

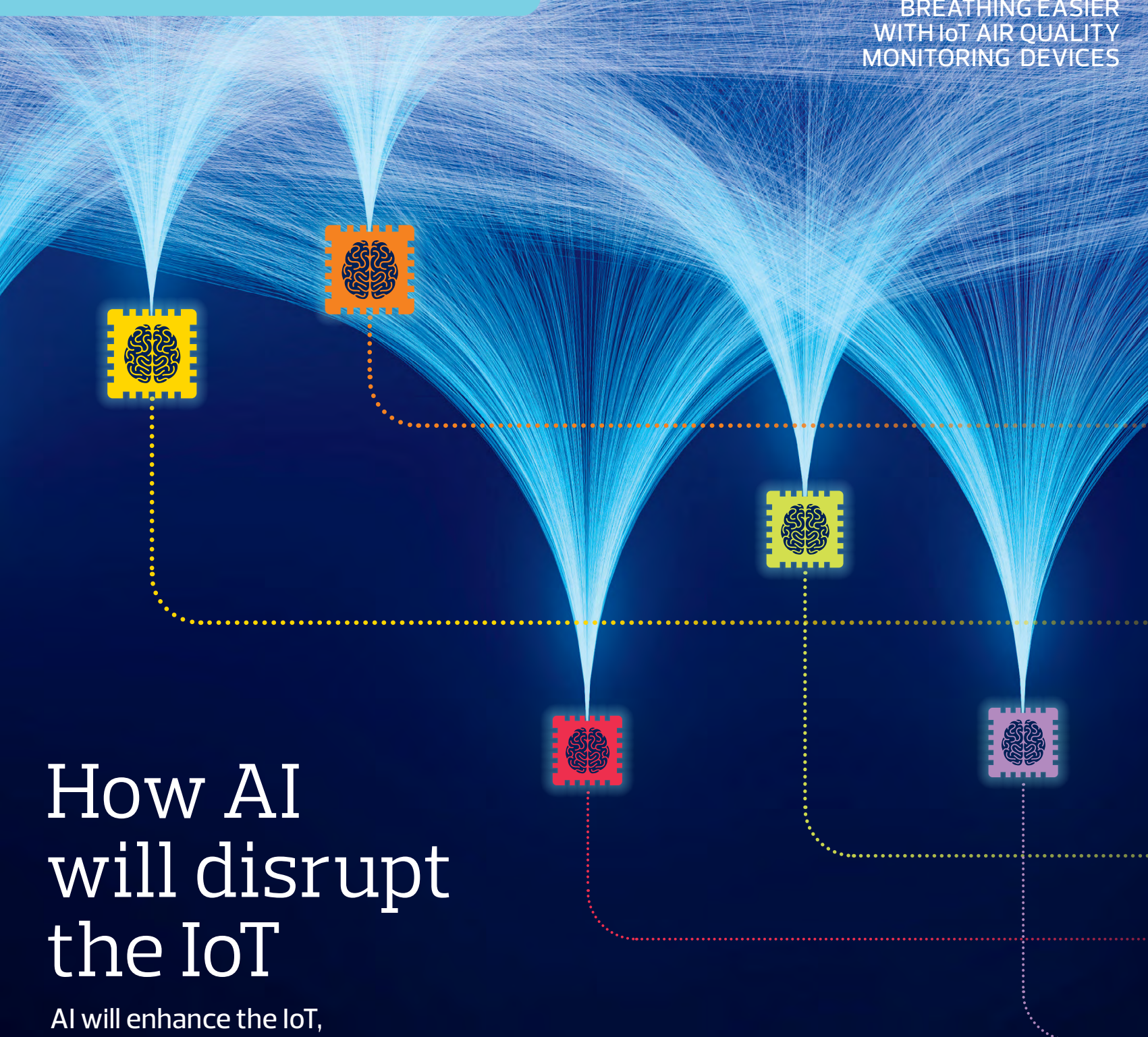


WIRELESS QUARTER



HOME IS WHERE
THE SMART IS:
MATTER MAKES
CONNECTED HOMES
CLEVER

AIR CARE:
BREATHING EASIER
WITH IoT AIR QUALITY
MONITORING DEVICES



How AI will disrupt the IoT

AI will enhance the IoT,
but challenges lie ahead

BLUETOOTH LE
TRANSFORMS THE IIoT

NEW SIP ENHANCES
CELLULAR IoT AND NR+

WHAT'S NEXT FOR
MULTIPROTOCOL SoCs

Issue 1, 2024

Are you ready?



Ultra-low power multiprotocol SoC that takes the nRF52 Series to the next level, with a massive leap forward in performance, efficiency, and security.

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Welcome

Vegard Wollan
CEO



Innovative solutions for tomorrow's IoT

After six months as CEO at Nordic I've come to appreciate the depth of the company's engineering expertise. It ranges across all the foundational technologies of the IoT: [Cellular IoT](#), [DECT NR+](#), [Wi-Fi](#), [Matter](#), [Bluetooth LE](#), [Thread](#) and more. We also have specialist teams designing [range extenders](#) and [Power Management ICs](#). This wide-ranging engineering expertise ensures Nordic is a leading industry player offering a comprehensive range of IoT solutions.

Beyond the technical teams, I also thank every employee at Nordic for their unwavering dedication and hard work, and for maintaining the strong, inclusive company culture that's the backbone of our success.

Our staff makes Nordic far more than a low power wireless IoT company. No firm in the world comes close to Nordic's ultra low power connectivity, but we are also leaders in other key areas of the IoT. For example, our fifth generation SoC, the [nRF54 Series](#), is compact, has superior processing power, generous memory and excellent energy efficiency. Read more about what that means for the IoT's future on [pg12](#). And the [nRF9151 SiP](#) allows designers to build compact, low power cellular IoT and NR+ solutions for massive IoT. Find out more on [pg8](#).

Rather than focusing on individual components, the company is addressing systems-level challenges. The approach makes Nordic a complete solution provider, taking responsibility for an IoT product from battery to antenna and all the way to the Cloud - with each element implemented with the lowest power consumption possible. We work hard to ensure our customers' development processes and time-to-market are as smooth as possible by offering comprehensive software, extensive development tools, a vibrant developer community, integration with industry partners, world-class technical support and [Cloud services](#) throughout the lifetime of their IoT end-product.

In summary, we aim to develop and commercialize solutions that allow developers to design the most energy-efficient products. The nRF54 Series and nRF9151, which are nearing volume production, perfectly achieve that aim, and future launches will build on this strategy.



We aim to develop and commercialize solutions that allow developers to design the most energy-efficient products

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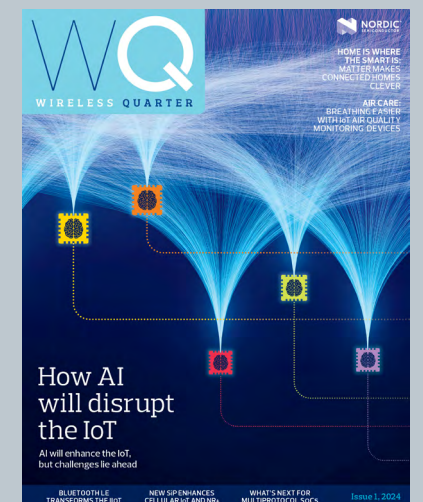
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Connected Health

