT devices, sensors, beacons, and actuators.

2Connect monitors humidity, temperature, air quality, air and water flow, volatile organic compounds (VOCs), vibration, movement, light, pressure, energy consumption, as well as traces of fungus, using a layered analytics and decision architecture. The platform assumes full responsibility for the capture of IoT data, analyzing real time information and taking corresponding remedial actions with automatic, wirelessly-triggered motor-, switch-, lock-, and valve-actuation, and visualization.

“2Connect provides our customers with the opportunity to rapidly deploy technology for monitoring buildings without being impeded by ‘legacy’ systems,” says Anders Due-Boje, Free2move CEO.

“The IoT is undergoing rapid development and early IoT adopters need a capability to support proprietary legacy technologies in the short term,” says Geir Langeland, Director of Sales & Marketing with Nordic Semiconductor.

“2Connect cleverly takes advantage of the nrF52832 SoC’s multiprotocol support to offer users both Bluetooth low energy and legacy FRAP stacks, thus ‘future proofing’ customer installations.”

Nordic expands with new offices in mainland China

Nordic Semiconductor has opened two new sales, marketing, and customer support offices in mainland China. The offices enable the company to provide fast sales and technical support to China’s burgeoning wireless design and manufacturing sector. The facilities are in addition to Nordic’s Asian HQ in Hong Kong.

The offices officially opened on March 1, 2016, and are based in Shanghai in northeast China, and Shenzhen in Guangdong province in the south of China. Each office is staffed by a Technical Sales representative and Field Applications Engineer and managed by Nordic’s existing Regional Sales Managers in China.

The opening of the offices is a response to the dramatic growth of companies designing and developing Bluetooth low energy solutions in China, particularly in the area of wearables, IoT, toys, health care, payment systems, and smart remote control with voice command.

“China has been growing steadily every year since Nordic started out in Asia in 2001,” says Ståle “Steel” Ytterdal, Nordic’s Director of Sales & Marketing – Asia.

“However, when we introduced Bluetooth low energy in 2010 sales exploded. That showed Nordic that there was a lot of innovation going on in China and we needed to position ourselves to closely support these customers.”

The opening of the Shanghai and Shenzhen offices strengthens Nordic’s relationship with its current distribution partners – Avnet, Arrow, Honestar, New Spirit, Rutronik, and Xuntong - providing an increased presence in mainland China and the basis for further collaboration on joint meetings with potential and existing customers.

New modules v4.2 compatible

Taiyo Yuden, has selected Nordic’s nrF52832 Bluetooth low energy System-on-Chip (SoC) for its new EYSHCNZXZ and EYSHJNZXZ Bluetooth low energy modules. The modules are fully-tested Bluetooth low energy solutions compatible with the latest version of the Bluetooth Core Specification (4.2), simplifying the design of a wide range of connected products where performance, small size, and low power consumption are key factors. The use of Nordic wireless technology for the modules continues a long-term design partnership.

Global IoT security spending to climb

Worldwide spending on Internet of Things (IoT) security will reach $348 million in 2016, a 23.7 percent increase from 2015 spending of $281.5 million, according to analyst Gartner Inc. Although overall spending will initially be moderate, Gartner predicts IoT security market spending will increase at a faster rate after 2020, as improved skills, organizational change, and more scalable service options improve execution. The company claims that by 2020 more than 25 percent of identified enterprise attacks will involve the IoT.
Bluetooth low energy gives model railroads a 21st century makeover

One of the world’s largest model railroad makers has transformed a decades old market with the introduction of the first Bluetooth low energy controlled trains. *E-Z App* from Bachmann Trains brings smartphone and tablet wireless touchscreen control and app-based interactivity to the model train market for the first time, reducing the start-up cost and complexity for model railroad enthusiasts.

*E-Z App* was developed in conjunction with Bluetooth model train PCB design specialist, BlueRail Trains, using Nordic Semiconductor’s nRF51822 System-on-Chip (SoC)-based BMD-200 modules from U.S. engineering firm Rigado.

Bachmann says *E-Z App* brings simple wireless touchscreen control and intuitive app-based interactivity to the traditional model train market for the first time.

“This includes putting, quite literally, at a user’s fingertips features such as speed table controls [acceleration and deceleration rates], volume controls for sound effects, lighting effects, and many other variables,” says Rich Janyszek, Senior VP of Sales & Marketing at Bachmann.

“In addition, the *E-Z App* control system automatically keeps track of all locomotives that are present on a track layout and lists them on the program’s opening screen in a roster that can be accessed at any time. This makes it possible for multiple users to simultaneously control their locomotives on a single layout.”

Janyszek adds that *E-Z App* supports wireless smartphone and tablet control of any of its *E-Z App* compatible model trains over a range of up to 33 meters, and is also compatible with all MFI-approved game controllers.

“It has been incredibly refreshing to see adults, young children, and experienced hobbyists downloading the app because of its simplicity, and rediscovering the pleasure of model trains,” comments David Rees, CEO & Creative Director at Bluerail Trains.

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**Nordic nRF52 Series SoC wins CEM Editor’s Choice Award**

Nordic Semiconductor’s next generation nRF52832 Bluetooth low energy System-on-Chip, has won the *China Electronic Market* (CEM) Editor’s Choice Award 2015 in the “Most Competitive Interface Products in China” category.

Jointly hosted by CEM magazine and China Electronic Exhibition & Information Communication Co., Ltd., the selection criteria for the award considered brand influence, market share, technological innovation, and product service. The nRF52832 SoC was judged to fulfill all of these criteria, including a sound sales performance in the Chinese market. The nRF52832 SoC featured among the best of its peers in market share and boasted one or more innovative features—in particular its unique Near-Field Communication (NFC) tag—while Nordic also demonstrated pre-sales, sales, and after-sales services that were fast, meticulous, and thoughtful, resulting in higher customer satisfaction, according to the CEM editors.

“The applications base for Bluetooth low energy technology has seen strong growth, but the recent emergence of wearable healthcare devices and smart-home applications will provide a strong impetus for further growth in the Bluetooth market,” comments Ståle “Steel” Ytterdal, Nordic Semiconductor’s Director of Sales & Marketing in Asia.

“Our nRF52 Series SoCs address these markets with compact high-integration solutions that support the ULP wireless capability these new markets demand. We are very honored to receive the Editor’s Choice Award from CEM.”
School project sees BBC micro:bit carried to edge of space and back

A school in Yorkshire, England recently launched a BBC micro:bit to the edge of space, carried up into the stratosphere by a helium balloon.

The project was the brainchild of computer teacher Peter Bell, and saw pupils from Rishworth School design and engineer a module integrating the micro:bit, sensors, a GPS tracking device, and an on-board camera to take pictures and record video on its journey.

A team of 20 pupils tracked the weather balloon and its cargo as it made its way up to a height of 32,588 meters, before the balloon burst and the module began its descent, reaching a speed of 290 km/hr when a parachute deployed and returned the module to Earth safely. Thanks to the GPS tracking device, the school was able to follow the module’s descent and locate it in a farmer’s field some 100 miles away from where it was launched.

“We were in two cars following the signal and it was very exciting. We heard later from a pilot that air traffic was rerouted because something was coming down to earth fast and it was our computer,” says Bell.

