ultra low power
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QUARTER 1 | **SPRING 2016**

COVER STORY

Wireless tech unmasks skiing's secrets

Nordic claims prestigious award

IoT stimulates new business models

Subarctic Silicon Valley thrives

NORDIC
SEMICONDUCTOR

OPINION

Svein-Egil Nielsen

Finnish talent strengthens Nordic's engineering team

High-tech companies around the globe face the same challenge. And it's a challenge that directly threatens continued success and a buoyant bottom line. Finding the highly-skilled and innovative engineers needed to develop existing products and create new ones is tough.

At Nordic we realized long ago that engineering talent was the lifeblood of the company; for example, over 80 percent of our employees are engaged in research and development (R&D). We are continually looking for the best engineers to refresh and grow our team. We collaborate closely with academic institutions such as the University of Technology in Trondheim in an effort to attract newly-qualified engineers to our ranks. The collaboration includes employing undergraduates on summer break assignments, and assisting Masters students with their theses. It has resulted in a steady stream of skilled individuals keen to hone their engineering skills under the guidance of Nordic's experienced staff.

But our demand for engineers is such that the supply from universities is insufficient for all our needs. To fill the gap, we've encouraged applicants from all over the world to apply for posts here in Norway, with a good degree of success. In our hardware and software development groups we now have engineers from scores of countries. A fortuitous side effect of this global recruitment drive is that different cultures have unique approaches to solving problems. For example, where a Norwegian-, British or U.S.-educated engineer is sometimes constrained by their formal training to adopt a strict methodology to solve a technical problem, an Indian engineer might take an "out of the box" approach and come up with the solution. The next day, the Western-trained engineers might be the ones that solve a tricky problem with which their Asian counterparts have been struggling.

While Nordic wouldn't attempt to recruit engineers directly from competitors, it does track what's happening in those companies in case, in the unfortunate event of a restructuring, talented individuals come on to the market. Such a situation occurred in 2014 when Nokia, Broadcom, and Ericsson looked to consolidate their operations in Finland resulting in a pool of highly-experienced engineers looking for their next career move. Our intention was to recruit a few of these people for our Norwegian operation – but we ended up opening offices in Oulu and Turku now staffed with more than 110 engineers. These teams are now working on an exciting new range of wireless products for Internet of Things (IoT) applications that should hit the market in 2018. It's a good result for Nordic, the cities of Oulu and Turku, and, most importantly, the engineers themselves. You can find out more about this in the story on page 16 of this issue.

Yours Sincerely,

Svein-Egil Nielsen
Chief Technology Officer

Contributors

Page 10

Page 16

Page 18

John Leonard is Product Marketing Manager with Nordic. In this issue he explains how the IoT will change how businesses make money

Sally Ward-Foxton is an electronics freelance journalist. On page 16 she explores how the city of Oulu in Finland has reinvigorated its position as a high-tech hub

Kat Kent is a tech journalist and a wireless applications engineer. Here she shows how cyclists' expectations are leading to better wireless products

NORDIC
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2.4 GHz | Sub 1-GHz | Bluetooth | ANT+

nRF52832 Bluetooth Smart SoC enters mass production

Nordic Semiconductor's nRF52832, the most advanced Bluetooth Smart System-on-Chip (SoC) available on the market today, has entered mass production and includes previously unannounced features.

The nRF52832 is certified to the latest version of the Bluetooth specification and the Bluetooth software protocol includes a new 'LE secure connection' capability that supports encrypted wireless communications. Device Firmware Upgrade (DFU) security has also been enhanced.

A new flexible RAM scheme allows developers to optimize how much memory is used by the software protocol for any given configuration, and the chip features concurrent multi Master-Slave network support. The latter feature allows, for example, a smartwatch to act as both a hub to other wireless sensors and as a

Nordic's new nRF52832 has now gone into mass production

wireless peripheral to a smartphone at the same time.

The nRF52832 marries barrier-breaking performance to power efficiency, offering new levels of design flexibility, and includes an on-chip NFC tag for consumer-friendly Touch-to-Pair. It also features a category-first 64MHz ARM Cortex-M4F processor, a high performance, low power 2.4GHz multiprotocol radio, and automatic power optimization.

"Current single-chip Bluetooth Smart solutions are struggling to

keep up with the rate of innovation in Bluetooth Smart – the fastest growing wireless market in history – particularly in applications such as wearables and IoT," says Kjetil Holstad, a Product Manager with Nordic. "[However] the nRF52832 redefined the Bluetooth Smart single-chip category when it was announced in June last year and no competitor has launched anything to match it since," adds Nordic Product Marketing Manager, Pär Håkansson.

Mesh solution supports hundreds of sensors

U.S. based Internet of Things (IoT) solutions provider, Delphian Systems, has specified Nordic's nRF51422 multiprotocol ANT and Bluetooth Smart Systems-on-Chips (SoCs) in what is said to be a fully developed, ready-to-design-in, Class-1 certified wireless mesh network IoT solution.

Known as SecuRemote Smart, the system comprises cellular (2G CDMA) and Ethernet-based Cloud connectivity bridges, a device management portal and, according to Delphian, unique iOS/Android smartphone control via Bluetooth Smart. SecuRemote is also said to employ an end-to-end data encryption layer along with additional levels of access security via a cloud services portal.

SecuRemote features two modules. The SRU232 long-range module is designed for AC powered use and has a range of up to 300m. The SRU233 short-range module is intended for battery use and has a range of up to 100m. Both modules incorporate a Nordic S310 SoftDevice

SecuRemote Smart is smartphone compatible

(software protocol), are FCC / IC approved, and according to Delphian offer an industry-best +10dBm radio output power.

"With SecuRemote Smart, we took the OEM's perspective that a complete IoT solution should be easily adapted and customized by enabling the customer's use-case-specific sensors and data analytics," says David Baughman, Business Applications Development Manager of Delphian Systems. "The firmware allows the modules to automatically form a self-healing mesh network of up to 250 sensor devices."

In brief

IOT gateway starter kit

The Bluetooth Special Interest Group has released a new architecture and supporting toolkit that enables developers to quickly create Internet gateways for Bluetooth products. Bluetooth gateways allow any Bluetooth sensor to relay data to the Cloud and back again. The architecture expands the potential functionality of the Internet of Things (IoT) by giving anyone the ability to monitor and control fixed Bluetooth sensors from a remote location.

Nordic revenue up in Q4 2015

Nordic Semiconductor has reported revenue of $46.5 million during the fourth quarter of 2015. The result represents growth of three percent over the same period in 2014. Sales of Bluetooth Smart solutions contributed $28.7 million towards the result, or 61.7 percent of total revenue during Q4 2015. The result represented an increase of 25 percent year-on-year despite some customers holding off orders in anticipation of volume production of the new Nordic nRF52 Series SoCs.

Bicycle safety profile released

Canadian software protocol developer ANT Wireless has announced the early release for members of its ANT+ interoperable device profile for Bike Radar sensors, a wireless profile supporting radar-based cyclist safety. The new device profile improves cyclist safety by wirelessly transmitting live feedback of the relative distance and speed of vehicles behind the rider and displays this critical information in front of them so they can keep their eyes on the road. (*See this issue page 18*.)

In brief

Logistics analytics platform launched

Turkish supply chain technology company, Tag2Sense, has selected Nordic's nRF51822 SoC for its Tag2Sense logistics monitoring and analytics platform. The platform comprises a wireless data and event logger, bridge, and Cloud platform, allowing logistics companies to monitor a range of environmental variables of goods in transit, transmitting the data in near real time to the Cloud. From the Tag2Sense iOS app on a smartphone, the user can configure the data logger, setting sensor thresholds in seconds.

Wearables use surges in 2016

Nearly 275 million wearable electronic devices will be sold worldwide in 2016, an increase of 18.4 percent from the 232 million units sold in 2015, according to a Gartner Inc forecast. The company said wearables sales will generate revenue of $28.7 billion, and of that, $11.5 billion will be from smartwatches, largely due to Apple popularizing wearables as a lifestyle trend. Fitness wearables, including wristbands and sports watches, continue to increase in popularity, driven in part by U.S. wellness programs.

Managed services boost smart home

ABI Research has projected smart home device shipments to double year-on-year in 2016, as service offerings developed over the past few years provide solid impetus for wider adoption. While hardware sales will continue to drive revenues over the next five years, the company said by 2020 recurring service revenues will account for close to a quarter of all smart home revenues, up from under 20 percent today. This transition is fueled by the growing adoption of managed smart home systems from a range of security, telco, and cable firms.

Bicycle power meter pedal offers world first multiprotocol support

One of the world's top cycling power meter specialists, PowerTap, has unveiled its one-piece power meter pedal. The product employs Nordic's nRF51422 multiprotocol System-on-Chip (SoC) to provide multiprotocol ANT+ and Bluetooth Smart wireless communication to any compatible bike computer, smartphone, tablet, or watch.