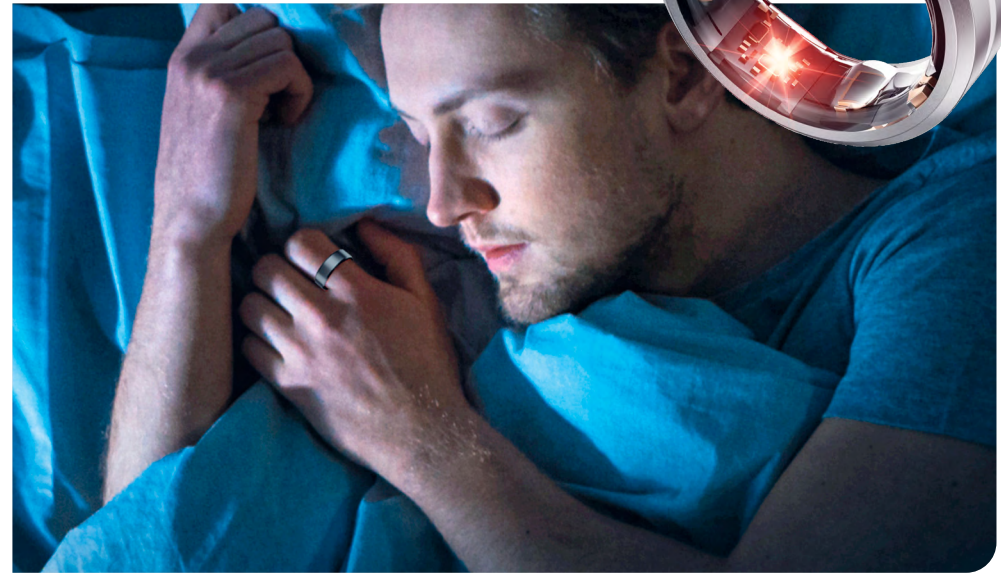
Smart ring delivers non-invasive diabetic risk assessment

Smart digital health solution manufacturer, Joint Chinese Limited, has launched what it claims is the world's first non-invasive diabetic risk assessment smart health ring. The J-Style JCRing is powered by Nordic Semiconductor's nRF52840 SoC. In addition to non-invasive blood glucose estimation, the product integrates a host of additional sensors to record the wearer's VO₂ max, blood oxygen saturation (SpO₂), temperature, heart rate, and heart rate variability (HRV) as well as sleep and activity data.

"The J-Style JCRing is the future of personal health measurement and has been developed for users who need to continuously monitor their body data, as well as people concerned about their personal health and fitness," says Yan Hongwu, General Manager, Joint Chinese Limited.

The J-Style JCRing comes in a miniaturized 8-mm wide and 2.9-mm thick form factor, in a range of U.S. standard ring sizes. Despite its small size, the device offers advanced operation and superior data security, thanks to the Nordic SoC's rich set of features.

The nRF52840 SoC is available in a wafer level chip scale package (WLCSIP) to support both cost- and space-constrained wireless



designs, while its Arm Cortex-M4 processor with floating point unit (FPU) provides ample computational overhead to supervise the sensors and run the sensor algorithms.

The SoC's Arm CryptoCell-310 cryptographic accelerator ensures personal data remains secure on the device and during transmission, which is essential in sensitive health applications.

The nRF52840 SoC's robust and stable Bluetooth LE wireless connectivity enables the user to view and analyze their health data via the JCRing app on their smartphone.

The smartphone iOS and Android app also enables users to set personalized goals and receive health advice, while female users can use the product to manage and track their menstrual cycle.



Connected Health

Overdose prevention device alerts emergency services

Canadian company Lifeguard Digital Health has launched a drug overdose prevention device. The LifeguardLite system will promptly alert emergency services in the case of a suspected overdose, using the cellular connectivity provided by Nordic Semiconductor's nRF9160 SiP.

The mains-powered device allows residents to set a timer when they're about to consume a substance. After finishing their substance

consumption, residents can press the 'I'm OK' button. Should the resident then not extend (using the 'Extend' button) or cancel the timer, an alarm will sound for the last ten seconds of the allotted time, and if the alarm is still not switched off during that time the device will notify both building administration and emergency medical services.

Residents can also use the solution to alert staff of other emergencies, simply by

pressing the 'Start' button and letting the timer expire.

"The intended market for the LifeguardLite is organizations that manage social housing buildings, as the devices can be installed in individual rooms," says Jeff Hardy, CEO at Lifeguard. "There's also opportunity for [the product] where there are high incidents of overdoses, such as public bathrooms and supervised consumption sites."

Waste Management

Streamlined container management and logistics

Norwegian company Sensorita has launched a smart waste management solution designed for businesses that maintain and collect waste containers. The Sensor1 uses radar technology based on research from the Norwegian University of Life Sciences to assess the fill levels and contents of large waste receptacles. This data is then processed on the Sensorita Cloud platform to assist in the management and collection of these containers.

"The problem that waste companies have is that once a container is placed with a customer, it essentially becomes invisible," says Ulrikke Lien, CEO at Sensorita. "Sensorita solves this problem by providing a rugged sensor with radar and GNSS that can be retrofitted to existing containers."

"The sensor takes radar images of the inside of the container multiple times per hour, which are then sent to the Sensorita Cloud platform for analysis. Our Machine Learning [ML] algorithms are trained on millions of radar images, and are able to estimate how full the receptacle is and the main material it contains."

The Sensor1 is powered by Nordic's nRF9160 SiP, using its Arm Cortex-M33 processor to



oversee the imaging process. Additionally, the nRF9160 employs a combination of cellular network location data and GNSS trilateration to record the precise location of each container. This data is then transmitted to the Sensorita Cloud platform through the LTE-M/NB-IoT modem integrated into the Nordic SiP.

The platform uses ML algorithms to analyze the data, calculating fill levels and predicting optimal emptying schedules, offering notifications, status updates and integration with route planning tools. It also provides the container ID, location, customer specifics, bin type and waste categorization.

Smart City

Smart streetlight controllers turn LED luminaires into IoT assets

Launched by leading smart city solutions provider, obiWAN (formerly Urban Control), a range of smart streetlight controllers can convert a regular LED luminaire into an IoT asset. Once fitted, the Zhaga obiWAN DCobi-NBZG, the matchbox-sized internal obiWAN DCobi-NBIN and the NEMA obiWAN ACobi-NBNM controllers can be used to access information about the smart luminaire's precise location, identity and health status. The devices can also be used to remotely control, monitor and meter the luminaire. The controllers can dynamically adapt to several scenarios to provide better lighting and save more energy.

Additionally, several sensors—including a location, ambient light, mains power monitoring, temperature, and tilt and impact—

can be connected to the lighting interface of the smart controllers, with the acquired data relayed to a smart city Central Management System (CMS). A variety of sensors compatible with the intelligent lighting interface can also be deployed around the streetlight controller, such as a movement detection, light spectrum, and people/vehicle identifier and counter.

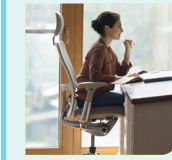
Each obiWAN luminaire controller is powered by Nordic Semiconductor's nRF9160 SiP, with sensor data transmitted directly to the Cloud via Nordic-enabled cellular IoT connectivity.

To make its products more compact and with lower power consumption, the company plans to become the first Nordic customer to use Onomondo's new SoftSIM, a software-based, UICC SIM.



In Brief

CONTEST WINNER PROVIDES POSTURE REMINDERS



A connected wearable solution that uses end devices such as smart home lighting to remind people working in home offices to correct their posture has won top prize in the inaugural Nordic Semiconductor and Hackster.io 'Make it Matter' design competition. The 'Gently Communicating Home using Matter' winning project employs a body-worn Bluetooth LE-powered IMU and flex sensors—used to monitor the wearer's posture—connected to a Bluetooth LE to Matter bridge. The Matter enables the sensors to connect to any Matter smart home device to provide a visual prompt to the user to correct their posture if the sensors detect they are slouching.

The platform uses ML algorithms to analyze the data, calculating fill levels and predicting optimal emptying schedules, offering notifications, status updates and integration with route planning tools. It also provides the container ID, location, customer specifics, bin type and waste categorization.

CELLULAR MODEL ELEVATES UAV EFFICIENCY



Researchers from the University of Missouri-Kansas City, have developed a model, dubbed GREENSKY, that enhances the energy efficiency and operational time of unmanned aerial vehicles (UAVs) in cellular networks. UAVs play a pivotal role in rural, remote and disaster-struck areas where traditional network infrastructure is absent. The GREENSKY model optimizes the recharging and routing processes for UAVs, maximizing flight duration while minimizing energy consumption. The model strategically uses existing cellular base stations as charging points, significantly reducing travel distances for recharge.