At the heart of the micro:bit is a Nordic Semiconductor nRF51822 System-on-Chip (SoC).

Wireless transmitters deliver pinpoint location information

Apple has been awarded a patent for a system of city-wide low power wireless transmitters capable of sending pinpoint-accurate location data as well as environmental alerts to iPhones.

The patent entitled “System with wireless messages to enhance location accuracy” attempts to solve signal reception issues that crop up in densely populated cities, while increasing the granularity of positioning data. The solution is said to consume less power than A-GPS, Wi-Fi positioning, and cellular triangulation techniques.

The patent calls for a multitude of stationary transmitters to be installed at strategic locations near a city’s roads. Each transmitter is a smart wireless hub supporting Bluetooth low energy, Wi-Fi, and GPS.

In operation, a stationary waypoint device would broadcast its location via Bluetooth low energy messages. Each message would be sent out at a known signal strength, allowing the receiving device, like an iPhone, to extrapolate its relative location based on a received signal strength indicator value, thereby determining its absolute position depending on the number and quality of messages received.

Applied to navigation, the system could be configured to track vehicle movement with a high degree of accuracy, for example, along off-ramps and on-ramps or forks in a road, where traditional GPS systems often fail to resolve user position adequately.

Wireless standards slash IoT costs

Smart cities of the future may look towards open wireless standards to save billions in Internet of Things (IoT) deployment costs, according to market intelligence firm Machina Research.

The firm said choosing open standards - for example Bluetooth low energy - would lead to more interoperability between networks and applications, cutting costs by as much as 30 percent, and encouraging deployment of IoT solutions.

Machina Research predicts that by 2025 smart cities may spend $1.12 trillion on deploying smart technology, but could save up to $341 billion if they use open wireless standards instead of proprietary technology. On top of the lowered cost for deployment, Machina also predicts 27 percent more connected devices by 2025 if open wireless standards are adopted by smart cities and IoT providers.

The firm said the current issue is IoT providers are bundling proprietary wireless technology with their deployment software, instead of using open source alternatives.
New Eddystone beacon format addresses security concerns

The Ephemeral Identities addition to Google’s more secure Eddystone beacon format is now supported by a dedicated Nordic Software Development Kit

Beacons are driving new proximity-based services. The devices comprise low-cost Bluetooth low energy transmitters for indoor or outdoor use, placed in a particular location or point of interest. The beacon transmits its identity to any Bluetooth 4.0-equipped mobiles in range; those hosting a companion app can be located and the software can trigger various types of notifications.

Because beacons have the potential to identify the location of smartphones to within a few meters, they enable content delivery specifically targeted to that location for users who want it. As such, the technology is predicted to be rapidly adopted by stores as a way to boost sales.

Analyst Business Insider, for example, estimates that the top 100 U.S. retailers could reap $4.44 billion in sales by the end of this year as a result of the influence of beacon-triggered smartphone notifications.

However, despite the potential, beacons have taken a little longer than initially predicted to catch on. “Beacons are a core building block of the Internet of Things,” explains Reidar Martin Svendsen, Technical Product Manager with Nordic Semiconductor, “but security and privacy has been a concern with today’s beacon formats.”

The root of the problem is Bluetooth low energy technology’s use of a unique identifier to pair with mobile devices for the exchange of information. In most applications this is not an issue, but because a beacon is designed to pair with any mobile device that comes within range, a fixed identifier can leave open a ‘back door’ for the unethical to eavesdrop on communications and perhaps access private information about a consumer with the intention of malicious attack.

This perceived vulnerability is holding back beacon deployment. “Privacy is the top consumer barrier to wide adoption of beacons,” Adam Silverman, an analyst with Forrester Research, told technology publication Wired.

Hardening beacon security

In April, Google introduced new technology to enhance beacon privacy by launching Eddystone-Ephemeral Identities (EID), an addition to the Eddystone beacon format that itself was announced in mid 2015.

The company explains that Eddystone-EID provides developers more power to control who can make use of a beacon’s signal, enabling a new set of use cases for users to be able to exchange information securely and privately. The secret of the technology is a beacon ‘frame’ (or signal) that changes pseudo-randomly, and consequently is only recognizable to a controlled set of users (those that have signed up to the service).

An Eddystone-EID beacon uses an AES-encrypted eight-byte beacon identifier that changes pseudo-randomly with an average period (from one second to just over nine hours) determined by the developer. The identifier is generated using a key and timer running on the beacon. The key is generated and exchanged with a resolution service using a defined protocol and only the beacon and the service to which it is registered have access to the key. If registered with the service beacon ‘attachments’ are served in the normal way across a secure link to a consumer’s mobile.

Apart from the security improvement, Eddystone-EID also introduces other enhancements such as an ability to broadcast URLs. “[Now, for example] advertising posters [could have] the ability to broadcast a relevant web address to smartphones nearby - making it easy for interested parties to find out more about the advertised item without having to download an app first,” notes Nordic’s Svendsen.

Nordic is one of fifteen manufacturers currently supporting Eddystone-EID, a list which also includes Sensoa and Estimote, beacon makers that use Nordic’s Bluetooth low energy wireless technology. When Google introduced Eddystone-EID, Nordic simultaneously announced its Software Development Kit (SDK) and supporting tools for engineers looking to work with the more secure beacon technology.

The ‘nRF5 SDK for Eddystone’ enables development of Eddystone-EID beacons to provide real-world context to users in a huge variety of proximity-based beacon applications. The SDK also features a Generic Attribute Profile (GATT) that allows beacons to be configured from a smartphone.

“The SDK is designed for Nordic’s nRF52 Series Bluetooth low energy Systems-on-Chip (SoCs). A future upgrade will also allow for the existing nRF51 or nRF52 Eddystone beacons to be updated to Eddystone-EID via an over-the-air (OTA) firmware update.”
Nordic’s nRF52 Series powers new generation of RF modules

The nRF52832 SoC is enabling manufacturers to build a powerful new breed of Bluetooth low energy modules based on proven architecture, says Mitsuo Yamazaki

The RF modules market is booming. According to IHS, in mid 2015, modules made up about a third of the overall low power wireless market and the company expected that proportion to grow to 40 percent by 2018. This statistic should come as no surprise; the lure of a pre-engineered, tested and compliant RF solution for manufacturers with little or no experience with wireless connectivity, yet needing to make their products “smart”, is compelling.

U.S.-based Bachmann Trains, for example, one of the world’s oldest and largest traditional model railroad and train manufacturers, teamed up with RF module maker Rigado to bring Bluetooth low energy technology to model train engines. Bachmann says wireless connectivity brings touchscreen control and app-based interactivity to the model trains for the first time. (See this issue pg6.)

In addition to Bachmann, scores of manufacturers find the trade-offs brought by choosing a module—higher cost bill of materials and fewer opportunities for product customization compared to an RF solution assembled from discrete components—are well worth making to simplify design and manufacturing. A single module, for example, can be reused across multiple products, easing the problem of supporting numerous unique wireless designs.