The PowerTap pedals are said to provide industry-leading power measurement accuracy and reliability, employing eight strain gauges to measure force, as well as a high precision encoder to measure angular velocity. The PowerTap pedals are calibrated at both high and normal operating temperatures to create a unique and predictable response to thermal changes.

PowerTap pedals provide high measurement accuracy of a cyclist's power output

Targeted at both professional and serious amateur cyclists, the pedals can be swapped across multiple bikes a user might own or train with, and run off an AAA battery to deliver over 100 hours of continuous use, or 60 hours under typical intermittent use conditions.

"In cycling power is the truest measure of your performance," says Justin Henkel, Product Manager at PowerTap. "Our PowerTap pedals are designed to provide unrivaled insight into the way a cyclist pedals and their efficiency in a sport where the tiniest fractions of a second can spell the difference between winning and losing.

"The pedal is a very complex place from which to measure power in cycling," continues Henkel. "The key is being able to measure the forces that are driving the bike forward [force and angular velocity] while limiting the amount of 'noise' from the forces that aren't.
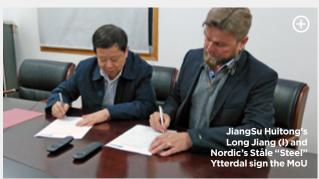
"By combining ANT and Bluetooth Smart technology in a single chip Nordic developed the perfect wireless solution for sports," adds Henkel.

Nordic signs MoU with Chinese Bluetooth Smart remote control company

Nordic has signed a memorandum of understanding (MoU) with China-based Bluetooth Smart remote control manufacturer, JiangSu Huitong Group.

The MoU sees Nordic become JiangSu Huitong's original design manufacturer (ODM) partner for the company's range of smart remote controls based on Nordic's nRF51822 Bluetooth Smart System-on-Chip (SoC), and nRFready Smart Remote 2 Reference Design.

JiangSu Huitong is a global supplier or smart remote controls for a number of major TV manufacturers including Philips, Sharp, and Toshiba, and has developed several models employing the nRF51822 SoC. The smart remotes provide both key press and voice control operation, over-the-air (OTA) firmware upgrades, as well as a range of 'smart' control options including 'air

JiangSu Huitong's Long Jiang (l) and Nordic's Ståle "Steel" Ytterdal sign the MoU

mouse', D-pad gestures, and touch pad control.

Powered by two AAA alkaline batteries, the smart remotes can be used in standard operation for three years via key press control, or eight months with voice control before battery replacement.

"This is a big potential market, and the cooperation with Nordic is a 'win-win' situation for both companies," says Long Jiang, a Director of JiangSu Huitong.

"With strategic help and support from Nordic, Huitong can develop more innovative products quickly ... and can further expand global market share."

"By working closely together, JiangSu Huitong Group's engineers gain a closer insight into Nordic's wireless technology and we enhance our knowledge of the evolving HID sector," says Ståle "Steel" Ytterdal, Nordic's Director of Sales & Marketing – Asia.

Cross country skiing monitor provides real time performance analysis for professionals

Consumer electronics company, Exiops, has launched a Bluetooth Smart cross country skiing performance analysis monitor called SKIIOT, that can analyze skier performance, and track weather conditions in real time.

Primarily targeted towards semi- and professional cross country skiers, SKIIOT attaches to the heel of a ski boot, or lower shin above the ski boot, and measures and records a range of performance-related data.

Information gathered includes air temperature, air pressure, humidity, relative altitude, snow temperature, speed, as well as heart rate (if used in conjunction with a SKIIOT compatible heart rate belt).

SKIIOT employs Nordic's nRF51822 SoC to provide wireless connectivity to the skier's Bluetooth Smart Ready smartphone or SKIIOT compatible smartwatch. This in turn acts as a router to the SKIIOT Cloud service where the data is processed to allow the skier, coaching, and support staff to monitor performance in real time via the SKIIOT app.

Post-ski, the skier or coaching staff can access and analyze a range of data including section performance, slide duration, slip and kick count, as well as compare the performance of

SKIIOT analyzes a range of ski performances data

multiple athletes for coaching purposes.

"With the data SKIIOT collects, everyone is able to access the information of the track, right after the skier has uploaded it. This way, there are no secrets, no mysticism around which wax to put on, or what clothes to wear," says Janne Regelin, Exiops Chief Marketing Officer. "SKIIOT will unveil these secrets."

SKIIOT employs a rechargeable 250mAh Li-Ion battery, which provides up to 40 hours of skiing time between recharges, thanks in part to the ultra low power consumption of the nRF51822. (*See this issue page 14.*)

Nordic launches nRFready smart remote reference design

Nordic Semiconductor has launched its latest nRFready Smart Remote 3 reference design that is said to make the development of advanced Bluetooth Smart remotes as easy as clicking on a list of check box options, minimizing time-to-market and unnecessary design risk.

Targeting remote control OEMs/ODMs and smart TV, set-top box, and digital media device manufacturers, the nRFready Smart Remote 3 reference design is designed to deliver a rich, intuitive, and engaging end-user experience. It employs state-of-the-art voice input and speech recognition control, a six-axis motion sensing 'air-mouse', multitouch trackpad technology, and 39 developer-programmable buttons and legacy IR hardware support.

"One area we have worked hard to optimize is the voice input control," explains John Leonard, Nordic Semiconductor Product Marketing

Developing advanced Bluetooth Smart remotes has been made easy

Manager. "This includes developing a more robust wireless link for audio data, and 20 percent better current consumption

compared to Nordic's previous nRFready Smart Remote 2 solution."

Leonard claims developing advanced Bluetooth Smart remotes using the nRFready Smart Remote 3 reference design has been made easy thanks to a configuration Wizard that works in the Keil development environment.

"The Wizard and underlying software is built in a modular format that has refined the developer element allowing every parameter of the remote to be configured and fine-tuned," explains Leonard.

"This includes function decisions such as whether to employ a track-pad or motion sensing, or specifying the number of milliseconds it takes for the remote to wake-up from sleep mode."

The nRFready Smart Remote 3 reference design employs Nordic's nRF51822 System-on-Chip (SoC) and is designed to work as an add-on for Nordic's existing nRF51 Development Kit.

Module provides up to 50m range

Chinese firm Wireless-Tag Technology has developed a Nordic Semiconductor nRF51822 SoC-based Bluetooth Smart module, the WT51822-S4AT, designed for use in home appliance, intelligent hardware, and industrial applications requiring up to 50m range capability. The module offers a UART port for connection to an external microprocessor or microcontroller, while its 18.5 by 9.1 by 2mm package size is said to be one of the most compact available.

Smart leggings made to measure

Israeli smart clothing manufacturer LikeAGlove has released a pair of smart leggings that help women find the perfect pair of jeans in a fraction of the time. Users don a pair of wireless sensor-equipped one-size-fits-all leggings which take the wearer's measurements, and send the data via Bluetooth Smart to an iOS or Android app on a smartphone. The app then searches a database for the jeans that will be the perfect fit for the user's shape and size.

In brief

Wireless motion platform takes virtual reality gaming to next level

▶ Texas-based Virtuix has unveiled its new Omni virtual reality (VR) motion gaming platform, employing Nordic's nRF51822 multiprotocol System-on-Chip (SoC) to provide wireless connectivity between up to 16 wearable sensor modules and a sensor hub, as well as to Bluetooth Smart Ready devices.

The base of the omnidirectional motion platform is a smooth, concave disc, allowing the user to walk, run, and change direction freely with 360° freedom of movement when wearing a pair of Virtuix Omni shoes with a proprietary low friction shoe sole.

The movement of the user's feet is captured by Virtuix Omni Tracking Pod wireless sensors mounted to the top of the Omni shoes. The Omni Pods are Inertial Measurement Unit (IMU)-based tracking devices employing the Nordic SoC, accelerometer, gyroscope, and a magnetometer to accurately track the movement of each foot.

Up to 16 wearable sensor modules, each powered by an

The gaming platform allows the user to walk, run, and change direction with 360° freedom of movement

⊕

nRF51822, communicate wirelessly with the unit's sensor hub. From there the data is transferred to a wireless headset and to a host application running on a Bluetooth Smart Ready device or via USB cable to a PC.

The Virtuix Omni takes advantage of the nRF51822's multiprotocol capability, using a proprietary 2.4GHz protocol based on Nordic's Gazell software to communicate between sensors and hub, while the hub communicates with the mobile device-powered host application using Bluetooth Smart.

"In a man/machine system like a VR motion sensor, the system's latency needs to be low enough that it isn't perceptible to an average human user," says David Allan, President of Virtuix.

"Bluetooth Smart had the low power, but it didn't support the latency requirement. So we designed our own 2.4GHz protocol based on Nordic's Gazell software with low latency yet with a power consumption comparable to Bluetooth Smart."