German systems engineering and development company, Systemtechnik LEBER GmbH, has joined Nordic's growing Nordic Partner Program (NPP) as a design partner. For more than 30 years, Systemtechnik LEBER (STL) has been providing development services in the field of embedded and mechatronics systems. The company offers finished products as well as design services for customer-specific development. These development services range from schematic and layout design to hardware, firmware and software development, as well as complete product development with all necessary tests and approvals.

SYSTEMTECHNIK LEBER JOINS PARTNER PROGRAM



German systems engineering and development company, Systemtechnik LEBER GmbH, has joined Nordic's growing Nordic Partner

Program (NPP) as a design partner. For more than 30 years, Systemtechnik LEBER (STL) has been providing development services in the field of embedded and mechatronics systems. The company offers finished products as well as design services for customer-specific development. These development services range from schematic and layout design to hardware, firmware and software development, as well as complete product development with all necessary tests and approvals.

Audio & Music

LE Audio/ Auracast broadcast audio TV streamer unveiled

Global hearing technology solutions provider, GN Group, has launched a world first [Bluetooth LE Audio](#) ('LE Audio') and Auracast broadcast audio TV streamer. The product enables people suffering from hearing loss to stream hi-fidelity audio between their television and their hearing aids, with all the benefits of Auracast. Working seamlessly with the company's new ReSound Nexia hearing aids or other LE Audio compatible solutions, the TV-Streamer+ integrates a Nordic Semiconductor LE Audio- and Auracast-capable wireless SoC. The SoC delivers low power, low latency and long range wireless connectivity together with improved audio quality.

"The new TV-Streamer+ gives people with hearing loss immediate speech clarity at their preferred volume while at the same time



supporting Auracast," says Thomas Olsgaard, a Principal Engineer with GN.

By using the new Nordic-powered TV-Streamer+ it's possible to stream audio from any sound source such as a television, to an individual or a group using receiving devices such as ReSound Nexia hearing aids or Auracast-compliant wireless earbuds, for example. This means the wearer of the hearing aids can hear the audio stream with perfect clarity by adjusting their sound preferences via the ReSound Smart 3D app

on their smartphone, while their friends and family members can simultaneously listen at a comfortable volume directly via the audio source, or through their own Auracast-compliant hearing device.

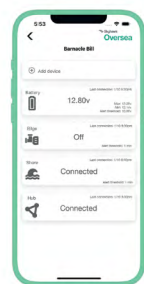
GN has also integrated Nordic's [nRF52840](#) SoC into the ReSound Nexia hearing aids' charging case, enabling seamless wireless connectivity between the hearing aids, the charging case, and the associated smartphone app. This provides smart charging and battery level updates.

Asset Tracking

Remote boat monitoring system operates for years on batteries

U.S. connected electronics engineering company, Skyhawk, has launched a cellular IoT-based monitoring system that provides boat owners with peace of mind that their boats are safe, secure, seaworthy and ready to go. The Skyhawk Oversea solution is designed for both powerboat and sailboat owners and is comprised of sub-GHz RF sensors and a battery-powered cellular IoT gateway—the Oversea Hub—which employs Nordic Semiconductor's [nRF9160](#) SiP.

The cellular connectivity ensures boat owners can constantly keep track of the location and status of their boat via the Oversea smartphone app. The solution recently won the 2024 Innovation Award for Consumer



Electronics and Mobile Apps at the Miami International Boat Show.

The user can select from a suite of sensors reporting a wide range of data for remote boat monitoring including battery voltage, bilge pump activity, shore power connection, entry, passive infrared motion, sound, temperature & humidity, high water and directional sensors. This data is transmitted to the water- and dust-proof Oversea Hub which in turn relays the sensor data to the Cloud using the LTE-M/NB-IoT modem in the Nordic SiP. Additionally, the nRF9160 SiP employs a combination of cellular network location data and GNSS trilateration to record the precise location of each gateway and boat.



By the Numbers

\$17.6 billion by 2029

The global [cellular IoT](#) market is predicted to be worth \$17.6 billion by 2029—up from an estimated \$6.2 billion in 2024—according to recent data by market analyst Mordor Intelligence. The company's report said the increasing adoption of advanced technologies alongside an increasing number of connected devices, were two of the major factors expected to fuel the global growth of cellular IoT.

Wearables

Bluetooth LE hybrid smartwatch delivers accurate health data

French consumer electronics company Withings has launched an advanced, hybrid smartwatch which provides wearers with accurate, around-the-clock health metrics in an elegant 'diver style' stainless steel design. The lightweight, water resistant ScanWatch Nova integrates temperature, accelerometer, altimeter and multi-wavelength photoplethysmography (PPG) sensors in a compact form factor. The watch can deliver a wide range of health data to enable wearers to better manage their health over time.

Equipped with Nordic Semiconductor's [nRF52840](#) SoC to supervise the sensors and provide wireless connectivity, the smartwatch generates a wide range of health data including 24/7 temperature tracking, on-demand electrocardiogram (ECG), heart rate and heart rate variability (HRV), sleep parameters, respiratory insights, activity tracking as well as menstrual cycle tracking. The nRF52840 SoC's Arm Cortex-M4 processor provides ample computational power to run the sensor algorithms, while the Bluetooth LE wireless connectivity enables the user to review their daily health metrics, view historical trends



and get insights into their health from the associated iOS and Android smartphone app.

"ScanWatch Nova is a 24/7 hybrid smartwatch that allows the user to monitor and understand their health on a deeper level than was previously possible," says Matthieu Menanteau, Head of consumer products at Withings. "From one wrist-worn device you can detect the onset of illness with day and night body temperature fluctuation tracking, detect potential cardiac anomalies, measure your blood oxygen levels, as well as help boost your activity and achieve a more restful sleep."

Asset Tracking

Wireless technologies combine for indoor/outdoor asset tracking

India-based Tavago Tech has developed an asset tracker employing a combination of cellular IoT, GNSS, Wi-Fi and Bluetooth LE wireless technologies. The Tuff device enables the detection of asset movement, operation and tampering. It is a battery-powered locationing device designed to enable global indoor and outdoor tracking of personnel, cargo and assets. It features a vibration sensor to detect asset operation parameters, a highly accurate three-axis accelerometer for movement detection, a device tamper sensor to detect if the device is tampered with or opened, and a sensor to detect if the device is removed from the asset.

Equipped with the Nordic nRF9160 SiP, Tuff employs low power GNSS and NB-IoT connectivity for both indoor and outdoor

tracking. The cellular connectivity relays data to the Cloud. In addition, the Nordic [nRF7000](#) Wi-Fi 6 Companion IC facilitates indoor locationing based on the SSID of Wi-Fi access points. The solution also employs the Nordic [nRF52833](#) SoC to serve additional use cases by pairing with Bluetooth LE beacons or to provide standalone Bluetooth LE connectivity.

Tavago Tech uses Nordic's nRF Cloud for assistance when acquiring GPS, cellular and Wi-Fi location information from the nRF7000 and [nRF9160](#).

Tuff uses a rechargeable Li-ion battery and integrates the Nordic [nPM1100](#) Power Management IC (PMIC).

Common use cases include tracking lost pets, personal valuables and moving items, vehicles and high value cargo.



NORDIC ENDORSES CSA DEVICE SECURITY INITIATIVE



Nordic has endorsed the [Connectivity Standards Alliance's \(CSA\) IoT Device Security Specification 1.0](#), the alliance's accompanying

certification program and the Product Security Verified Mark. Nordic's support underscores its commitment to enabling the highest security standards for wireless IoT products. The CSA's IoT Device Security Specification 1.0 advances standardization of IoT security, providing a comprehensive framework for manufacturers to ensure their products are secure by design. The specification consolidates the requirements from major international IoT device security specifications and regulations.

ONE STEP CLOSER TO GROWING PLANTS IN SPACE



Highly stretchable sensors can monitor and transmit plant growth information without human intervention, report University of

Illinois Urbana-Champaign researchers in the journal, *Device*. According to study co-leader, chemical and biomolecular engineering professor, Ying Diao, the polymer sensors—Stretchable-Polymer-Electronics-based Autonomous Remote Strain Sensor or SPEARS2—are resilient to humidity and temperature, can stretch over 400 percent and send a wireless signal to a remote monitoring location. NASA is investigating how to use the tech in space to feed astronauts during long missions.