Rigado’s RF module selected by Bachmann

Trains was based on Nordic Semiconductor’s nRF51822 Bluetooth low energy System-on-Chip (SoC). The SoC integrates an ARM Cortex M0 processor, 2.4 GHz multiprotocol radio, up to 256 kB Flash, and up to 32 kB RAM. The SoC also features a unique software architecture that separates the RF software protocol from the developer’s application code ensuring that during software development the RF protocol can’t be corrupted. Launched in mid-2012, the nRF51822 is now used in millions of products across the world.

Rigado is not the only company to base a module on Nordic Bluetooth low energy technology. Nordic lists dozens of third-party nRF51822 SoC-powered modules on its website including those from companies such as Fujitsu, Laird, and u-blox.

Boosting performance

Last year’s launch of the Nordic nRF52832 Bluetooth low energy SoC allowed module makers to design a new generation of modules with significantly greater performance than those which came before.

Small but powerful: Taiyo Yuden’s smallest Bluetooth low energy module measures just 5.1 by 11.3 by 1.3 mm but incorporates a 64 MHz, 32-bit ARM Cortex M4F processor

The nRF52832 SoC is based on the proven software- and hardware-architecture of the nRF51 Series but features a 64 MHz, 32-bit ARM Cortex M4F processor delivering up to 60 percent more generic processing power, offering ten times the Floating Point performance, and twice the Digital Signal Processing (DSP) performance compared to competing solutions. The SoC has an enhanced 2.4 GHz multiprotocol radio offering Bluetooth low energy (fully compatible with Bluetooth 4.2), with -96 dB (receive) sensitivity as well as 512 kB Flash memory and 64 kB RAM.

The ARM processor enables the SoC to run applications that previously demanded a two-chip (2.4 GHz transceiver plus separate microcontroller) solution. At the time of launch, the nRF52832 SoC was the world’s most powerful single-chip Bluetooth low energy device and was recently recognized by China Electronic Market magazine as “the most competitive interface product in China”. (See this issue pg6.)

Several module makers already launched nRF52832 SoC-based products. Here in Japan, Taiyo Yuden has added to its range of nRF51 Series-based modules with two nRF52832 Series-based units measuring as small as 5.1 by 11.3 by 1.3 mm.

“Because the nRF52832 SoC’s hardware and software architecture are compatible with the nRF51 Series modules, it makes it much easier for customers to upgrade”

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And in the U.S. Argenox Technologies has also introduced a nRF52832 SoC-based module, measuring 9.7 by 14.3 by 2 mm and certified to FCC, ETSI, and CE standards. “The nRF52832 SoC makes Bluetooth low energy products smarter and better,” explains Argenox Technologies Founder and CEO, Gustavo Litovsky. “The chip makes the end solution faster to develop, lower cost, and more reliable, while allowing the designer to make fewer trade-offs in their selection of features.”

www.nordicsemi.com

COMMENT
The BBC micro:bit project is inspiring the next generation of computer science engineers

The British Broadcasting Corporation’s (BBC) educational project to give every year 7 schoolchild in the U.K. a free programmable learning device is almost fully rolled out, with nearly one million devices already in the hands of their new owners. The devices, called "micro:bits", are small (and wearable) boards equipped with a basic LED display, various sensors and buttons, and a Bluetooth low energy wireless chip with embedded ARM processor. The intention is to teach children the basics of programming with the hope of encouraging them into studying science, technology, engineering, and math (STEM) subjects and eventually pursuing careers in computer science. It’s a laudable aim, but how did this ambitious project come about?

Howard Baker was with the BBC’s education department, the team which drove development of the micro:bit. He explains that the initial idea followed a 2011 report from the U.K.’s worldwide renowned Royal Society. The report identified a steep decline in the number of students studying computer science at university. The report also revealed that the students’ skill level when they arrived at university had steadily declined. "[This was all happening] at a time when [future] jobs required more and more of these skills," Baker says. "That’s thinking skills associated with computer programming or organizing things in a way that a computer understands. We’d stopped learning these skills."

Repeating history

The current generation had no idea that programming skills were in demand in the U.K. Baker says. It came as a surprise to many schoolchildren that there is a strong British industry creating games and movies which represents an exciting potential career path for computer science and STEM graduates. The U.K. government changed the school curriculum as a result of the Royal Society report, but BBC Learning felt there was more that could be done. The BBC has a history of getting involved with practical projects to educate its home country; in the 1980s, a similarly ambitious venture called the BBC Computer Literacy project placed microcomputers in U.K. schools to encourage young people to learn to use them. A basic level of computer literacy was seen to be extremely important to prepare the workforce for the impending microcomputer revolution.

Called the BBC Micro, the computer given to schools in the 1980s could be programmed using BASIC computer language and represented many people’s first experience of using a computer. It was a successful project and is believed to have kick-started the

Building the BBC micro:bit

Sally Ward-Foxton speaks to the man behind the BBC’s ambitious educational project

Howard Baker

As soon as Nordic Semiconductor stepped in we knew we’d solved most of the hardware problems. Its chip is a brilliant solution”

Howard Baker

The U.K. government changed the school curriculum as a result of the Royal Society report, but BBC Learning felt there was more that could be done. The BBC has a history of getting involved with practical projects to educate its home country; in the 1980s, a similarly ambitious venture called the BBC Computer Literacy project placed microcomputers in U.K. schools to encourage young people to learn to use them. A basic level of computer literacy was seen to be extremely important to prepare the workforce for the impending microcomputer revolution.

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U.K.'s fledgling digital industries, in particular, the games industry. "The revolution did happen, every home did have a microcomputer – computers are now ubiquitous," Baker says. "The skills that we learned in the 1980s took us through the revolutions that followed very quickly after that. We were capable of building games, we were capable of coming up with the world wide web. But it was obvious [in 2011] that those skills were dipping."

Baker's Innovations team at BBC Learning started working with Manchester Metropolitan University, assembling panels of skills experts and teachers to discuss what form a potential educational project might take. Early ideas included a software version of the BBC Micro to teach basic programming. Kids loved the prototype, Baker says, but it was especially loved by parents who had used the original BBC Micro at school.

As this was happening, a new breed of electronics hobbyists called 'makers' – tech enthusiasts, engineers, and students – started to emerge. The rise of the Maker Movement coincided with the early part of the BBC Learning project and encouraged the notion that there ought to be a piece of hardware involved, that the kids could touch and play with, to make it feel more real. Some small smartphone-controlled robots were built as part of the project, which reacted to signals embedded in popular BBC TV programmes, and they were a huge success with children. This led to the Innovations team approaching the BBC's flagship children's TV programme, Blue Peter, with the idea of encouraging basic electronic assembly. However, the cost of materials for Blue Peter projects is limited to around £82 (£2.89), which meant that more expensive electronics projects weren't appropriate.

"I was cycling home and thought: 'what's the cheapest, smallest thing we could put in their hands, what could we give them that would be a kickstart?'", Baker says. "We'd have to be able to give it away, so it would have to be very cheap and it would have to have something on there that would immediately fascinate, like LEDs to write a message or make an animation. It needs buttons, an input/output to attach to a sensor, and it must be the easiest thing in the world to program. Like the BBC Micro – just tap in an instruction and the thing does it."