Self-balancing vehicle offers remote control function and 20km range

Beijing, China-based short distance transport equipment manufacturer, Ninebot Inc, has released its new Ninebot Nine self-balancing electric vehicle, providing a convenient and fun means of two-wheeled transportation over distances up to 20km.

Employing Nordic Semiconductor's nRF51822 System-on-Chip (SoC) to provide Bluetooth Smart wireless connectivity to both iOS and Android Bluetooth Smart Ready devices, the user is able to remotely control the vehicle from the Ninebot NineDroid app, as well as perform online diagnostics, check speed and distance, and set up parameters for enhanced user control.

The user's smartphone also acts as the 'key' for the Ninebot Nine, automatically locking the vehicle and providing an alarm, and alarm notification to the user,

if the vehicle is tampered with.

The vehicle's built-in gyroscope and weight, position, and speed sensors manage the self-balancing operation, automatically registering the rider's movements to adjust the vehicle's position in order to maintain balance. Powered by a lithium-ion (Li-ion) battery, Ninebot Nine is able to operate for up to two hours and cover up to 20km between recharges, depending on traffic conditions and the weight of the rider. Recharge time is between three and four hours.

Manufactured from an aircraft-grade magnesium alloy, the Ninebot Nine weighs only 12.8kg and the electric motor has a maximum power output of 700W. The vehicle's dynamic power algorithm allows it to comfortably navigate over small obstacles, as well as up hills with a gradient of up to 15 degrees.

⊕

The user is able to remotely control the vehicle from the Ninebot NineDroid app

Cloud-connection accelerates retail beacon adoption

Beacons that are Cloud-connected using a Bluetooth Smart mesh technology are set to reinvent the way the technology is deployed in the retail sector, making them cheaper to maintain, more robust, and more secure than existing commercially available solutions.

Unveiling the beacons at the International Consumer Electronics Show in January, manufacturer Beaconix said that, unlike current generation beacons, Beaconix Smart Beacons are Cloud-connected and controllable, enabling remote firmware upgrades, real time updates and programming, bidirectional communications, asset tracking, as well as sophisticated security measures.

The beacons are interconnected wirelessly using a form of Bluetooth Smart mesh technology. The company's product comes in advance of the Bluetooth Special Interest Group's (SIG) stated plan to introduce mesh networking support for the standard during 2016. (*See* ULP WQ *Winter 2015, pg 10*.) A single Beaconix Controller connects a large group of the Smart Beacons to the Cloud. Each Smart Beacon is independently-controlled and supports both Apple's iBeacon and Google's Eddystone protocols.

A single Beaconix Controller connects a large group of the Smart Beacons to the Cloud

The beacons can be instantly configured from the Cloud to alter the content they transmit, something Beaconix claims is particularly important for beacon networks made available to third party applications.

"Two main showstoppers [for beacons] have been the lack of reliable Internet connectivity in stores, and the cost associated with periodically dispatching technicians to service thousands of beacons. Beaconix's Smart Beacons effectively solve both problems," says Daniel Dreymann, CEO of mobile customer engagement platform, Mowingo.

Disney wants to improve viewers' engagement

Enhanced TV content via Bluetooth Smart

Walt Disney is investigating how it can use televisions that support Bluetooth Smart technology to deliver unique second screen content to multiple viewers watching the same program, according to a recently filed patent application.

The idea could, for example, allow two people watching the same tennis match to receive enhanced content on a tablet or smartphone based on preferences such as their favorite players.

"Televisions are not able to determine [what can be done to] enhance the viewing experience for the consumers," says Disney in the patent application entitled *Enhancing TV with Wireless Broadcast Messages*.

According to the application filed by former Disney Director James Malone, now product manager at Google, a television would be configured to transmit a broadcast message using Bluetooth Smart to any number of mobile devices, which in turn would transmit a request to a server to receive enhanced content from the Internet.

Sensor paves way for sweat-based health monitors

University of California, Berkeley engineers have developed a wearable flexible sensor array that can measure metabolites and electrolytes in human sweat, paving the way for wearable devices that alert users to health problems such as fatigue, dehydration, and dangerously high body temperatures.

Researchers say the device, which wirelessly syncs results in real time to a smartphone, is the first fully-integrated electronic system that can provide continuous, non-invasive monitoring of biochemicals in sweat.

"Human sweat contains physiologically rich information, thus making it an attractive body fluid for non-invasive wearable

The wearable sweat sensor can provide real time feedback on fatigue levels via a smartphone app

sensors," says study principal investigator Ali Javey, a UC Berkeley Professor of Electrical Engineering and Computer Sciences. "We have developed a system that simultaneously and selectively measures multiple sweat analytes."

The prototype developed by Javey and his research team packs five sensors onto a flexible board. The sensors measure the glucose, lactate, sodium, potassium, and skin temperature.

The sensor array uses off-the-shelf silicon components. The researchers developed an app to sync the data from the sensors to mobile phones, and fitted the device onto 'smart' wristbands and headbands.

Nordic takes home prestigious semiconductor industry 'Oscar'

Nordic Semiconductor ended 2015 by winning the award for "Outstanding EMEA Semiconductor Company" at the 21st Annual Awards Dinner of the Global Semiconductor Alliance (GSA).

A GSA Award is one of the semiconductor industry's most respected and prestigious, and often likened to winning a film industry Oscar from the Academy of Motion Picture Arts and Sciences.

The award was collected by Svein-Egil Nielsen, Nordic's Chief Technology Officer (CTO) and former Bluetooth SIG Chairman, at an Awards Dinner that brought together more than 1500 of the world's leading semiconductor company executives to celebrate the annual achievements of the industry and recognize the most successful companies and individuals across 12 categories.

Positioning itself as the premier trade association for the global semiconductor industry, GSA boasts 400 member companies that the organization says account for over 75 percent of the $350 billion of revenues generated by the global semiconductor market in 2015.

GSA provides a global collaboration platform to resolve industry-wide challenges, identify and articulate market opportunities, support and encourage entrepreneurship, and develop comprehensive market intelligence for its members.

Bluetooth Smart pioneer

Headquartered in the U.S., GSA opened its doors in 1994 as the Fabless Semiconductor Association (FSA). In 2007, FSA evolved into the Global Semiconductor Alliance to meet the demands of the worldwide industry. Regional offices were opened in Asia and Europe, and the EMEA [Europe, Middle East, and Africa] Award was added to its by then well-established annual awards program.

Nordic was shortlisted for the Outstanding EMEA Semiconductor Company award primarily because of its pioneering work in the field of Bluetooth Smart wireless technology, in which the

"Nordic Semiconductor was able to become a world leader in a highly competitive space, that of ultra low power wireless products, which is incredibly relevant in a world where everything is connected and everything is mobile, and where power consumption is a key battleground."

Sandro Grigolli, Executive Director for EMEA at GSA

company has been a global leader since the technology's creation as a hallmark element of the Bluetooth v4.0 specification. The specification was in part based on the ultra low power (ULP) wireless technology developed by Nordic during the early 2000s and long before ULP wireless was considered the mainstream technology it is today.

Nordic's continued focus on innovative engineering and large investment in research and development (R&D) enabled the company to build on this technological foundation to maintain a commercial advantage that culminated in record-breaking chip shipments and revenue growth during the 2014/15 financial year.

The financial performance included a more than doubling (123 percent increase) in sales of Bluetooth Smart chips in the first six months (H1) of 2015 compared to 2014, and an over 50 percent increase in large Bluetooth Smart customers during H1 2015.

The period coincided with the successful launch of Nordic's next-generation nRF52 Series Bluetooth Smart Systems-on-Chip (SoCs) in June 2015. The SoCs redefined what was possible with a single-chip by marrying barrier-breaking performance and power efficiency while adding consumer-friendly on-chip NFC Touch-to-Pair functionality. In addition, Nordic commenced operation of two Internet of Things (IoT) targeted R&D divisions in Finland (2015) and Poland (2014); released an IPv6 over Bluetooth Smart solution enabling end-to-end Internet communications to ease IoT development; released an Apple HomeKit solution for Bluetooth Smart; and witnessed shipments of development kits increasing from 7836 in the whole of 2013 to 16,000 in H1 2015 alone.

In naming Nordic Semiconductor Outstanding EMEA Semiconductor Company, GSA also took into consideration the market potential of the

company. This included the fact that Bluetooth Smart is a key enabler of the IoT and that Nordic is successfully targeting a range of new markets that will be enabled by the IoT including the smart home, industrial automation, automotive, asset tracking and management, and retail / point-of-sale systems.