PRIVATE CELLULAR IOT SET TO BOOM



ABI Research forecasts there will be 108 million IoT connections on private LTE (4G) and 5G networks in the manufacturing sector

by 2030. Manufacturing will be the biggest market for private 5G-IoT, according to the analyst, while the transportation industry will have 71 million IoT connections on networks in the same timeframe. ABI Research suggests the criticality of the manufacturing sector, in particular, is driving interest in LTE and 5G networks, and will tend towards cellular as a transport technology for data from more critical-grade IoT sensor applications. The firm cited automation of heavy machinery as a critical driver for private cellular.

Cellular IoT & DECT NR+

New nRF91 Series SiP enhances advanced cellular IoT and DECT NR+ applications

The nRF9151 reduces power consumption and component footprint while streamlining the development process

Cellular IoT (LTE-M/NB-IoT) is fast becoming the [leading LPWAN](#). According to IoT Analytics, NB-IoT and LTE-M made up 57 percent of the global LPWAN installed base in 2022.

The tech has global reach, is robust, features low power consumption and long range, and is highly secure. These attributes make cellular IoT an ideal connectivity solution for a whole host of applications.

To support these applications, Nordic Semiconductor has extended its nRF91 Series low power SiP for cellular IoT and DECT NR+ ('NR+') family with the introduction of the [nRF9151](#). The new SiP joins the nRF9160 and nRF9161, enhancing the company's end-to-end cellular IoT offering.

Previously, cellular IoT design has involved sourcing components from various suppliers, leading to challenges in cost, performance and power efficiency for developers. With its end-to-end strategy, Nordic now simplifies cellular IoT by providing an integrated solution encompassing hardware, software, tools, Cloud services, and support. (See [WQ Issue 2, 2023 pg10](#).)

The nRF9151 comprises a dedicated Arm Cortex-M33 programmable application processor with 1MB Flash and 256 KB RAM, multimode LTE-M/NB-IoT modem with DECT NR+ support and GNSS, power management, RF Front End, passives and crystals, all designed by Nordic.

The SiP fulfils 3GPP release 14 LTE-M/NB-IoT and the integrated modem ensures global connectivity without regional limitations. Support for an NR+ stack enables the SiP to support license-free Massive IoT applications.

"With the nRF9151, Nordic is targeting a crucial gap in the market, streamlining the development process, and reducing both the power consumption and footprint of cellular IoT and NR+ solutions," says Kjetil Holstad, the company's EVP Strategy and Product Management.

Compared with its nRF91 Series predecessors, the nRF9151 features a significant footprint reduction of 20 percent (measuring 12 by 11 mm). This allows for compact end-products without performance compromises.

In addition to Power class 3 (23 dBm), the nRF9151 also supports Power class 5 (20 dBm) output power, leading to 45 percent reduced peak power consumption.

And a resilient supply chain for the SiP ensures customers have a guaranteed volume supply.

Accelerating the development process

"The nRF9151 is a game changer for developers looking to scale their cellular IoT and NR+ products globally," says Kristian Saether, Product Director – Cellular IoT with Nordic. "That's because it's designed to accelerate the



Nordic's nRF9151 SiP extends the nRF91 Series for applications such as smart agriculture



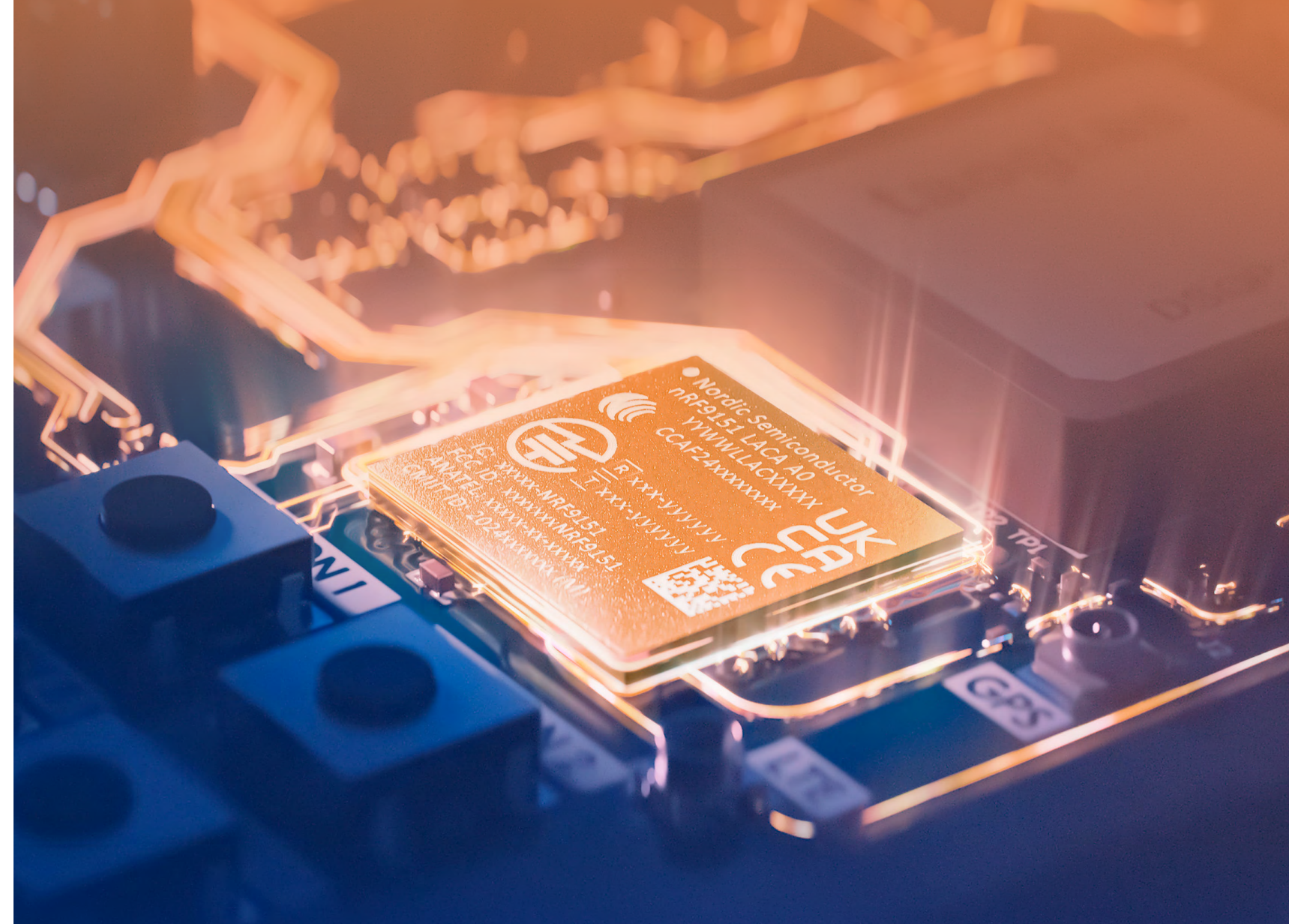
The nRF9151 SiP is not just a component, it's a highly integrated solution used to pioneer new IoT designs

development process and streamline the path to market. The SiP is not just a component, it's a highly integrated solution used to pioneer new IoT designs."

The nRF9151 is compatible with all the nRF91 Series software and tools, for example [nRF Connect SDK](#), nRF Connect for VS Code IDE and nRF Connect for Desktop. This allows customers designing with the nRF9151 to start their development project using the nRF9161DK and move over to the nRF9151 as soon as it's available.

Nordic's unified and scalable nRF Connect SDK includes apps and samples and the free-to-use nRF Connect for VS Code IDE. The IDE includes everything expected of modern design software. nRF Connect for Desktop includes a power profiler (requiring purchase of Nordic's [Power Profiler Kit II](#)) and a cellular monitor which analyzes modem traces, evaluates communication and enables network testing. These are powerful tools for debugging and development. (See [WQ Issue 4, 2023 pg36](#).)