**Thinking bigger**

The BBC micro:bit was born. A proof of concept device was made up by BBC R&D and trialed at various events with great success. But the project really gained momentum when newly-appointed Director General of the BBC, Tony Hall, announced that the BBC's big educational project of 2015 would be “Make It Digital”, an initiative to, in his words, "get the nation coding again". By then an integral part of this initiative, the micro:bit team realized they could, and should, think bigger.

An initial idea to build 10,000 devices was scrapped in favor of giving a device away to every child in a whole year group – a million devices in total. Towards the end of 2014, the Innovations team put out a call for commercial partners to help with hardware, software, learning resources, and finance. The partners worked together to finalize the spec of the device, which now included an on-board accelerometer and compass. U.K. IP vendor ARM developed and tested the basic hardware, Technology Will Save Us designed the shape, look and feel of the device, and it was manufactured by distributor Farnell element14.

ARM designed the hardware with simplicity in mind. This included a high level of integration leading to the selection of a Bluetooth low energy chip with an embedded ARM processor. Nordic Semiconductor’s nRF51822 is the brain of the micro:bit combining the latest Bluetooth low energy, ANT+ and proprietary wireless technology with a 32-bit ARM Cortex-M0 microprocessor. The nRF51822's microprocessor is powerful enough to look after the wireless connectivity while also running the code written by the kids and looking after the board’s other capabilities (with the exception of the USB functionality which is supervised by an NXP Semiconductors microprocessor). The wireless connectivity allows a micro:bit to communicate with other micro:bits, and Bluetooth 4.0 compatible smartphones, tablets, and computers.

"We knew from working with ARM that we wanted an ARM Cortex-M0, but as soon as Nordic Semiconductor stepped up with a [Bluetooth low energy System-on-Chip (SoC) with an embedded ARM microprocessor], and showed it can do all this stuff we
knew very quickly we'd solved most of the hardware problems,” Baker explains. “It was a brilliant solution; in one step, the micro:bit was equipped to do all the things it needed to do.

“Shake it and something happens, point it in a direction and something happens, tap it and a smartphone does something. That's what turns the children on and underneath, Nordic’s chip is making it all possible.”

The other important chip on the board is NXP’s uSB controller, chosen because it enables code to be ported to the board without first downloading a loader program (a potential obstacle to setting up the micro:bit). The company also provided the MEMS accelerometer and compass chips. The board also has 25 LEDs arranged in a grid, two buttons, pins to link to other sensors via crocodile clips, and an edge connector which can be used to connect to other hardware, such as Raspberry Pi or Arduino.

For the micro:bit’s software, Microsoft volunteered its “Touch Develop” platform and built a web app around it, before adding Google’s Blockly language at Baker’s request.

Baker was also keen to include Python, a software language widely used in the teaching community, and with the support of the Python Foundation, a special version of Python for embedded devices was added. Code Kingdoms was responsible for the micro:bit’s Javascript editor, and C++ is also available through ARM mbed, the development environment used by many embedded engineers.

“The kids have a pathway where they can start with moving graphical blocks, like a jigsaw puzzle (in Blockly), then play with Python and Javascript, and then even move on to C++ on a clear pathway,” Baker says.

Key to connecting the hardware and software is a C++ library which implements the interactions referred to by the higher languages. This important library was built by Lancaster University; it’s now a fully fledged open-source embedded operating system with a range of functionalities that the various communities using the micro:bit can build on.

Since most schoolchildren are very familiar with mobiles, connection to a smartphone is a great practical illustration of what coding can do. Samsung built an Android app which allows the micro:bit to be programmed wirelessly by a smartphone, and some of the smartphone’s functions to be controlled by the micro:bit. Smartphones equipped with Bluetooth 4.0 and later can communicate via the Nordic nRF51822 SoC which hosts a specially written Bluetooth Profile and Services, courtesy of the Bluetooth SIG.

“Not only does Bluetooth low energy mean I can sit on the bus and write my program on my smartphone, and transfer it directly to the micro:bit, but I can also get the micro:bit talking to and controlling the smartphone,” explains Baker.

Get ready for the IoT

Although the micro:bits are almost fully rolled out to the first target group, this isn’t the end of the project. The micro:bit hardware is now on sale to the general public through Farnell element14 and several other retailers and there will be add-on kits available from partners like Kitronic which will incorporate additional sensors and other learning materials. The micro:bits might also eventually be able to transfer data between each other, using the nRF51822 SoC’s proprietary radio functionality.

Another potentially exciting development is that the BBC is working with Nominet (the U.K. web domain name registry) to get micro:bits connected to the wider Internet, using a Raspberry Pi or smartphone as a gateway. Internet connectivity will effectively make a million-plus micro:bits a genuine part of the Internet of Things (IoT). The micro:bits can then act as sensor or actuator nodes for the Raspberry Pi or smartphone, connected via Bluetooth low energy, a USB cable or through the edge connector.

“The micro:bit is not just a tool to help kids code, it’s a tool to help kids get ready for the IoT,” Baker says. His view is that comparable to the microcomputer revolution in the 1980s, the IoT is the next technology revolution our society faces. “The micro:bit is absolutely about building IoT technology, it’s about experimenting with building things for the new world, and having the opportunity to do that,” he says.

ULP Wireless Q now available on Apple iPad and iPhone, Android tablets, and Amazon Kindle

Nordic Semiconductor’s ULP Wireless Q keeps you up to date on everything that’s happening in the Bluetooth Smart, ANT+, and proprietary ultra low power wireless technology sector.

The Apple iPad version of ULP Wireless Q (tinyurl.com/WQipad) is now joined by iPhone, Android (tinyurl.com/WQandroid), and Amazon Kindle (tinyurl.com/WQkindle) versions.

The digital version of ULP Wireless Q is designed to make the most of tablet devices’ large high-resolution display, and includes all the interactivity you’d expect, including links back to relevant articles archived on the Nordic website, new product releases, analysts’ information, blogs, videos, and much more.
ANT WIRELESS UPDATE

A decade of collaboration

Kat Kent looks back over ten years of successful and productive cooperation between ANT Wireless and Nordic Semiconductor

The ANT RF software protocol ('ANT') was developed in response to a need to wirelessly transport data, using very little battery power, from a footpod to a device such as a sports watch. Invented by Dynastream Innovations, based in Cochrane, Alberta, ANT was launched in 2003.

During those early years Dynastream worked closely with Nordic Semiconductor to develop silicon solutions that would bring ANT to life. The result of that collaboration was Nordic’s nRF24AP1, launched in 2005 and comprising a 2.4 GHz silicon radio running ANT. The transceiver was designed to work with a separate power-efficient microprocessor.

In 2006, Dynastream was acquired by Garmin Ltd, the U.S.-based company best known for its navigation devices and sportswatches. ANT was a strategic technology employed by the Garmin ‘Edge’ series of bike computers and ensured interoperability with peripheral wireless devices — such as speed, cadence, and power sensors — from a wide range of companies. ANT quickly became a de facto wireless standard for the cycling sector including the elite riders of the Tour de France.