Laying IoT foundations

"Within the global semiconductor industry, companies originating from the EMEA pioneered many of today's largest markets and invented new business models to support them," comments Sandro Grigolli, Executive Director for EMEA at GSA. "This includes the development of IP licensing frameworks which, among other things, laid the foundations for the smartphone revolution; leading-edge analog, mixed signal and RF applications that are proving critical enablers for the upcoming Internet of Things; and advanced automotive manufacturing and design technology that has

Nordic CTO Svein-Egil Nielsen receives the Award for "Outstanding EMEA Semiconductor Company" from Maria Marced (Chairwoman, GSA EMEA Leadership Council & President, TSMC EMEA) and Paul Harvey (Managing Director, Head of EMEA Technology, Bank of America Merrill Lynch).

transformed the functionality and features of modern cars and continues unabated into electric and self-drive vehicles."

According to Grigolli, the EMEA region boasts some of the global semiconductor industry's most recognized names, for example, ARM, Infineon, NXP, and STMicorelectronics. It is also home to success stories like CSR, now part of Qualcomm, Dialog Semiconductor, and Nordic Semiconductor, who have quickly grown into global leaders.

"Nordic Semiconductor is a perfect example of this," Grigolli continues. "A company that was able to become a world leader in a highly competitive space, that of ultra low power wireless products, which is incredibly relevant in a world where everything is connected and everything is mobile, and where power consumption is a key battleground.

"It is interesting to note that last year [2014] Nordic Semiconductor was also selected as a finalist for this award, and it was a close battle ultimately won by Infineon Technologies. What I believe made the difference this year is that the transformational power of the IoT - which Nordic Semiconductor is so well placed to exploit - has grown so obvious that it can be no longer ignored."

"To date, this is probably the highest independent recognition of the success Nordic Semiconductor has achieved as a company," comments Nordic CEO, Svenn-Tore Larsen. "I am immensely proud that Nordic has won this award and similarly proud of the people that have worked so hard to make such an achievement possible."

Larsen continues: "Nordic always puts its technology and customers first. We pioneered the ultra low power wireless category long before it evolved into the global technology that Bluetooth Smart has become.

"I genuinely believe this is still just the start for Nordic Semiconductor and ultra low

power wireless technology in general. There is a wireless revolution taking over the world called the Internet of Things, and Nordic Semiconductor and its wireless technologies are sitting right in the middle of it."

Since the "Outstanding EMEA Semiconductor Company Award" was introduced in 2009, Dialog Semiconductor won the award on three occasions in 2009, 2010, and 2011, followed by CSR, NXP, Infineon, and Nordic Semiconductor. The award finalists and winner are chosen by the EMEA Leadership Council, a group of semiconductor executives from the EMEA region, chaired by TSMC EMEA President Maria Marced. ◼

IoT stimulates new business models

When everything is monitored and connected to the Cloud, companies will change the way they make money, says John Leonard

By **John Leonard**, Product Marketing Manager, Nordic Semiconductor
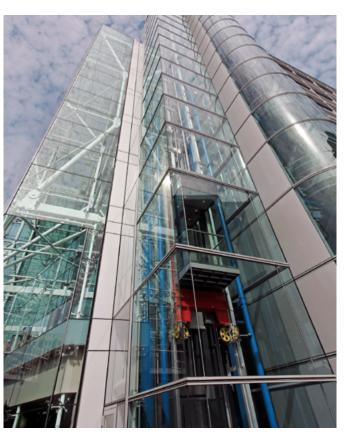
While there is much hype about the Internet of Things (IoT), behind the scenes, major collaboration on standards and clever engineering is taking place to make it possible for previously isolated devices to enjoy wired- or wireless-bidirectional connectivity to Cloud-based resources.

Nordic Semiconductor is playing a key role in the development of these systems with chips such as the nRF51 and nRF52 Series Bluetooth Smart solutions, development tools like the nRF5 Software Development Kit (SDK), and associated technologies such as Bluetooth Smart over IPv6 (see ULP WQ Spring 2015 pg 8). In addition, development work taking place in the company's Finnish research and development (R&D) division is set to extend Nordic's reach into IoT products powered by other wireless technologies (see this issue pg 16).

That a fully-implemented IoT will prove to be a disruptive technology is beyond debate. What's less certain is how this disruption will play out. But it's likely to have a major impact on the world of commerce; one only has to consider how the conventional Internet has transformed established businesses like retail, transport, and manufacturing to appreciate the prospects for a world where even the simplest objects become "smart" via connectivity.

Service not products

One key change will be how ubiquitous connectivity will allow companies to adopt more profitable business models. Consider, for example, an unassuming concern such as elevators; by adopting

Going up: The IoT will transform the elevator business and many others

IoT technology, the elevator company could transform its business from one that sells a product (the elevator) along with a maintenance contract, into one which sells "vertical transportation" as a service. The service would be moving people between the floors of a building, and the elevator company would look after everything (including maintaining and then replacing the elevator at the end of its service life) without the customer ever getting involved.

For example, today's planned maintenance schedules can only take into account historical wear and tear data and as such are unable to predict breakdowns or take into account the effects of variation in demand over the course of an elevator's life. Stoppages often occur during the middle of the day when

"Ubiquitous connectivity will allow companies to adopt more profitable business models"

the elevator's motor is working hardest and then the delays are at their most disruptive. In the future the elevator's electric motor will become a "thing" on the IoT with wireless sensors monitoring operating parameters such as power consumption, temperature, and vibration. Unusual readings could be interpreted by a powerful Cloud server to indicate an impending failure and flag maintenance or replacement in advance - allowing the elevator company to plan the work during night hours.

By proactively monitoring the performance of the elevator, the service provider will be able to replace expensive maintenance schedules with programs that overhaul the unit only when strictly necessary. Not only will monitoring reduce costs and improve profits for the elevator company, it will also enable the company to direct resources more rapidly and efficiently, to the advantage of the customer.

Other sensors could constantly provide data on elevator usage, allowing algorithms running on Cloud servers to predict periods of high use in advance such that the elevators could be accelerated to cope with demand, and then slowed to save power when usage tails off.

Some elevator companies are already taking advantage of connectivity and the "experiential" based maintenance scheduling it can enable. This is not the same as proactive monitoring but is a significant step on the road to that destination. Major elevator vendor Otis, for example, remotely monitors the usage of many of the elevators it supplies allowing maintenance schedules to take into account variations in demand. The company also uses connectivity to enable remote testing of elevators to ensure they are functioning correctly, and to send instructions to shut down any unit that shows early signs of failure.

But changing the business models of existing companies is only one part of how the IoT will disrupt commerce. The conventional Internet changed how almost any business went about making money, but also enabled a whole raft of firms that couldn't have existed before its invention – consider Amazon, Google, Facebook, Kickstarter, Uber, Airbnb, and the rest. The IoT will dramatically accelerate this new business creation. ■

Wireless charging unites to deliver

The AirFuel Alliance claims to consolidate wireless charging technologies into a single seamless and interoperable ecosystem. By Caroline Hayes

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

The panic of remembering to take the charger for every smartphone, laptop and tablet haunts every traveller and commuter. The industry has been working to end this anachronism.

Until recently, there were several approaches, promoted by different consortia. The Wireless Power Consortium developed the Qi specification, using inductive charging, while the Alliance for Wireless Power (A4WP) and the Power Matters Alliance (PMA) both advocated magnetic resonance-based charging. In June 2015, there was consolidation, when the A4WP and the PMA merged to form the AirFuel Alliance to promote both AirFuel Resonant, and AirFuel Inductive wireless charging technologies.

The Alliance represents a single standards body, with over 190 members. The organization's mission is to unify the industry and accelerate the advance and commercialization of consumer-friendly wireless charging, with a seamless, interoperable ecosystem. The group aims to make wireless power available in homes, offices, municipal buildings, in vehicles, and on public transport.

Members include semiconductor companies like Broadcom, Maxim Integrated, and Nordic Semiconductor, manufacturers, such as Blackberry, Huawei, Samsung, Motorola, Lenovo, Sony Mobile, and LG Electronics, as well as Starbucks and McDonald's.

Regulatory approval

At this year's Consumer Electronics Show (CES) in Las Vegas, the Alliance announced it has global regulatory Federal Communications Commission

Resonant wireless charging produces a wide field supporting simultaneous charging of multiple devices

"The size of the AirFuel Alliance is a powerful proposition, as global market leaders unite to evolve the technical specification"

(FCC) approval for the U.S., and also State Radio Regulation Committee (SRRC) certification for products in China. At the time, industry analyst IHS Technology commented that this is "one step closer to commercially available resonant products".

The ecosystem afforded by the combined size and strength of the Alliance is a powerful proposition, as global market leaders unite to evolve the technical specification and standard.

A roadmap was announced at CES in January, with the intention of unifying the wireless charging market, by incorporating both inductive and resonant (complying with the Rezence standard) technologies into a single certification.

AirFuel Inductive employs a coil powered by an AC voltage which induces an AC current in a second induction coil in the consumer's device. With a maximum power transfer of about 5W, charging is limited to a single smartphone which must be precisely positioned due to the charging field's short range.