The nRF9151 is compatible with Nordic's nRF Cloud. nRF Cloud is a Cloud service optimized for low power wireless devices. It includes services for locationing, device management, secure provisioning and identity, and firmware-over-the-air (FOTA) updates. The nRF9151 is expected to enter production by the end of this year.



Low power nRF9151 SiP

Lowest power cellular IoT solution for Massive IoT

Highly integrated and compact SiP supporting 3GPP release 14 LTE-M/NB-IoT and DECT NR+

SUBSCRIBE TO STAY UPDATED!

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Internet of Things

Bluetooth tech transforms the Industrial Internet of Things

Bluetooth wireless connectivity is enabling digital transformation across the IIoT, allowing industrial enterprises to overcome challenges and improve operations

To meet economic, supply chain, and regulatory challenges, while boosting operational visibility, efficiency, and productivity, industrial enterprises are increasingly investing in digitization and networking. A foundation technology behind this reshaping of the factory is the Industrial Internet of Things (IIoT) – an ecosystem of devices, sensors, applications, and associated networking equipment that collect, monitor, and analyze data from manufacturing operations.

'Industry 4.0' uses the IIoT to support large scale automation of traditional manufacturing practices, using widespread machine-to-machine communication (M2M), edge computing, and Machine Learning (ML).

Fundamental to this digital transformation is low power wireless connectivity. Wireless networks link machine tools, programmable logic controllers (PLCs), sensors, gateways, and the Cloud, enabling every part of the factory to gather and process data and share information with every other part and the wider Internet.

Although no single wireless technology can address the demands of every IIoT application, recently published research indicates there are growing opportunities for [Bluetooth LE](#) tech in the industrial setting.

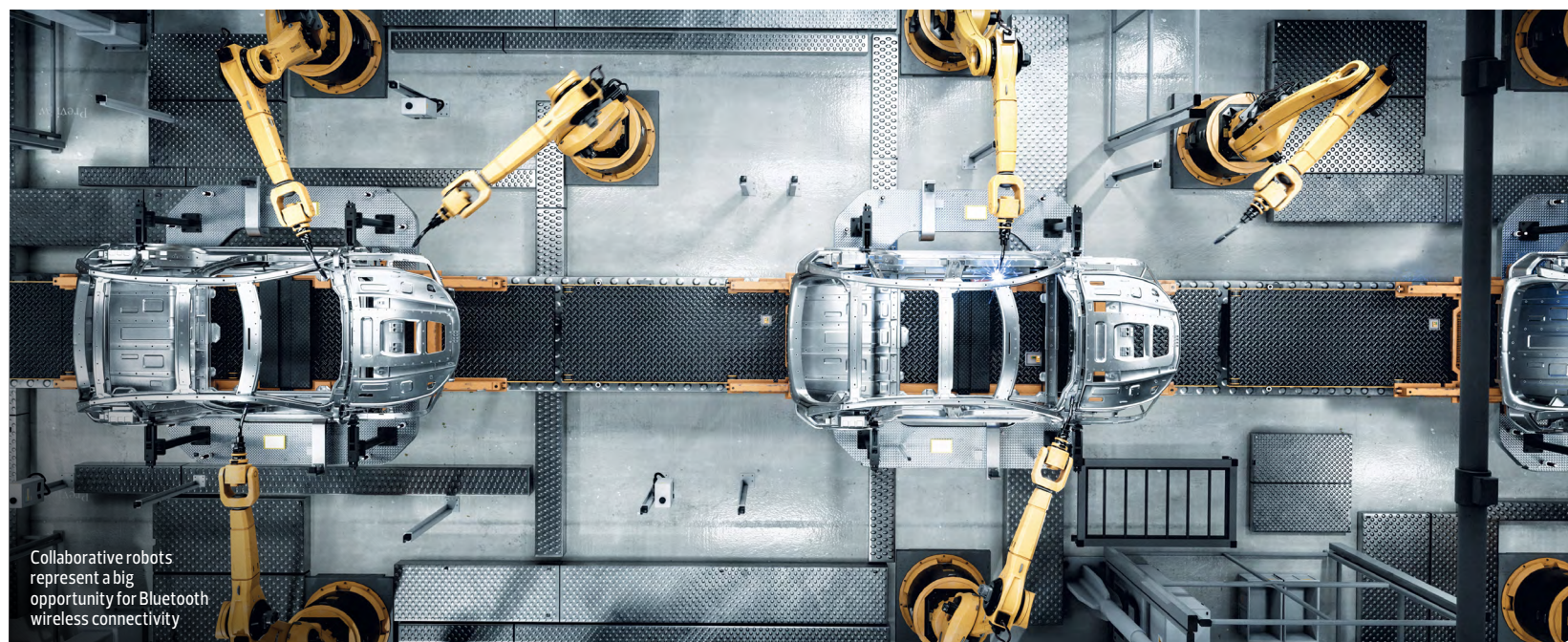
From consumer to factory manager

Despite softer consumer demand, the Bluetooth LE market has grown through 2022 and 2023, thanks in part to the expansion in industrial automation, according to the 2023 Wireless Connectivity Market Analysis market research report by Techno Systems Research (TSR). Further, the Bluetooth-enabled industrial devices market is expected to grow from 143 million annual unit shipments in 2023 to over 611 million by 2028, achieving a CAGR of 34 percent over the five-year forecast period, according to analyst ABI Research.

The ABI Research report shows real-time location systems (RTLS) and asset tracking represent the largest opportunity thanks to the availability of low-cost, Bluetooth LE tags that provide high-accuracy location services across a number of enterprises.

The second largest market is set to be commercial building automation, expected to grow from just 8.5 million units in 2022 to over 135 million annual unit shipments by 2028. This will also represent the fastest growth market in the industrial sector.

Other growth markets in the report include Bluetooth LE condition monitoring and predictive maintenance devices that are forecast to grow to 7 million annual unit



Collaborative robots represent a big opportunity for Bluetooth wireless connectivity

shipments and nearly 10 million annual unit shipments respectively by 2028.

Here come the robots

The ABI report notes another key opportunity for Bluetooth in industry is robotics. It says while many robots require wired connectivity, growing opportunities exist for Wi-Fi and Bluetooth LE to enable autonomous navigation, and robot-to-robot communication.

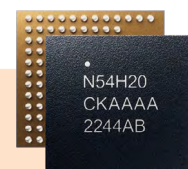
The largest opportunity both from an adoption and market size perspective will come from mobile robots that can send data about position, load, battery level, and additional metrics when traveling through an industrial environment. In addition to navigating dynamic environments, having a direct Bluetooth connection to a smartphone, tablet, or industrial HMI/Personal Computer (PC) can enable updating tasks or routes at any time.

ABI Research claims there are several inherent benefits of Bluetooth technology for industrial applications, including resilience to interference and robustness, ultra low power consumption, a ubiquitous presence in mobile and computing devices, and a strong presence in enterprise wireless infrastructure and IIoT gateways.

"If one looks at virtually any aspect of enterprise and



Research indicates that within industrial settings there are growing opportunities for low power Bluetooth technologies in particular



Need to Know

Nordic Semiconductor's new nRF54H20 SoC provides processing power and memory that make it perfect for running ML models and supporting next generation applications. This will help drive IIoT systems, which are already fueling smart factories and the growth of Industry 4.0

Krzysztof Loska

Technical Product Manager, Nordic Semiconductor



How to accelerate widespread adoption of Matter

Matter is gaining traction, but work still lies ahead

Matter is a standard protocol from the Connectivity Standards Alliance (CSA) that ensures interoperability between smart-home devices from different vendors.

With the backing of smart home ecosystem providers such as Amazon, Apple and Google plus chipmakers such as Nordic Semiconductor, the Matter protocol is gaining traction. However, smart homes still require some adaptations to accelerate widespread adoption of Matter. Specifically, two levels of integration are needed to encourage Matter adoption.

With the backing of the smart home sector, the Matter protocol is gaining traction

The first level of integration is the network infrastructure to enable Matter operation, for example, Wi-Fi access points supporting interactions with Matter over Wi-Fi end devices and second, Thread border routers to enable interactions with Matter over Thread end devices. Set-top-boxes (STBs) and Internet gateways with added Thread border router functionality are helping with the first layer of integration by delivering the Internet Protocol (IP) infrastructure required for Thread devices.