2007 saw the formal creation of the ANT+ Alliance, a group of companies committed to developing standardized and interoperable ANT+ products. 2008 saw the first ANT+ Symposium, an annual event hosted by Dynastream and sponsored by Nordic Semiconductor that continues each fall in the Canadian Rockies. ANT+ Alliance Members form technical working groups to focus on the solutions needed for their products and industry sectors. The collaboration between cycling companies has strengthened over the decade, with an impressive list of standards released. ANT+ Bike Speed and Cadence (2007), Power (2007), and Heart Rate (2008) Device Profiles were released shortly after the alliance was formalized. These device profiles were followed by Light Electric Vehicle (2011), Suspension (2014), Seatpost (2015), Bike lights (2015), Radar (2015), and Shifting (2016).

2009 saw the launch of the Nordic nRF24AP2 single-chip ANT solutions in both single channel and 8-channel variants. The cost-optimized single channel variant was used for ANT+ sensor products, while the 8-channel variant allowed products such as bike computers and sportswatches to synchronize with eight sensors concurrently.

Nordic brought an improved silicon technology to the new chip design, significantly lowering the purchase price, and taking 20 percent off the nRF24AP1’s peak current draw. For its part, Dynastream added several key features to ANT: for the nRF24AP2’s release: proximity search, continuous scan, and frequency agility.

Nordic’s flagship nRF52832 SoC platform that offers customers ultra-low power protocol options, like ANT, to solve our mutual customers’ unique connectivity use-cases,” says James Fujimoto, Director of ANT Wireless. “We highly value our partnership with Nordic, a partnership that has successfully brought ultra-low power connectivity solutions to market, and we look forward to many more years of successful partnering.”

Today, ANT has evolved into a technology for high node count networks that require low power operation across the network. Being highly configurable, ANT can be used to form point-to-point, broadcast, shared, and a variety of mesh network topologies that operate as part of proprietary network designs. ANT+ continues to lead the way in standardized solutions for the cycling sector, is strong in the fitness industry where high node count coexistence and manufacturer interoperability is key, and is a key player in the developing field of advanced running sensors.
### Ultra low power wireless connectivity solutions

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

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**Note:** The table above provides a comprehensive list of Nordic ICs, their operational bands, wireless protocols, on-chip peripherals, on-chip memory details, and application areas. Each entry is accompanied by the availability of development tools and reference designs, catering to the needs of various industries including sports & fitness, consumer electronics, automation, healthcare, wireless charging, and smart home. The table also highlights the availability of single board development kits and evaluation kits, catering to the needs of prototyping and testing stages.

**Source:** Nordic Semiconductor

**Links:**
- [www.nordicsemi.com](http://www.nordicsemi.com)

**Additional Information:**
- Nordic’s ULP wireless product selection guide offers a detailed listing of every Nordic product, with a focus on ultra-low power wireless connectivity solutions, allowing users to find the chip that best suits their needs.
- The guide provides information on IC type, operating band, wireless protocol, on-chip peripherals, memory details, and applications, along with availability of development tools and reference designs.
- For more detailed information, users are encouraged to visit the Nordic Semiconductor website or contact their local sales representative.
The thriving Maker community owes a big debt to Hernando Barragán.

In 2004, the Colombian created an electronics development platform called “Wiring” for his Master’s thesis while studying at the Interaction Design Institute Ivrea (IDII) in Italy. His goal was to create low-cost, simple tools for non-engineers to develop digital projects. The Wiring platform comprised a PCB using an Atmel Atmega128 microcontroller and an Integrated Development Environment (IDE) to ease programming.

To reduce platform cost, Gianluca Martino led the design of a new platform based on a cheaper Atmel microcontroller, the ATmega8. Massimo Banzi, together with David Mellis (another IDII student) and David Cuartielles, ‘forked’ the Wiring project software and added support for the new board. They christened their board and their software fork “Arduino” (named after a bar in Ivrea which in turn was named after Arduin of Ivrea, who was King of Italy from 1002 to 1014).

Arduino hardware and software were ‘open source’, available via a public license (“open source”, as defined by the Open Source Hardware Association (OSHWA), is “hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design”).

In the ensuing decade, Arduino has forged a sustainable ecosystem beloved of the maker and developer community. That ecosystem comprises a range of single board computers (SBC – now based on processors from several major vendors in addition to Atmel), expansion boards, software libraries, an easy-to-use IDE (which encourages the use of license-free design tools), and a worldwide development community dedicated to sharing information, software, and technical solutions.

Makers are a growing global grouping of spare-time designers, hobbyists, and amateur engineers (see ULP Wireless Q Winter 2014 pg16) who use their spare time to construct fun, often useful, and occasionally commercial, devices from electronics, mechanical components, and plastic packaging.

One U.S. maker association estimates that around 75 percent of its members base the electronics for their projects on Arduino and other open-source hardware platforms, while most of the others build their own SBCs from schematics detailing Arduino hardware.

Actual numbers are hard to find, but anecdotal evidence from organized gatherings such as “Maker Faires” across the world seem to confirm this estimate. That makes for a lot of Arduinos in the wild, approaching one million according to recent calculations.

Lowering the shields It hasn’t taken long for the maker community to latch on to

Arduino readies for the IoT

The world’s most successful open-source ecosystem has embraced native wireless connectivity. ULP Wireless Q finds out the reasons why
At the heart of the Arduino Primo lies a Nordic nRF52832 SoC

“Developers familiar with the Uno wanted an Arduino that enabled them to design IoT applications without the need for shields”
Over the horizon: what next for the semiconductor industry?

The Internet of Things and open source hardware are the great hopes for a revitalized semiconductor industry. ULP Wireless Q reports...
Industry experts appear to agree. The report cites Morgan Stanley analyst Mark Edelstone who predicts the IoT will “drive semiconductor demand for years” as it evolves from networked consumer electronics products, to networked industries, and beyond to “networked everything”.

It’s a prediction firmly backed by Nordic Semiconductor,

“Nordic is already the leader in the Internet of ‘my’ things, but the bigger opportunity is in the Internet of Things around us.”

Svenn-Tore Larsen, Nordic’s CEO, who used the word, “preaching the IoT almost before from the top down. “I’ve been firmly believe in that number. people might be skeptical but we believes there will be more than

HBr [Harvard Business Review] massive opportunity for wireless. CEO. “We all know the IoT is a www.nordicsemi.com

Open source hardware could be the final frontier for the semiconductor sector

“We are more concerned with realizing true automation than the presentation of big data, and we are a subscriber to the philosophy that the IoT should operate without screens,” continues Hannevik. “We believe successful IoT systems should take action based on set-policies rather than having to ask humans for decisions for every action.”

The Rambus and GSA report claims another possible solution to the semiconductor sector’s growth predicament may be to take a lead from the software industry’s trend towards open source. The report quotes Eric Weddington, an open source architect for GPS technology vendor, Trimble, who claims “integrated circuits could be the final frontier of open source.”

Inspired by open source

The report notes several hardware initiatives inspired by the open source concept have launched in recent years, primarily for students, hobbyists, and independent developers, or makers. Among the leaders of the Maker Movement is Arduino, an open source platform for developing microcontroller-based prototypes.

Arduino recently launched a low cost IoT-targeted programmable single board computer (or ‘base board’) called the Arduino Primo (see this issue pg3 and pg16), at the heart of which sits Nordic’s nRF52832 System-on-Chip (SoC).