AirFuel Resonant uses a primary coil "transmitter" generating an electromagnetic field oscillating at a frequency of 6.78MHz. Resonant wireless charging gains its advantage because by ensuring both coils (the charger coil and the one in the user's device) resonate at the same frequency, power transfer efficiency is markedly improved. More power can be transmitted allowing multiple devices to charge from a single charging pad at the same time. (*See ULP WQ Autumn 2015 pg 14*).

Bluetooth Smart technology powers the communications link between transmitter and receiver coils using the 2.4GHz frequency band for optimized charging.

AirFuel Resonant is based on the Rezence standard for wireless electrical power transfer, using magnetic resonance, originally developed by A4WP. It uses a Bluetooth Smart wireless link to control power levels and supports power transfer of up to 50W. At CES, the AirFuel Alliance announced it would focus on charging solutions beyond 50W.

Member companies have already established a far-reaching ecosystem to support wireless charging.

Nordic Semiconductor, for example, has developed the S120 eight-link protocol stack and the nRF51 Wireless Charging software development kit (SDK), which supports Rezence. The S120 Softdevice is a Bluetooth Smart protocol stack for the company's nRF51822 SoC. It includes all Bluetooth Smart energy protocol layers and supports up to eight simultaneous links. The SDK includes profiles for the Rezence Power Transmitting Unit (PTU) and Power Receiving Unit (PRU). A charging pad, based on the two components, can support simultaneous charging for up to eight devices. ■

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
			System-on-Chip	Connectivity	Transceiver	CPU	FPU	DSP	Memory (OTP: One Time Programmable)	MPU	Balun	Oscillators	NFC-A tag	2-Wire	ADC	AES	Analog Comparator	Battery Monitor	I2S	PDM	PWM	Real Time Clock	RNG	SPI	S/PDIF	Temperature Sensor	UART	USB	Accessories	PC Peripherals	Sports & Fitness	Gaming	Cellphone Accessories	Consumer Electronics	Automation	Healthcare	Toys	Wearables	Smart Home	Beacon			
nRF52 Series																																										
nRF52832	2.4GHz	Bluetooth Smart v4.2, Proprietary & ANT	●			Cortex M4F	●	●	64kB RAM 512kB Flash	●	●	32MHz / 32kHz Crystal 64MHz / 32kHz RC	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	–	Single Board Dev Kit	
nRF51 Series																																										
nRF51822	2.4GHz	Bluetooth Smart v4.2 & Proprietary	●			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	Bluetooth Smart v4.2, Proprietary & ANT	●			Cortex M0			32kB or 16kB RAM 128kB or 256kB Flash	●		16MHz / 32kHz Crystal 16MHz / 32kHz RC		●	●	●	●				●	●		●	●		●	●		●	●	●	●	●		●	●	●	●	●	●	Smartphone Demo Apps	Single Board Dev Kit, Dongle	●
nRF8000 Series																																										
nRF8001	2.4GHz	Bluetooth Smart v4.0		●		–			–			16MHz / 32kHz Crystal 32kHz RC											●		●					●	●	●	●	●	●	●						PC Desktop, Smart Remote, Smartphone Demo Apps	nRFgo Dev Kit, Prog. Kit	
nRF8002	2.4GHz	Bluetooth Smart v4.0		●		–			–			16MHz Crystal 32kHz RC						●												●											Key Tag, Smartphone Demo Apps	nRFgo Dev Kit, Prog. Kit	
nRF24AP Series																																										
nRF24AP2-1CH	2.4GHz	ANT		●		–			–			16MHz / 32kHz Crystal											●		●					●		●		●		●	●					Smartphone Demo App	ANT Dev Kit	
nRF24AP2-8CH	2.4GHz	ANT		●		–			–			16MHz / 32kHz Crystal											●		●					●		●		●		●	●					Smartphone Demo App	ANT Dev Kit	
nRF24AP2-USB	2.4GHz	ANT		●		–			–			16MHz Crystal													●					●		●		●		●	●					ANT USB Dongle	ANT Dev Kit	
nRF24L Series																																										
nRF24LE1	2.4GHz	Proprietary	●			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	Proprietary	●			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	Proprietary	●			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	Proprietary	●			8051			2kB + 256B RAM 16kB + 1kB OTP			16MHz Crystal			●							●		●				●	●		●		●		●	●					PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24L01+	2.4GHz	Proprietary			●	–			–			16MHz Crystal											●		●				●		●		●		●	●					–	Eval Kit	
nRF24 Series																																										
nRF2460 (mono)	2.4GHz	Proprietary		●		–			–			16MHz Crystal	●																					●		●						Microphone	nRFgo Dev Kit	
nRF900 Series																																										
nRF9E5	433 / 868 915MHz	Proprietary	●			8051			4kB + 256B RAM			4 / 8 / 12 / 16 / 20MHz Crystal			●				●	●		●								●				●						–	Eval Kit	
nRF905	433 / 868 915MHz	Proprietary			●	–			–			4 / 8 / 12 / 16 / 20MHz Crystal											●							●				●						–	Eval Kit	

The rise and rise of wireless sports technology

Sophisticated data and analytics are delivering professional sports performance monitoring to the masses. ULP Wireless Q reports

What's the greatest technological advancement in sports history? It's the sort of water cooler question certain to work sports fans up into a frenzy. In the pre-digital era sports technology was heavily concentrated on improving sports equipment and performance through better engineering and design. Think, for example, titanium golf clubs, composite tennis racquets, carbon fiber skis, or electronic shifting for bike derailleurs.

With the advent of digital technology, component miniaturization, smart devices, and wireless connectivity, the landscape shifted. Sports technology was no longer focused solely on advances in equipment, but also on improving the sporting 'experience' through performance monitoring, training support, and more accurate results. Crucially, it was also no longer targeted just at cash rich, professional sports, but also directly at recreational fitness enthusiasts willing to pay a premium to shave a few seconds off their personal best, or take a shot off their handicap.

Boom time for wearables

In the early days this saw the proliferation of pedometers, heart rate belts, and early wearable devices that along with recording your time could, for example, approximate the distance travelled based on your stride length and estimate the 'training effect' based on heart rate. Powered by proprietary technologies, such devices enjoyed popularity amongst tech early adopters and sports nuts. But the explosion of smartphone ownership, alongside the introduction of interoperable ultra low power

LEFT LEG
50%   178W

RIGHT LEG
186W   52%

PowerTap pedals can independently measure left- and right-foot power data

"Wearable technology is poised to affect the way any game is played … shifting sports more than anything has ever done before."

wireless technologies in the form of ANT+ and Bluetooth Smart from chip vendors like Nordic Semiconductor, changed everything.

A report released in late 2015 by U.S.-based independent research analyst WinterGreen, *Smart Wearables, Sport and Fitness: Market Shares, Strategy, and Forecasts, Worldwide, 2015 to 2021*, observed that the sports & fitness performance wearables market was set to grow from $3.5 billion in 2014 to $14.9 billion by 2021, and that: "Wearables are poised to affect the way any game is played, shifting sports more than anything has ever done before."

"Next generation smart wearables leverage better technology … better data gathering, better reliability, better

navigation, better analytics to turn data into information," notes WinterGreen. "In sports and fitness technology, it is not about what data can be shown, it is how meaningful the data is in terms of improving athletic performance or managing overall personal fitness. Wearables bring big data, enough data that it can be turned into actionable information."

According to Susan Eustis, leader of the team that prepared the study: "The ability to offer sophisticated analytics for the wearable devices is what provides sophisticated application capabilities. Vendors have been forced to realize that people need interpretation of data, they need to know the meaning of data collected by the wearable."

Developers of smart wearable devices for runners have been

quick to catch on, and the days of basic time and distance data gathering are long gone. Last year, San Francisco-based, Scribe Labs launched its [runScribe](#) wearable footpod that not only captures basic data such as pace and distance, but also monitors the precise movements of a runner's foot, allowing them to analyze their running characteristics to improve performance and prevent injury.

Attached to the runner's shoe, runScribe uses a nine-axis sensor to provide an array of kinematic metrics. These include stride rate and length, surface contact time, foot strike type, pronation excursion, and impact and braking G forces, delivering an data set that is then uploaded via Bluetooth Smart to a web dashboard via a mobile app.

"We are a small team with a simple vision – we want to help athletes improve their performance by understanding performance metrics and working to improve where they can, visualizing it in a simple, actionable fashion," says runScribe CEO, Tim Clark.

"Bluetooth Smart is fundamental to the runScribe experience because it enables us to have a small, lightweight footpod that the user isn't even aware of while running."

Another company making huge strides in running performance monitoring is Colorado-based sports technology company, Athlete Architect. Last year the company launched its aptly named Stryd wearable device for measuring running power.

Stryd consists of the ANT+ and Bluetooth Smart wearable device, a smartphone app, and a Cloud-based training platform, providing runners with real time feedback on exertion, form, efficiency, and fatigue, all from their existing sports watch or iOS or Android smartphone.