Second, widespread adoption demands Matter integration with European- and China domestic-based smart home ecosystems. What's needed is Matter Controller integration with these ecosystems' smart-speakers, -displays,

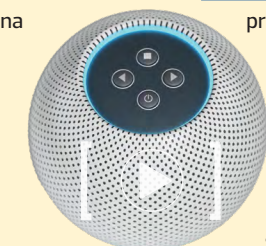
-home hubs and other smart-home products, and associated mobile apps and Cloud integration for remote controls. Today, European and China consumers tend to use a Matter Controller from one of global ecosystems vendors (for example, Amazon, Apple, Google or Samsung), but integration of Matter with local smart home ecosystems would further accelerate its adoption.

Smart-home vendors should also be aware there are still some compatibility issues and even the ecosystems that have integrated Matter do not support it equally. First, the ecosystems don't support all device types available in the Matter specification, and the set of supported device types is different for each ecosystem. Second, not all ecosystems support all features for every device type. For example, while everyone supports moving blinds up and down, not all ecosystems yet support slat rotation on slatted blinds. Fixing those issues is necessary for a widespread adoption of Matter.

Finally, greater traction of Matter demands powerful wireless chips because they need to support Bluetooth and Thread or Wi-Fi, as well as feature enough computing power and memory to run the Matter stack. Even more resources will be needed if the chip is to support advanced smart-home applications in addition to running Matter.

Nordic is a member of the CSA and its fifth-generation SoC, the

nRF54H20 is an example of a product perfectly matched to tomorrow's Matter demands. The SoC features plenty of computing power combined with lots of non-volatile memory and RAM.



How AI Will Disrupt the IoT

Incorporating AI into the IoT will dramatically enhance its capability and flexibility. But first significant engineering challenges will need to be overcome

In Short

By incorporating Machine Learning, edge devices move beyond just checking data to inferring what change means – and then do something about it

Many of today's IoT-connected devices, while able to perform edge computing, lack the resources to run contemporary ML models. A solution comes in the form of Tiny Machine Learning

Despite the tough engineering challenges, developers are already introducing IoT products with ML into the commercial sector

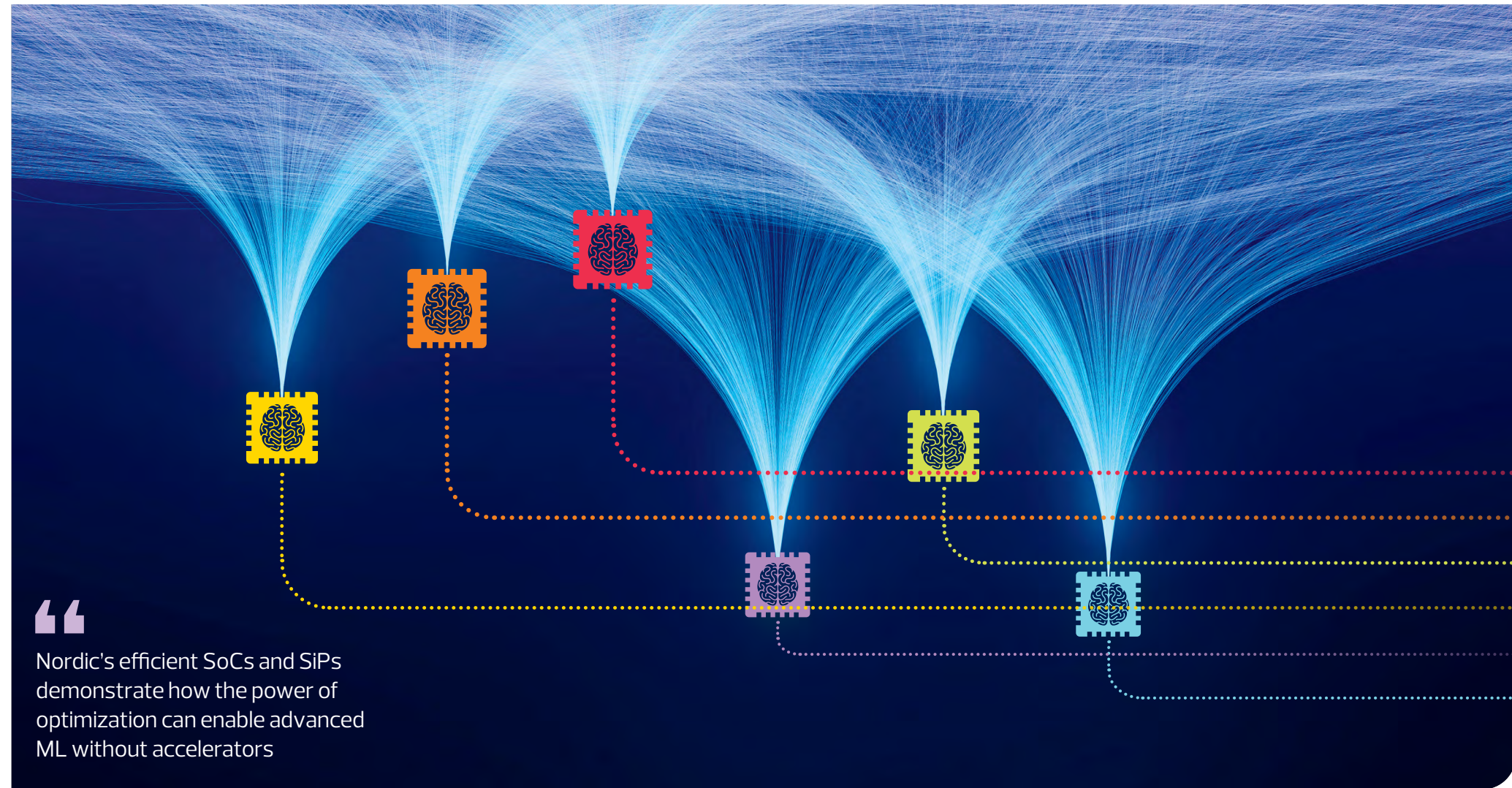
Back in 1956 Allen Newell, Cliff Shaw and Herbert Simon put together a computer program called *The Logic Theorist*. Funded by the RAND Corporation, the program intended to mimic the problem-solving skills of a human and is considered by many to be the first example of Artificial Intelligence (AI).

Fast forward to today, and the poster child of AI is the large language model (LLM). LLMs are computational algorithms that achieve general-purpose language generation and other natural language processing tasks by learning statistical relationships from text documents during an intensive training process. OpenAI's ChatGPT is perhaps the best-known example.

Useful though they are, LLMs are a niche application of AI. Where things get exciting is when huge volumes of data collected by automated systems are used to feed Machine Learning (ML) algorithms. ML is an application of AI that allows computers to learn without direct programming or instruction – continually enhancing the machine's intelligence.

And with the IoT we have a global interconnected network with the capacity to collect a virtually limitless volume of data. That data cannot only be fed to computers in the Cloud, but it can also be used to fuel ML algorithms that enhance the intelligence of the billions of connected devices making up the IoT. This means even the most modest IoT device can become continually smarter, offering huge potential for the future of industry, commerce, education, medicine and more.

For example, consider the lowly refrigerator. There are billions of them across the world consuming fully 12 percent of global electricity consumption. By constantly feeding ML models with external and internal temperature data, how much food is stored in the cabinet, how often the door is opened, and advanced data such as when the load on the electricity grid is lower, a smart fridge



Nordic's efficient SoCs and SiPs demonstrate how the power of optimization can enable advanced ML without accelerators

compressor controller can rapidly adapt to usage patterns and have a significant impact on both energy usage and carbon emissions. It's a rosy picture. The challenge is bringing together the hardware and software to make it all seamlessly work.

MOVING TO THE EDGE

In 1999, when Kevin Ashton coined the phrase "the Internet of Things" his vision of the network was different from today's IoT. Ashton saw billions of cheap and compact sensors feeding their data to powerful centralized computing resources where the heavy computation would be done. Ashton's forecast was visionary but flawed; sending continuous data from many devices across a network is complicated, energy-intensive and expensive.