“It has been estimated that the number of connected devices worldwide will increase from today’s approximately 15 billion to 200 billion in 2020,” says Federico Musto, CEO & President of Arduino S.r.L. “These numbers are astonishing … makers, entrepreneurs, small and large companies, kids, and venture capitalists are paying close attention, and the playing field is very broad. From smart homes, to data analytics, to security, the applications are endless.”

“One of Nordic’s strategies is to closely support the maker and hobbyists communities so that they can painlessly incorporate Bluetooth low energy wireless connectivity into their electronic development projects,” comments Geir Langeland, Nordic’s Director of Sales & Marketing. “Because Arduino-based electronics make up around 70 to 80 percent of amateur engineers’ projects, it was an easy decision when Arduino asked us to supply the nRF52832 SoC to form the heart of its first native Bluetooth low energy wireless base board.”

Indeed the future of the semiconductor sector looks bright, notwithstanding the set of challenges it, as any industry in its relative infancy, faces. The IoT looms as a potential ‘killer app’, while forward thinking companies look to tap into new markets slowly, but increasingly, built on open source. Collaboration will be key, but semiconductor companies know it, and are progressively embracing innovation models built on interdependence, as the sector as a whole moves towards a sustainable and bright future.

Rambus and GSA’s “Charting a New Course for Semiconductors” report is available from the GSA Global website at gsaglobal.org.

Open source hardware could be the final frontier for the semiconductor sector
For most people, utopia is a world without wires. No more rat’s nest of cables behind equipment or in drawers, no trailing wires to trip over while charging phones or laptops, and no cables to lose or leave behind in hotels, offices, and homes.

Such a vision goes some way to explain why awareness of wireless charging is growing. More than three quarters (76 percent, an increase of 36 percent since 2014) of respondents to a consumer survey (Wireless Charging Consumer Insights Report) conducted by analysts IHS in June 2015 had heard of wireless charging technology. However, just 20 percent of respondents made use of the technology, and only 16 percent employed it on a daily basis.

Why is wireless charging, which is as simple in concept as placing a smartphone, tablet, camera, or smartwatch on a charging pad or mat, not already ubiquitous? Part of the reason is because, like consumers, the industry itself is still getting its act together. Groups championing various standards have realigned themselves recently with the merger of the Alliance for Wireless Power (A4WP) and the Power Matters Alliance (PMA) last year to form the Airfuel Alliance – tasked with promoting consumer-friendly wireless charging and its ecosystem. Another standards body is known as Wireless Power Consortium (WPC). (See ULP WQ Spring 2016, pg11.)

To make matters even more complex, there are two established wireless charging technologies, inductive and resonant. The Airfuel Alliance primarily promotes resonant charging (under the ‘Rezence’ specification), while the WPC touts its inductive charging standard known as ‘Qi’ (pronounced “chee”).

Charging technologies

Resonant wireless charging uses two coils tuned to resonate at the same (relatively high) frequency. The oscillating current generated by the primary coil (in a charging pad) creates an oscillating magnetic field, which induces an alternating current in the secondary coil (the receiver, housed in the device to be charged) that can be used to do useful work such as charging a battery.

Inductive charging is also based on two coils, but the transmitter and receiver coils are tuned to (slightly) different relatively low frequencies. Again, the alternating magnetic field generated by the transmitter coil is converted to electrical current by the receiver.

With inductive charging, the transmitter has to be precisely aligned with the receiver for efficient charging to take place. As a result, the range is limited to between 2 to 10 mm, and each receiver coil can only power a single transmitter coil. Resonant charging is more flexible, with charging over a distance of up to 50 mm, and without the need for the coils to be precisely aligned or even parallel to each other. In addition, each primary coil can power several secondary coils.

Inductive charging is markedly more efficient than resonant technology, but this is countered by resonant charging’s convenience of a wider field, the ability to charge through surfaces, and the capability to charge multiple devices simultaneously.

The commercial lines are becoming blurred as the most recent WPC Qi receivers (built into mobile devices) can operate in both inductive and resonant mode. The operation mode is defined by the transmitter. The Airfuel Alliance is also working to incorporate both resonant and inductive technologies into a single certification to accelerate commercialization of its wireless charging.

“The playing field is quite open, and a first, ‘killer app’ is needed,” says John Leonard, Product Marketing Manager with Nordic Semiconductor. Adding intelligence using a control loop, managed by Bluetooth low energy wireless technology such as that supplied by Nordic could
produce such a differentiating application.

Unlike Qi, in which charging pads are live all the time, the Airfuel Alliance technology uses Bluetooth low energy wireless connectivity to periodically check if a mobile device is present and needs charging. The bidirectional wireless link between the transmitter and receiver coils allows a Power Transmitter Unit (PTU) to ‘advertise’ for a Power Receiving Unit (PRU), such as a mobile or smartwatch. When detected, the PTU communicates with the PRU over the wireless link. In this way, the PTU engages the charging sequence, determines how much charge is required, and any other PTUs in the vicinity that have detected the PRU can return to sleep mode.

This power saving feature could be critical, says Leonard. “While generating a field may not be significant, it still consumes energy,” he points out. If multiple PTUs are placed in a single area for convenience (for example, an office), only the one closest to the PRU needs to be active.

Bluetooth low energy technology’s communication between the PTU and PRU also controls the charge. The PRU can signal when, for example, it is 80 percent charged and the remainder of the charge can be scaled down to avoid overcharging – a significant feature considering the dangers of overcharging the fragile lithium-ion batteries at the heart of today’s consumer electronics devices.

Leonard believes that the ability of the Airfuel Alliance’s resonant charging technology to penetrate through surfaces, such as a wooden desk, marks the first wave of innovation. Because of resonant charging technology’s wider field, the device to be charged does not have to be precisely aligned with the transmitter. The transmitter pad does not even have to be visible, it can be embedded in worktops or furniture. This opens up opportunities for designing in a PTU to a work surface and simultaneously charging a smartphone, tablet computer, and a smartwatch, for example. A single PTU can simultaneously wirelessly charge several devices, in part due to the multichannel communication support of chips such as Nordic’s nRF51822 Bluetooth low energy solution. Nordic has released a version of the System-on-Chip (SoC) with a special protocol stack (an ‘S120 SoftDevice’) which enables a PTU to independently supervise up to eight charging devices. When used with the company’s nRF51 Wireless Charging Software Development Kit (SDK), the SoC and SoftDevice enable developers to design resonant wireless charging applications for multiple devices.

Support for Bluetooth low energy-enabled wireless charging continues at Nordic, explains Leonard, with a reference design planned for release this summer. The design will address the layout of charging chips supplied by third parties, as well as software to adapt designs to specific requirements.

Future ambitions
The ease and convenience of resonant charging opens up many design possibilities. Charging in the proximity of a PTU with Bluetooth low energy control means that wireless charging can begin almost without the user thinking about it. The scope for embedding PTUs into work surfaces or furniture in the home or office appeals to the aesthetics of interior design and is practical for users. Leonard cites a future scenario of being able to place a recipe book over a transmitter embedded in the work surface and still wirelessly charge a device without interruption while preparing dinner.

For medical environments, eliminating cables will increase safety and convenience, and also contribute to maintaining sterile environments by minimizing contact.