The device's sensors calculate run power, measured in Watts, an objective and instant measure of overall running performance unlike, say, heart rate, which can be distorted by a range of environmental factors.

"The data runners use in training hasn't changed much in 30 years. There has never been an accurate or easy way to show training intensity and efficiency,

runScribe's wearable footpod monitors the precise movement of a runner's foot

and athletes and coaches have repeatedly told us that holds them back," says Robert Dick, CEO of Stryd. "Our goal was to provide one number [power in Watts] that can consistently help anyone run better."

Unmasking skiing's secrets
The boom in sports monitoring has now spread to skiing.

"There's high tech surrounding every other sport, and so there is with skiing," says Janne Regelin, Chief Marketing Officer of Exiops, the company behind a new cross country skiing performance analysis monitor called SKIIOT. "But skiing, in the end, is a group of very well kept secrets pertaining to knowledge about snow and techniques for sliding on it. SKIIOT unveils these secrets."

SKIIOT attaches to the heel of a ski boot, or lower shin above the ski boot, and measures and records a range of

performance-related data that is sent wirelessly to a Bluetooth Smart Ready smartphone or compatible smartwatch, which in turn acts as a router to the SKIIOT Cloud service where the data is processed to allow for pre-, during, and post-ski analysis.

The data recorded includes air temperature, air pressure, humidity, relative altitude, snow temperature, speed, as well as heart rate if used in conjunction with a compatible heart rate belt. The skier's location is also provided if they use a compatible smartwatch or have enabled GPS on their smartphone.

And it's not only runners and skiers who are benefitting from the increased sophistication of wearable devices, technology for cyclists has moved a long way from the analog handlebar-mounted speedometers and odometers of 30 years ago.

Earlier this year one of the

world's leading cycling power meter specialists, PowerTap, unveiled its PowerTap cycling pedals, employing eight strain gauges per pedal to measure force and a high precision encoder to measure angular velocity. The pedals can independently measure left- and right-foot power data and are said to be the first to offer multiprotocol ANT+ and Bluetooth Smart wireless connectivity to bike computers and other devices, courtesy of Nordic Semiconductor's nRF51 Series SoC technology.

"In cycling, power is the truest measure of your performance," says Justin Henkel, Product Manager at PowerTap. "Our PowerTap pedals are designed to provide unrivalled insight into pedalling technique and efficiency in a sport where the tiniest fractions of a second can spell the difference between winning and losing."

Henkel believes that in a world where marginal gains mean the difference between first and nowhere, technology is here to stay: "I can only see sensor technology in sports continuing to grow immensely over the next decade as sensors continue to become smaller and more accurate. This will yield invaluable new types of data and insights for athletes as to how they could further improve competitive performance in a sector where the mantra 'you can't improve what you can't measure' holds universally true." ∎

Athlete Architect's Stryd wearable calculates the power a runner generates which is the most precise way to gauge intensity and effort

View your power on your smart watch

Clip it on sync and go

Real-time coaching from your smart phone

Picturesque Oulu has bounced back from major company divestments

Business Oulu

Subarctic Silicon Valley

After some blue chip divestments, the Finnish city of Oulu is reinventing itself to maintain its reputation as a high-tech hub. Sally Ward-Foxton reports

Sally Ward-Foxton is a freelance journalist specializing in electronics

At first glance, the statistics don't make it sound all that special: Oulu is the fifth largest city in Finland with around 250,000 inhabitants, and outside Russia, there are no larger cities that are more northerly. However, this subarctic city has been thriving courtesy of the education, talent, and entrepreneurship of its inhabitants to become the "Silicon Valley of the Nordic region".

This state of affairs is all the more remarkable given the major divestments by some of the biggest players in tech in the last few years.

Around 100 employees in Oulu were affected in a first tranche of Nokia layoffs in 2011, but the biggest blow came in the summer of 2014, when Microsoft announced that it would close the Oulu smartphone development centre it acquired from Nokia with the loss of a further 500 jobs.

Less than a week later (in a move not directly related to the Microsoft decision) Broadcom announced it was axing its mobile chipset R&D centre in Oulu, at the cost of another 430 positions.

Rather than signal the end of Oulu's tech industry, these events created a huge pool of available technical talent. This didn't

At a glance

- **The Finnish city of Oulu is undergoing a renaissance, following hi-tech closures in 2014**
- **Mobile and wireless tech companies are moving in to take advantage of the pool of talent**
- **Oulu also has a healthy and growing start-up scene**

go unnoticed by the industry and several tech companies, especially those in the mobile, wireless, and related sectors, moved quickly to take advantage of the available personnel.

"This world class talent was very attractive to many global companies," says Juha Ala-Mursula, Executive Director of Business Oulu, an organization owned by the city which implements Oulu's industry policies and provides companies with development services. "Since then, around 15 new well-known brands have started activities in Oulu. By the end of December 2014, fewer than 90 persons were left unemployed [from the Microsoft and Broadcom layoffs]."

The large pool of technical talent, Ala-Mursula adds, is only part of what makes Oulu attractive.

"Almost all 15 companies that landed in Oulu in the last two years are growing," he says. "The main reasons are the effective ecosystem, availability

of a skilled workforce, good innovation environment, and testing facilities. We have a long history of developing world-class, wireless, battery-operated, state-of-the-art products with good design."

Nordic Semiconductor was one of several wireless tech companies to snap up some of this ready-made technical talent.

"A sizeable amount of those laid off in August 2014 by Broadcom were software and IC engineers for wireless devices," explains Svein-Egil Nielsen, CTO of the Norway-based ultra low power wireless connectivity vendor. "We thought it would be a good opportunity to recruit a few people and relocate them to Norway to work in our offices there. But when we had our first recruiting event, we had more than 300 people show up – everyone was asking, why don't you open an office in Oulu? That was a good question."

Nielsen explains that "in record time" Nordic was able to hire a management and engineering team and after just a couple of months the company opened a new Oulu R&D office comprising 60 people. That was in January 2015; a little over a year later, there are now 90 people working there. In fact, Nordic now has around half as many R&D engineers in two Finnish offices (Oulu and Turku) as it does in its Norwegian offices.

"That kind of growth would be impossible in Norway," he says. "We could only hire one or two people at a time. But in Finland, we could get up to a good number of people, very experienced people, very fast...We were given a great opportunity by the teams and the availability of talent. What we did well was to take the opportunity that presented itself and went with it."

Nordic's plan for the future includes forging a close relationship with the local university – in a similar way to its tie-up with the technical university in Trondheim, the company's home city.

"We're planning to implement a similar scheme to what we do in Norway," says Nielsen. "We will encourage students to take

Entrepreneurs go to extremes to secure investment in Oulu

Polar Bear Pitching

"In Finland, we could get up to a good number of very experienced people, very fast ... that kind of growth would be impossible in Norway" Svein-Egil Nielsen, CTO, Nordic

summer jobs with us and help others with their Masters thesis. The idea is to provide a stream of talented engineers to fuel the growth of our development teams in Finland."
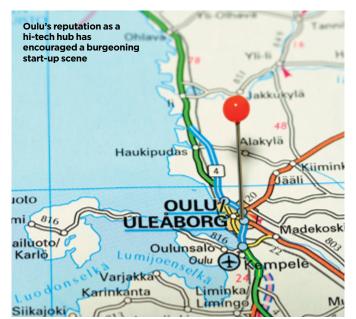
Today, Oulu boasts players from low-level silicon, hardware, related software, kernel, RF, device conception and system design, all the way to infrastructure development and Cloud software.

Nokia's networks division still has a base of several thousand employees in the city, working on 5G and Internet of Things (IoT) projects, and ARM also

has a big IoT development base there, following its acquisition of Sensinode in 2013.

"The local wireless ecosystem is now stronger than before the Microsoft and Broadcom layoffs," Business Oulu's Juha Ala-Mursula says. "The full ecosystem is available in the same city, and everything can be reached within 15 minutes."

A strong start-up scene

Oulu's reputation as a hi-tech hub has encouraged a burgeoning start-up scene. The region brings its own unique flavour to start-up business with

initiatives such as the Polar Bear Pitching event, in which start-up CEOs pitch their companies as quickly as possible while standing in chest-deep freezing water in a hole in the ice, aiming to attract investors. Billed as "The World's Coolest Start-up Event", the pitch-fest certainly works as an ice-breaker; the organizers say that over 60 percent of pitchers from previous events have secured the funding they needed to run their businesses. There is also a €10,000 cash prize for the best pitch.

"Entrepreneurship has always been a key value in local society," Ala-Mursula says. "All key local stakeholders are actively encouraging young entrepreneurs to develop their own dreams and we now have over 600 start-up companies in the city, with about 400 of them aiming to become scalable global businesses."