Today we minimize network traffic by distributing the IoT's intelligence to the edge. This is possible because contemporary IoT devices, while still featuring modest resources compared with Cloud computers, have matured into impressive products complete with dedicated application processors and ample memory resources. That has allowed the IoT to support widespread distributed computing resources whereby individual devices are capable of significant edge processing.

At the most basic level, edge processing enables IoT devices to locally sift through data to decide which is mundane and which indicates things are changing and should be forwarded for further analysis. By adding ML to the mix, edge devices move beyond just checking data to see if it has exceeded preset thresholds, to inferring what the change means – and then doing something about it.

"Nordic Semiconductor calls this new capability 'Edge AI', and it brings some key advantages to IoT products," says Kjetil Holstad, EVP Strategy & Product Management with the company, a global provider of wireless solutions for the IoT. "Inputs can be processed locally in real time, so there's no need to use bandwidth to send raw data across a wireless link and no time is wasted waiting for a response from the Cloud. Secondly, local processing uses less power than sending data over the air, allowing an IoT device to operate for longer or use smaller batteries.

"Finally, and perhaps most importantly, by adding Edge AI to their devices Nordic customers can add new and innovative features to their products that make them stand out from competitors," adds Holstad.

One example of such a feature is a temperature sensor monitoring a machine bearing. The sensor could use an ML model to infer that a gradual temperature increase in the bearing is simply the machine warming up and not

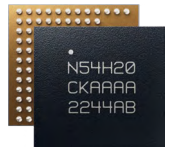
something about which to be concerned. But a more rapid bearing temperature increase could be indicative of lubrication failure and trigger the sensor to shut the machine down before damage occurs.

"Data is the fuel of any predictive maintenance engine. Its quality and quantity is the limiting factor for analyzing root causes and predicting failures well ahead of time," says consultant Deloitte in its *Predictive Maintenance* positioning paper. The IoT provides this precise data in spades and together with Edge AI brings massive economic potential to the predictive maintenance sector.

Deloitte says unplanned machine downtime is costing industrial manufacturers an estimated \$50 billion each year. By implementing predictive maintenance, the company says material cost savings amount to five to 10 percent a year on average; equipment uptime increases by 10 to 20 percent; overall maintenance costs are reduced by 5 to 10 percent; and maintenance planning time is reduced by 20 to 50 percent.

THE ENGINEERING CHALLENGE

Enhancing the IoT with AI and ML will only bring benefits, but implementing the technology at scale is challenging. Many of today's advanced ML models require significant



Tech Check

The nRF54H20 features multiple Arm Cortex-M33 and RISC-V processors and ample Flash and RAM memory. Equipped with Edge Impulse's TinyML software, the SoC can run advanced ML models

By the Numbers

\$117 billion
Global Machine Learning market in 2027

Source: AI Multiple Research

\$2.5 billion
Value of Tiny ML shipments in 2030

Source: ABI Research

10%
Savings from AI in annual U.S. healthcare spending (approx. \$360 billion)

Source: National Bureau of Economic Research

computing resources and power consumption to perform inference (in other words running the ML models and making decisions based on the data input). But a huge number of today's IoT-connected devices, while able to perform some edge computing, lack those resources.

A solution comes in the form of Tiny Machine Learning or TinyML (a trademarked term from the TinyML Foundation which has become synonymous with the technology). TinyML is a subsector of ML that streamlines the tech to make it suitable for battery-powered, microcontroller-based embedded devices. TinyML enables compact IoT sensors to perform ML tasks with real time responsivity.

While TinyML has enabled today's wireless SoCs to support ML, tomorrow's new generation of hardware will be able to run far more advanced ML routines. For its part, Nordic Semiconductor has invested millions of research dollars to bring this hardware to market.

"We've engineered our low-power SoCs to run ML in such an optimized way we don't need dedicated ML accelerators," explains Nordic's Holstad. "The key is to marry innovative engineering to maximum data processing and minimum power consumption."

"As AI and ML in the IoT evolves, so will the demands that will be placed on it; that could mean a future where ultra low power embedded devices do feature dedicated ML accelerator cores. But for now, our efficient SoCs and SiPs demonstrate how the power of optimization can enable advanced ML without accelerators."

Examples include Nordic's dual core [nRF5340](#) and the new, fifth generation wireless SoC, the [nRF54H20](#). These

“ By adding Edge AI to their devices engineers can add new and innovative features to their products that make them stand out from competitors



SoCs are powered by Edge Impulse's TinyML software. (See sidebar *Nordic Inside: Machine Learning for battery-powered sensors*.)

"With the nRF53 and now the nRF54 Series, Nordic has successfully broken the trade-off between processing power and power consumption," explains Holstad. "That means developers have immediate access to the high processing power and low power consumption needed to support advanced ML on battery-powered SoCs. And Nordic also supplies all the development tools and software needed for them to embark on their ML projects."

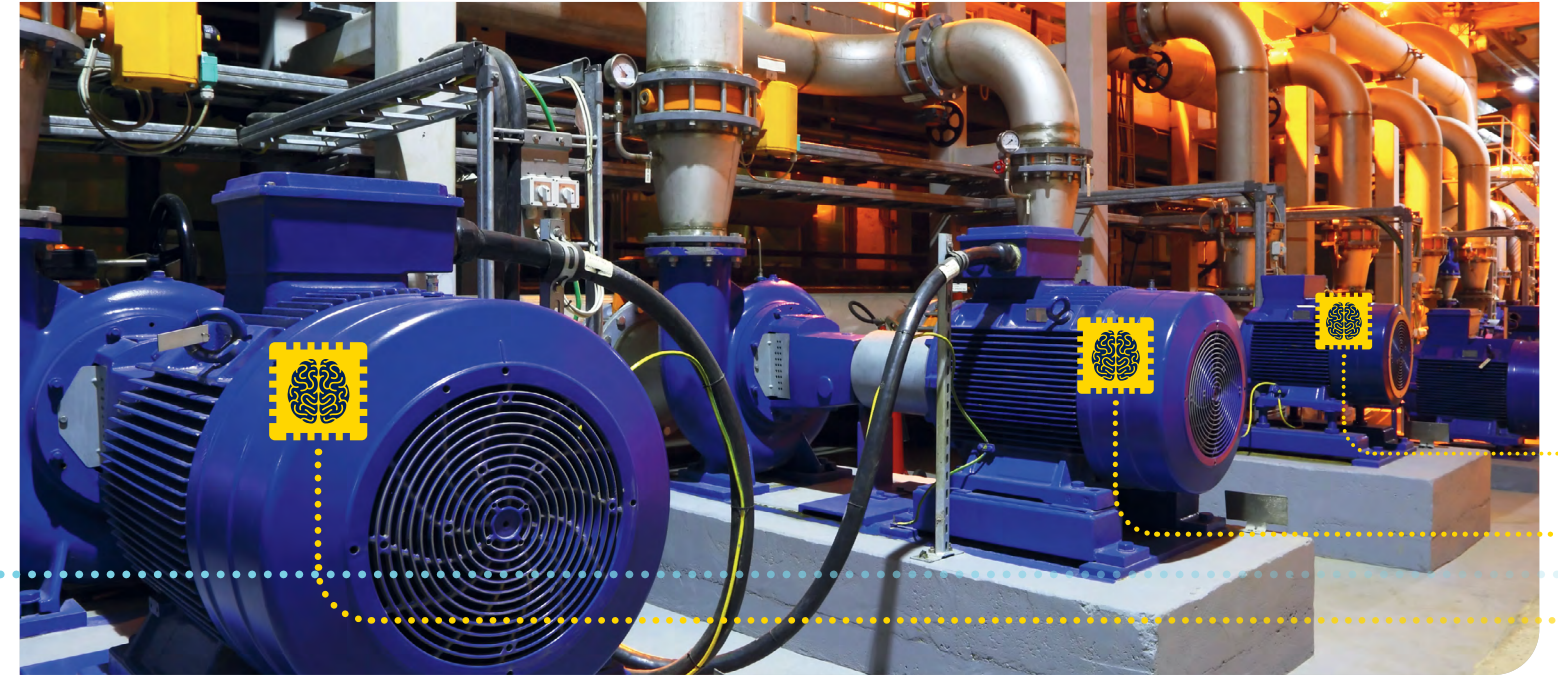
ML IN ACTION

Despite the tough engineering challenges, developers are already introducing IoT products with ML into the commercial sector. One example is Norwegian company [Sensorita](#). The firm has launched a smart waste management solution based on Nordic's [nRF9160](#) SiP cellular IoT product. Sensorita's device uses radar technology based on research from the Norwegian University of Life Sciences to assess the fill levels and contents of large waste receptacles.