Resonant charging in cars will also be convenient and practical. As there is no need for precise alignment, even if bumps in the road dislodge the mobile, charging continues uninterrupted. During the Consumer Electronics Show (CES) 2016, there were announcements around wireless charging, some designed to bridge the gulf between WPC’s Qi and the Airfuel Alliance’s standards. NuCurrent, for example, introduced circular antennae supporting both standards, and Convenient Power announced the industry’s first Rezence v1.3-certified wireless charger.

Wireless charging is even progressing to the automotive sector, with Mercedes announcing that its next-generation Mercedes S-Class Plug-in Hybrid Electric Vehicle (PHEV) will use wireless charging for its batteries from summer 2017. So it seems that while progress thus far has been slow, the proclamation from analysts IHS that “2016 is set to be a great year for wireless charging technology designers and electronics manufacturers alike”, appears to be well founded. The consumer will soon start to see the benefits when convenient, intelligent, and energy-efficient wireless charging is integrated into mainstream devices to accelerate deployment and design innovation.
Tangram Factory Smart Rope

This smart jump rope not only counts the number of successful rope jumps but also displays the total in the user’s line of sight.

According to WinterGreen research the market for smart sports and fitness devices is set to grow from $3.5 billion in 2014 to $14.9 billion in 2021, as better technology and superior data gathering capabilities drive adoption. The Tangram Factory Smart Rope, for example, provides an extensive dataset for post-workout analysis via the complementary app on the user’s smartphone.

Rope jumping is one of the most physically taxing activities, with three 10-minute sessions per day burning upwards of 400 calories. By comparison engaging in high impact aerobics, basketball, rowing, squash, swimming, or cross country skiing for a similar length of time would burn less than 300 calories.

Alaskan-born Peter Nestler holds a number of extreme jump rope records including most rope jumps on a unicycle in one minute, most rope jumps while keeping a soccer ball in the air in one minute, as well as most jumps while wearing flippers, and most underwater rope jumps. He also holds the most rope jumps in one hour record with 12,702 jumps - an average of 3.5 jumps per second.

Smart Rope’s proprietary sensors detect full 360-degree revolutions of the rope, tracking them as successful jumps. The rope itself is embedded with 23 LEDs in a flexible printed circuit board (FPCB) design, that display the number of successful jumps in the jumper’s line of vision.

Tangram Factory’s Smart Rope employs Nordic’s nRF51822 System-on-Chip (SoC) to provide Bluetooth low energy connectivity to smart devices. Powered by a 300-mAh Li-polymer battery, the Smart Rope can be used for up to 36 hours between recharges.
Hi, I’m Chris Hansen and I joined Nordic earlier this year to manage the company’s new Internet of Things (IoT) Labs Group based in Portland, Oregon, U.S. I previously worked at Intel Corporation where among my many responsibilities I served on the Bluetooth SIG Board of Directors. The Board role was interesting but being an engineer at heart I also joined the technical Core Specification Working Group. That’s where I learned about the technical details of Bluetooth wireless technology.

I think my biggest contribution to Bluetooth was being the Chair of the Board during the establishment and development of Bluetooth 4.0 that included Bluetooth low energy as a hallmark feature. It was a challenge from both a technical and organizational perspective because it involved balancing the needs of member organizations and target applications, many new to Bluetooth technology.

Nordic’s IoT Lab was formed to enable the company’s devices to become integral to the tremendous growth of the IoT. The initial focus is on helping developers to connect to the Internet as easily as possible. The IoT has the potential to be a game changer for the wireless market because the capacity of the internet is going up while the cost is going down. Simultaneously, there are countless devices in homes and businesses that can benefit from low-cost wireless connectivity, monitoring and control.

Today, the same processes are in motion in the IoT that happened in computing over the last 30 years. Not only does this make the future of the IoT exciting, it also adds the potential to create new IoT business opportunities for Nordic in new applications and technologies.

My job is to make this happen starting early in 2017. I predict that there will be impacts on our design tools and developer support, and even on the next generations of our silicon. The team in Portland will be very small so I am counting on help from other groups at Nordic.

I’m an easy person to work with and promise to bring beer from Portland on my frequent trips to Oslo in an attempt to win friends and influence people!

Outside of work I enjoy outdoor activities such as hiking and skiing. Oregon is a great place for both. The Cascade Mountain Range is an hour’s drive east of Portland with its prime ski areas and thousands of miles of hiking trails. West of Portland is home to many established hikes that overlook the Pacific Ocean.

Did I mention beer? It’s not a coincidence that the new Nordic office is situated in the ‘brewery blocks’ of Portland given that the first employee here got a say in the location!

Indoors, I like to relax by fixing and restoring things. Later this year I’ll be restoring a 1970 Ford Mustang Fastback with my 14-year old daughter. But my ongoing passion is designing and repairing old vacuum tube amps. Ebay is a great place to buy old amps. My wife gets upset every time Fedex shows up with another new amplifier. She says I have enough littering the house already, but I know what she really means is it could and should have been another surprise gift for her! I guess after 22 years of marriage I’ve still got a bit to learn.

“The same processes are now in motion in the IoT that previously happened in computing. This makes the future exciting with the potential to create new opportunities for Nordic”
A decade of ultra low power wireless

2006 to 2016
Building a billion-dollar IoT company: Bluetooth low energy is just the beginning

The last ten years and the next decade encompass Nordic Semiconductor’s IoT strategy. At the midpoint, Nordic’s CEO, Svenn-Tore Larsen, takes stock over the past ten years, Nordic Semiconductor has transformed from a little-known supplier of sub 1 GHz and 2.4 GHz proprietary ultra low power chips into the largest Bluetooth low energy solutions provider in the world. Such a change resulted in Nordic being voted 2015’s ‘Outstanding EMEA Semiconductor Company’ by the Global Semiconductor Alliance.

But what’s behind this meteoric rise and will the company be able to sustain it? Svenn-Tore Larsen, Nordic’s CEO for the past 14 years, thinks so; he’s predicting the company could become a billion-dollar Internet of Things (IoT) giant in just a few years from now.

“Between making a decision and seeing if it plays out, there will often be years of sleepless nights, on-going investment with no revenue, criticism and doubt from concerned investors and analysts, and frankly a lot of tedious and exhausting work to be done. But you have to have faith that it will pay off.”

Handsome pay off

Part of what Larsen refers to is the decision by Nordic to back Bluetooth low energy technology. Entering the sector required the company to overcome enormous financial, technological, and commercial challenges. “It was almost six years between the birth of [Bluetooth low energy technology’s forerunner] Wibree in 2005 [a technology adopted by the Bluetooth SIG in 2007] before the first products and any revenues,” Larsen explains. “Six years waiting to see if a strategic decision transitions into a commercially viable technology is a lifetime in this business.”

“But eventually it paid off handsomely,” he continues. “However, today we face greater challenges to growth than ten years ago.”

Larsen explains that while outsiders regard Nordic as a pure Bluetooth low energy company, it’s actually been at the forefront of the Internet of Things (IoT) for more than a decade. “The IoT can be traced all the way back to the world’s first wearables in 2004: [Nordic chip-based] Suunto t6 sportswatches with wireless heart-rate, speed & distance monitors, and a computer dongle,” says Larsen. “These were the IoT in miniature PAN [personal area network] format, but nonetheless comprised wireless sensors bringing data from the real world to the Cloud: albeit a ‘Cloud’ which then comprised little more than a computer with Internet access.”