Indeed, mass layoffs from big companies have helped made Oulu a very fertile breeding ground for start-ups.

iProtoXi is one of them; this young technology company has created a development platform for IoT applications, which includes Aistin Blue, a simple-to-use sensor system which uses Nordic Semiconductor Bluetooth Smart connectivity.

Janne Kallio, CEO of iProtoXi, explains that after working in R&D at Nokia for more than 20 years, his department was closed. He applied for, and won, a 'bridge' grant as part of a Nokia initiative to help laid-off employees start their own companies, and got iProtoXi off the ground in early 2012 with another ex-Nokia colleague and two others. Along the way, the company has also received funding from Tekes, the Finnish publically-funded agency for financing R&D in Finland.

"[These programs] gave us the freedom to develop the idea we had in Nokia," Kallio says. "Other skilled people have also started their own businesses and we now have quite a few promising technology start-ups here. Because of our similar backgrounds, we form a unique network and there is an inspirational atmosphere." ∎

Oulu's reputation as a hi-tech hub has encouraged a burgeoning start-up scene

Cycling demands more from wireless technology

The proliferation of sensors for the cycling sector is asking questions of the developer. Kat Kent explores some answers

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

Today's plethora of sensors and controllable devices for cyclists presents new opportunities and challenges for cycling product designers. For example, speed, cadence, muscle oxygen, and traffic detection sensors, plus heart rate monitors (HRM), power meters, action cameras, bike trainers, suspension controls, seat post controls, bike radar, and a set of bike lights are all commercially-available devices which a consumer would expect their bike computer to handle. But that's not all; cyclists have also been quick to embrace connectivity between their smartphone and cycling computer such that SMS and incoming call notifications appear on the screen of the computer as they ride.

Precise definition of a product's target customer can narrow down the list of sensors that need to be supported. For example, a bike computer aimed at commuters would likely need to support e-bikes, bike lights, phone notifications, and radar.

Different features, such as suspension and seat post controls, would appeal more to a mountain bike enthusiast. However, it's also possible that a cyclist might not only cycle to work, but also use their static trainer in the evenings and take their bike out on the road (or mountain) to set a new personal best on the weekend.

Increasing channel count

In short, designing wireless cycling products is becoming increasingly challenging.

ANT chips such as Nordic

Cyclists have been quick to embrace smartphone and bike computer connectivity

"As the variety of cycling sensors on the market continues to increase, the issue of reducing wireless clutter will gain urgency"

Semiconductor's nRF51422 System-on-Chip (SoC) typically support up to eight ANT connections, one per channel. In the case of ANT+ bike lights a shared network topology is used so that only one channel is required for several lights. But even with this channel optimization, eight channels may not be enough. Previously, increasing the channel count demanded the use of multiple chips - multiplying the design complexity and cost. Fortunately, a new generation of ANT-compatible chips is hitting the market; Nordic's nRF52832 SoC, for example, is capable of supporting up to 15 channels. (A recently-released new ANT software stack also allows the nRF51422 SoC to now support up to 15 channels as well.)

Today, it is a challenge to find Bluetooth Smart chips that can support as many connections as those supported by ANT chips (typically a Bluetooth Smart chip caters for 3 to 4 channels with the number being hardware specific) – but this is likely to increase as Bluetooth Smart makes inroads into the cycling sector.

Another interesting development in the ultra low power wireless chip sector are chips that simultaneously support ANT+ and Bluetooth Smart protocols. Designers are capitalising on the opportunity to design sensors and bike computers that can support both

popular protocols without having to produce two versions of their products. Both Nordic's nRF51822 and nRF52832 SoCs are capable of simultaneously handling ANT+ and Bluetooth Smart. PowerTap cycling pedals (*see this issue pg 4*) are a good example of a recently released product that takes advantage of Nordic's multiprotocol technology.

Although the 2.4GHz spectrum allocation used by both ANT+ and Bluetooth Smart is sufficiently wide (100MHz) to allow many separate frequency allocations, ANT+ sensors mostly run on the ANT+ frequency (2.457GHz) to enable faster connection times and concurrent synchronization with multiple displays. This has not historically caused significant interference issues due to ANT's built-in time adaptive coexistence feature. However the increasing numbers of sensors on today's

and tomorrow's bikes raise the likelihood of interference. The cost of richer data from multiple sensors is an increased requirement for product testing in tough RF environments (e.g. cycling in the rain with every sensor active), and robust handling of data drop-outs.

One solution is to reduce the frequency of data transmission from each sensor, for example, from 8Hz to 4Hz, which approximately halves the prospect of interference. This could be achieved by reducing the transmission of unused data "pages"(for example, in ANT+ bike power, data is usually sent in two formats to increase the number of displays capable of interpreting the data but this could perhaps be user-selectable to just one format).

Designing for the future

Another solution to the issue of interference is to reduce the number of active sensors by making each do more than one job. For example, crank-based power meters can indicate cadence, removing the need for a separate cadence sensor. Speed and distance sensors can also be eliminated when

PowerTap pedals simultaneously support ANT+ and Bluetooth Smart

the bike computer's GPS is used to calculate this information instead. Similarly the number of transmitting channels per sensor should be minimized. For example some HRMs can now double as power meters (2 x 4Hz channels), but when an actual power meter is present on the bike the HRM power data is unlikely to be used and should be switched off. To make the most of this opportunity to reduce "wireless clutter", manufacturers will need to introduce technology to determine and configure the optimal protocol and transmitted

dataset at a particular time across the whole personal area network.

A clear vision of what really matters to the customer becomes crucial in light of the added development and material cost, and increased time to market that can occur when wireless sensors proliferate. Feature selection, and optimal presentation of meaningful data are achieved through careful consideration of the end-user experience. Such consideration might determine that "less is more" and fewer sensors will satisfy the target customer (for example,

a commuter), thus easing the design complexity.

If the target market (for example, a keen amateur road cyclist) prefers an ever greater number of sensors, choosing hardware with the maximum number of channels to connect to separate sensors will provide increased design flexibility.

Potential interference challenges can be addressed by strong RF antenna design, robust handling of data drop-outs, and thorough testing to ensure the combination of sensors will play nicely together. Superfluous or duplicate data sent by multiple sensors should be handled automatically by the bike computer, or by asking the user to manually prioritize information sources via the computer's user interface.

As the variety of cycling sensors on the market continues to increase, the issue of reducing wireless clutter by configuring the rate of data transmissions and setting unused sensors into sleep mode will gain urgency. Companies need to work together to agree standard technical solutions to reduce the possibility of conflict between their sensors' transmissions. ■

Interoperable connectivity underpins future of IoT

Getting the IoT right allows firms to focus on products not connectivity, explains Mike Rounding

Consumers don't ask for an "Internet of Things"; Instead, they want to buy "connectivity" embodied in devices from different manufacturers that successfully talk to each other (while doing all the other things the user expects). Everything bundled under the Internet of Things (IoT) banner will need to figure this out if the concept is to meet its promise.

The fitness industry got interoperable connectivity right some time ago and, as a consequence, was one of the first industries to embrace the IoT. As machines connected to networks, harvested data, and were controlled remotely, the need for interoperable connectivity grew. At ANT Wireless we have spent over a decade developing a successful software approach to the interoperable connectivity that now underpins the emerging IoT.

Bike Radar sensors allow cyclists to determine what's behind them without taking their eyes off the road

"The IoT isn't just about connecting devices to the Internet"

New business opportunities

As the IoT matures, new business opportunities will spring up: For example, consider the new application of radar for bikes.

The ANT+ interoperable device profile for Bike Radar sensors, launched last year, is the cycling industry's first-of-its-kind wireless standard supporting radar and introduces the new sub-segment of cyclist-awareness to the industry.

For bicycle commuters and road cyclists alike, vehicular traffic is a constant source of worry and potential danger. Knowing what's in front of you is easy, but knowing what's behind is not.

The new device profile wirelessly transmits live feedback of the relative distance and speed of vehicles behind the cyclist and displays this critical information in front of them so they can keep their eyes on the road. This is IoT at its most helpful.

Outside of the fitness space, we are working with companies like Delphian Systems with their "SecuRemote®" solution that provides seamless connectivity between devices and Cloud applications in commercial and home applications (*see this issue page 3)*, and Birdi, which manufactures an ANT-enabled smart detector that detects both fast-burning and smoldering fires, while minimizing false alarms.

From ANT Wireless' perspective, the IoT isn't just about connecting devices or machines to the Internet or to each other; rather, it refers to devices becoming nodes on pervasive networks that use open, interoperable interface definitions, or profiles. When this is done right, Internet community-like behavior follows, allowing companies to focus on developing innovative end-use products and not just on their connectivity, extending the variety within an ecosystem and allowing it to scale independently.