Larsen continues: “Bluetooth low energy expanded this further by allowing a network of wireless sensors to talk to a smartphone. This is heading towards a wireless sensor network able to deliver data to the Cloud from anywhere in the world via a global ecosystem of wireless WANs [wide area networks]. “This technology will be needed by governments, organizations, and individuals which are being forced to do more with less. Countries face unprecedented challenges, such as aging populations and diminishing workforces. The old economic and business models just aren’t going to be sustainable or viable anymore.”

Larsen says this technology will be massive in scale: global and ubiquitous; simple to use making it applicable to the mass-market; low cost; simple to install and maintain, and battery operable. Such a technology will make it possible to bring economies of scale, automation, and optimization to everything.

The IoT is the game changer

“The IoT will enhance every aspect of how we live, work, and play in the coming years. That’s the real promise; the game changer,” Larsen explains. “So to me the IoT is inevitable. It will also be orders of magnitude bigger than Bluetooth low energy is today, but will be impossible to achieve without that technology, making Bluetooth low energy ubiquitous. But the IoT will require much more than Bluetooth low energy to operate.”

Nordic’s recent recruitment of highly-talented cellular RF engineers [formerly employed by the Finnish arms of Nokia, Ericsson, Motorola, and Broadcom] represents an ambitious bet on a Bluetooth low energy-based cellular WAN solution that Larsen believes will become a fundamental part of the IoT.

“Nobody has more ultra low power wireless engineering expertise or is investing so much revenue in developing the perfect IoT solution than Nordic,” he concludes. “The last ten years and the next ten years are all part of the same story; the only difference from a decade ago is that we now know we’re only half way towards our aspiration to become a world-leading IoT company.”

“Between making a decision and seeing if it plays out, there will be years of sleepless nights, investment with no revenue, and criticism and doubt from investors and analysts, plus a lot of tedious and exhausting work. But you have to have faith”

SVENN-TORE LARSEN, CEO, NORDIC SEMICONDUCTOR
A decade of ultra low power wireless

From Wibree to IoT: ten years of development in ULP wireless connectivity

In June 2006 Nordic Semiconductor mapped out a strategy to be a leader in a new, interoperable form of ultra low power wireless technology which was to become Bluetooth low energy. Today that strategy has played out and the company now sets its sights on the Internet of Things. Here are some of the milestones passed on the way.

The last decade has seen Nordic Semiconductor progress from a small niche company to the leader in ultra low power (ULP) wireless connectivity. Back in 2006, the company designed sub-1 GHz and 2.4 GHz transceivers, running proprietary RF protocol software, teamed with separate 8-bit processors; today it dominates in the field of highly-integrated 2.4 GHz ULP multiprotocol Systems-on-Chip (SoCs) sporting embedded 32-bit ARM M0 and M4F processors.

Those early transceivers carved a niche powering wireless mice, keyboards, and sportswatches while today SoCs are found in everything from wearables to home automation, asset tracking to beacons, and audio streaming to wireless charging.

Nordic’s products have found favor with developers of all levels of expertise from senior engineers with giant consumer electronics companies, through junior engineers in start-ups, to makers and hobbyists, and even schoolchildren. And while this product development has progressed, the company’s staff has found time to play key roles in the Wibree Alliance, ANT Alliance, and Bluetooth Special Interest Group (SIG); while management has invested heavily in R&D, sales, support, distribution, and training. There’s even been a little time to enjoy the kudos that comes from winning awards for innovative products and making outstanding contributions to the chip industry. This timeline recalls key product, application, and business milestones from the last ten years as the company looks forward to a new decade dominated by the IoT.
CD quality wireless audio

Flexible, full-color technology platform of new Nordic nRF5 Series provides lightning fast measurements, enabling new possibilities.

Dime-sized USB dongles

The nRF24L01 chip has found many uses in the world of digital photography, from tiny PC peripherals to video surveillance systems. 180 Mbps transmitted speed means that pixel values can be transferred over a wireless link in a matter of seconds.

Wireless initiative

Nordic announced the acquisition of Infinera’s wireless division, known as the first step in its bid to become a key player in the ultra-low-power wireless market.
ULP wireless pioneer’s past builds toward an IoT future

After a decade developing Bluetooth low energy technology, three senior Nordic executives tell how the company is using that experience to build its next platform, ultra low power wireless connectivity for the IoT

Bluetooth low energy technology’s success looks like it was always assured. But ten years ago no one could be certain if the fledgling technology would catch on. A similar situation is now emerging with the IoT.

“The IoT is a race to win the battle of the Cloud-connected socket,” says Svein-Egil Nielsen, the company’s CTO. “Wiring is expensive to install and maintain so the sockets will be wireless. Success will depend on how many things a device can connect to and how easily and cost-effectively it can do that. Standards aid both those factors, that’s why standards will be fundamental to the IoT.

“But nobody knows which of several wireless standards is going to dominate. Nordic is developing what it thinks will be a game-changing IoT technology based on Bluetooth low energy wireless, but we’re not naïve or arrogant enough to think that automatically qualifies us to hit a home run. Sony, for example, thought a technically superior Betamax would win over VHS, but we know how that one played out.”

“Nobody really knew if Bluetooth low energy was a viable technology in its early days either,” reflects Nielsen, who apart from his senior role with Nordic was also Chair of the Bluetooth SIG from 2011 to 2013. “Before Bluetooth low energy, ‘classic’ Bluetooth had only proven itself in wireless data transfer between mobile devices, audio, and [less well known] wireless payment terminals used in retail. There were no guarantees for the low energy version.”

However, according to Geir Langeland, Nordic’s Director of Sales & Marketing, one thing the company was confident about was that a low energy form of Bluetooth would be based on an ultra low power [ULP] wireless technology similar to that which Nordic had pioneered in the early 2000s. Nordic’s technology consumed little power because the radio devices slept for most of the time - waking up very quickly to send data, and returning to sleep as soon as possible. Such techniques allowed the company’s technology to operate for months from batteries as small as the coin cells found in watches, while also offering good bandwidth.

“Long experience gave Nordic a technical and commercial edge in the ULP sector,” says Langeland. “So we made the decision to promote Bluetooth low energy technology like crazy, while investing heavily in R&D to ensure the products would lead their class. The result of this ambitious program was the first commercial Bluetooth low energy chip in 2010 [nRF8001], intensive developer training, and continuously evangelizing to the world how great Bluetooth low energy was for enabling battery-powered wireless applications that weren’t previously viable.”

Such an ambitious strategy wasn’t easy for a small, relatively unknown Norwegian company with a track record solely in proprietary ULP wireless technology to pull off.

“It did feel like the established Bluetooth technology semiconductor players dismissively laughed at our aspirations to break into the sector,” recalls Thomas Embla Bonnerud, Nordic’s Director of Product Management.
"It did feel like the established Bluetooth technology semiconductor players dismissively laughed at our aspirations to break into the sector. But they’re not laughing now!"  

THOMAS EMBLA BONNERUD Nordic’s Director of Product Management
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