IoT expansion

So what does this mean for ANT wireless technology in the future? The credibility the company has established in the fitness space - built with its long-term partnership with Nordic Semiconductor and the Norwegian company's nRF24AP1/2, nRF51 Series, and now the nRF52 Series Systems-on-Chip - has encouraged other industries to turn to ANT Wireless' ultra low power and scalable wireless solutions.

For example, business IoT deployments are at the forefront of our IoT expansion. This sector is making use of sensing, monitoring, and control use-cases involving the connection of large numbers of nodes. These use-cases are well suited for the ANT protocol.

But not every fledgling IoT company is destined for success. The challenge any start up company faces is defining which problem it can solve. The IoT isn't a single-vendor, -technology or -sandbox environment: Success is only assured in a wide ecosystem of interoperable partners. Just ask the sport and fitness industry. ■

Mike Rounding is Product Manager with ANT Wireless. Visit www.thisisant.com for more information on ANT+ solutions

ZITKO Walk Posture and Activity Wristband

Unlike other activity bands designed only to motivate the wearer to exercise more, this fitness wearable also helps correct gait, posture, and overall body balance

According to Juniper Research approximately 110 million people will be using fitness bands worldwide by the end of 2019, while the line between activity wearables and smartwatches blurs as both devices increasingly perform similar functions. ZITKO Walk is a case in point; it not only tracks steps taken, distance travelled, calories burned, and hours slept, but also alerts the user to incoming calls, as well as performing biometric security functions

ZITKO Walk uses a six-axis motion sensor to analyze the speed, angle, and amount of rotation in the user's wrist to determine bad posture - for example if they walk while hunched over, while looking at their smartphone, or with their hands in their pockets. At the same time the device compares left versus right arm swing to monitor and correct poor body symmetry, gently vibrating to alert the user that they need to take corrective action

ZITKO Walk employs Nordic Semiconductor's nRF51822 System-on-Chip (SoC) to provide Bluetooth Smart wireless connectivity to both iOS and Android-compatible Bluetooth Smart Ready devices. Powered by a 50mAh lithium polymer battery, the device can operate for up to five days between recharges, thanks in part to the ultra low power consumption of the nRF51822

The activity tracker record for the most steps taken in a month is currently held by Finnish man Pekka Luodeslampi, who walked a total of 1,560,554 steps in 31 days, averaging over 50,000 steps per day. That's the equivalent of about 40 kilometers, or almost a full marathon every day for a month

The wearable tech market has its origins not in health and fitness but in gambling. In 1961, math professor Edward Thorp built a wearable computer he claimed helped predict the outcome of a spin of a roulette wheel. Using his toes he could manipulate switches to tell the computer when the ball started moving, the computer would then estimate where it would stop, and alert him where to place his bet via an earpiece

Taking tomorrow's wearables from smartphone to standalone

Bluetooth Smart SoCs will make wearables the first mass-produced IoT product

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

Smart watches such as Magellan's Echo can transmit and receive data from a smartphone for up to 11 months from a single CR2032 coin cell

"Tomorrow's wearables will be far more powerful products able to operate independently of mobiles"

Just a decade ago wearable electronics was a niche technology targeted at fitness gadget early adopters and which used proprietary technology. But today, wearable devices have become the latest hot toys for the mass market. Analyst Markets&Markets, for example, estimates the "global wearable technology ecosystem's" value will reach US$14 billion by 2018, growing at a compound annual growth rate (CAGR) of more than 18 percent between 2013 and 2018.

The contemporary market is typified by the smart watch - a device that brings the functionality of the smartphone to the wrist in a convenient and (sometimes) stylish package. The current crop of smart watches has been made practical by the 2010 introduction of Bluetooth v4.0, which included Bluetooth low energy as a hallmark element.

Bluetooth low energy (known to the consumer as "Bluetooth Smart") is an ultra low power wireless link which is compatible with the "Bluetooth Smart Ready" technology embedded in most smartphones. In the last several years, major technology companies such as Apple, Google, and Microsoft have announced "native" support, including application programming interfaces (APIs), for the latest version of Bluetooth technology. This support makes it much easier for engineers to develop wearables that leverage associated smartphone-based apps to maximize their usefulness.

Moreover, Bluetooth Smart requires very little battery power,

helping conserve the life of the host wearable device's small-capacity cell. Smart watches such as Magellan's Echo can transmit and receive data from a smartphone - while also allowing a user to control smartphone functions such as music replay from their wrist - for up to 11 months from a single CR2032 coin cell.

Smartphone independence

But as impressive as smart watches are, their functionality relies on the presence of a smartphone to provide computational power and Internet connectivity. Tomorrow's wearables will be even more powerful and able to operate independently of mobiles to function as standalone "things" connected to the Internet of Things (IoT). Some of these products are already in development thanks to a new generation of Bluetooth Smart Systems-on-Chip (SoCs) which integrate processors with the power to communicate directly with other devices on the Internet and run complex applications, yet boast low current consumption to

extend battery life.

The IoT is in its formative years and many technical challenges remain before its promise is realized. But most industry observers agree that proliferation will rely on the "things" making up the network speaking the same language in order to limit complexity and cost. IPv6 is the preferred protocol for Internet communication and manufacturers of wireless products of various flavours -including Bluetooth Smart, IEEE 802.15.4 and Wi-Fi - are adapting

their technologies to include IPv6 transport layers.

Wearables, as an established market with a growing consumer base, is a technology sector that's poised to make the leap from the Internet of my Things to the IoT proper by taking advantage of a slew of new Bluetooth Smart SoCs. These single-chip solutions have the processing capability to support IPv6 over Bluetooth Smart communications and complex software without requiring the resources of a smartphone. Such capability opens up thousands of new applications for wearables beyond the current smart watch and fitness bracelet niches.

In addition to powerful SoCs, IoT players such as Nordic Semiconductor are making it extremely easy for wearable product developers to focus on innovation––instead of worrying about aligning protocols or working with complex gateways to facilitate Internet communication––by providing SoCs and SDKs, based on open standards, that work "right out of the box". ∎

Embedded Computing Design

This is an extract of an article first published in *Embedded Computing Design* in November 2015

Radio system design by day, crashed car restoration by night

Hi, I'm Yrjö Kaipainen and I joined Nordic Semiconductor just over a year ago as part of its strategic acquisition of ex-Broadcom wireless software and IC engineers in Finland during 2014 (*see pages 16 & 17 this issue*).

I work from Nordic's newly-created Turku office in Finland (about 1 hour 45 minutes' drive from where I live in Espoo). Along with about 20 colleagues, we are currently working on developing a new Internet of Things (IoT) targeted product for Nordic that employs low power Wide Area Network (WAN) and Bluetooth Smart wireless technology.

My job is to oversee the radio systems and algorithms, and any related standardization and industry collaboration activities that may be required.

One of the things I really like about working at Nordic is the passion and energy created from being within a small but fast growing, agile, and ambitious company that is looking to make a real difference in the world.

For me, this has created an environment where I can observe myself making weekly 'quantum progress' in the projects I am responsible for. This, I believe, is because all the people, resources, and talent required

Yrjö with his latest car restoration: A crash-damaged, ex-demonstration 2010 Lexus GS 450H (hybrid) with 3.5l engine bought from an insurance company for €20,000

is located in close proximity; and because we are given the freedom and versatility to work and learn at our full capability without being hindered by unnecessary company politics and bureaucracy.

At Nordic you really get the feeling that the company wants you to flourish and, in turn, achieve its ambitious growth and expansion plans into new promising IoT markets.

Outside of work I have

reincarnated my old interest in playing squash to keep fit. But my true passion is any activity that enables me 'to think by hands' in contrast to the more academic and conceptual nature of my job. This includes house maintenance, repairing, building, and furniture carpentry. But by far my favorite (and one I've been doing since I was 15-years old) is restoring crashed cars: typically at the rate of one every two years that I then sell to relatives or friends to cover my costs.

For me this is a powerful form of meditation. After spending just a quarter hour with this hobby I find all my daily stresses and worries just fall away. And I've often observed that without any conscious effort, my mind and body become extremely relaxed, and with it my thoughts naturally more organized and unified.

The only downside is for my family who have to live in what they refer to (on a good 'publishable quote' day) as a house with an 'old car junk yard' attached to it.

But because they know how much I enjoy this activity, they suffer my hobby, although it has cost me a lot financially in various forms of bribes, gifts, and 'deals' to ensure this tolerance is maintained! ∎

Personal Profile

NAME:
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JOB TITLE:
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JOINED NORDIC:
January 2015

BASED:
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INTERESTS INCLUDE:
Restoring cars, DIY, carpentry, squash

"I can observe myself making weekly 'quantum progress' in the projects I am responsible for because all the people, resources, and talent required is located nearby"

nRF52832

In production

Next generation Bluetooth SoC

Cortex M4F

512kB flash / 64kB RAM

Multiprotocol radio

NFC transceiver

Unique Power management system

Unique DMA system

3x3 mm WLCSP

> **For more info go to nordicsemi.com**

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