"Customers move waste disposal containers and dispose of different waste than agreed, and the waste company then has no idea how full the container is, what's in it or when it should be picked up," says Ulrikke Lien, CEO at Sensorita. "This creates problems for logistics and production planning, not to mention increased CO₂ emissions from unnecessary pickups."

Sensorita has addressed the problem with a rugged sensor incorporating radar and GPS. The sensor takes radar images of the inside of the container multiple times per hour, and these are then sent to the Sensorita Cloud platform for analysis. Using ML algorithms trained on millions of radar images, the sensor can estimate how full the receptacle is and the main material type it contains.

The nRF9160 SiP uses cellular network location data and



GNSS trilateration to record the precise location of each container and transmits the sensor data to the Sensorita Cloud platform through its LTE-M/NB-IoT modem.

Sensorita also uses ML to optimize the route taken by trucks as they travel round cities emptying the waste containers. The results are fuel savings, reduced man-hours and lower carbon emissions.

More efficient fridges, predictive maintenance and waste bin optimization are important, but they are niche. When ML is widely deployed on the network the results will be dramatic. One example is its impact on healthcare. Wireless SoCs like Nordic's nRF54H20 will support [wearables](#) with a wide array of sensors such as heart rate, heart rate variability, temperature, respiration rate, blood oxygen, stress, fatigue and other physiological signs. Such wearables won't be just for fitness fanatics, but worn by seniors, adults and children alike.

Armed with ML and cellular IoT connectivity the wearable becomes a device that can continuously monitor multiple vital signs simultaneously. And if some or all show signs of change, the wearable's ML model could determine if the trend is trivial or a serious medical emergency. An example might be a sudden change in blood oxygen level, heart rate, blood pressure, and respiration that indicate an imminent cardiac problem. If things are serious, the wearable could notify first responders while also providing them with vital data ahead of arrival.

Such a device could protect stretched healthcare budgets by cutting down on hospital visits while optimizing the care of people who really need it. That would save hundreds of billions of dollars across the world.

The ability to perform ML on low power, embedded devices that can run on batteries will transform the IoT. It will make the network even more intelligent, capable, and flexible. And it will enable new types of products and applications that were previously impossible. It makes for an exciting future and one which is much closer than you might think.



Sensorita's smart waste management solution employs radar, GPS and ML to optimize the emptying of city waste receptacles

Need to Know

In 1950, British mathematician Alan Turing proposed a 'learning machine' that could learn from inputted information and become artificially intelligent. Then in 1959, Arthur Lee Samuel, an American engineer, coined the term "Machine Learning". His checkers-playing program was among the world's first successful self-learning algorithms

Nordic Inside:

Machine Learning for battery-powered sensors

Nordic's new nRF54H20 SoC integrates multiple Arm Cortex-M33 processors and RISC-V coprocessors, with each processor optimized for a specific type of workload. The SoC's computing resources are supported by embedded high-capacity, non-volatile memory and RAM. These resources make the nRF54H20 (together with other multiprotocol SoCs from Nordic's product range such as the nRF5340) capable of supporting TinyML software.

TinyML is a streamlined form of Machine Learning (ML) suitable for compact, battery-powered sensors and is supplied by Nordic design partner, Edge Impulse. Nordic provides an app—developed in collaboration with Edge Impulse—that can be used to train and deploy embedded ML models on the company's [Thingy:53](#) IoT prototyping platform. The app allows the developer to upload raw sensor data to the Cloud-based Edge Impulse Studio and deploy trained ML models to the Nordic Thingy:53 over Bluetooth LE.

This capability leads to development of sensors such as the [Atomation Atom](#), powered by Nordic's [nRF52840](#) SoC. The sensor measures oscillations to determine if a machine motor is vibrating more than it did yesterday, or monitors temperature to check if a bearing is running hot when the machine is in operation. Each Atom functions for up to three years using a 3.6-volt Li-ion battery. The sensors monitor and process information locally, instead of sending a constant stream of data back to a central system. When thresholds are exceeded or equipment is acting outside of normal parameters, data is sent to a gateway via Bluetooth LE wireless connectivity.



State of Play

AI can get it wrong too

Companies are turning to AI to boost business in many areas (see graph) and the results can be spectacular. But caution is advised because sometimes things can go very wrong. As reported by *CIO* magazine, a University of Cambridge COVID-19 risk detection program was trained on a data set that included scans of patients lying down and patients that were standing up. The former were more likely to be sick, which led the algorithm to identify higher COVID risk based solely on the position of the person in the scan. Another health program was trained with a data set that included chest scans of fit children. The algorithm learned to identify children rather than high-risk patients

How companies are using AI to boost profitability



Source: Forbes Advisor

Home is Where the Smart is

Most of us live in connected homes, but with the increasing adoption of unifying connectivity standard Matter, we will soon also be realizing the smart home dream

In Short

Connectivity standard Matter will unite disparate ecosystems, delivering a fully integrated smart home experience to consumers

Backing by vendors such as Amazon, Apple, Google and Samsung, will ensure any Matter-certified device will work with any other, out-of-the-box

Chipmakers are optimizing both hardware and software with the existing and future requirements of the Matter standard in mind

By any measure we live in connected dwellings. According to 2022 U.S. census data, over 91 percent of people reported having Internet in their house, but a connected home and a smart home are not the same thing. Connecting your PC or TV to the Internet to browse or watch Netflix, is somehow removed from a smart home setup where all your devices and appliances are connected to the Internet to enable convenient remote and automatic control.

The challenge is that setting up and maintaining a fully integrated smart home can at best be infuriating and at worst impossible. The core issue is that [smart home](#) devices from different vendors haven't previously played nicely together. Products built for one ecosystem, won't work as planned with another. For example, your 'brand A' smart lights can't be configured or controlled by your 'brand B' digital voice assistant. Multiply that by hundreds of brands and dozens of device types, and it's easy to see why consumers lost interest in the smart home. After all, it's not that big a deal to manually switch on lights and draw the drapes when you get home. Then [Matter](#) arrived.

WHY MATTER MATTERS

Matter is an open-source connectivity standard for the smart home developed by the [Connectivity Standards Alliance](#) (CSA). It works by building on top of existing smart

home wireless connectivity technologies—[Wi-Fi](#), [Thread](#) and [Bluetooth LE](#)—as well as (wired) Ethernet.

The choice of connectivity technologies selected for Matter was carefully considered. Wi-Fi is established in hundreds of millions of homes across the world and Wi-Fi 6 (that includes power-saving technology that allows designers to trade-off some throughput for longer battery life), makes it even better suited to smart-home applications. Thread is a low power wireless standard that seamlessly integrates with larger IP networks, and Bluetooth LE wireless tech is interoperable with smartphones which then form the ideal interface for commissioning and configuring new smart-home products. Matter provides a unifying application layer—in essence a 'common language'—across these technologies, that manufacturers can develop to, guaranteeing compatibility and interoperability for their products.

By providing interoperability across ecosystems from major suppliers such as Amazon, Apple, Google and Samsung, Matter promises to kickstart smart home technology adoption by providing consumers with confidence that whatever piece of smart home kit they buy, it will work with any other Matter-certified device. Mom and Dad can control home automation with Siri, while the kids who prefer Alexa as their voice assistant can do so without any compatibility concerns, irrespective of who is in control at any given time.

This is important, because according to research from the University of Reading in the U.K., a leading barrier to smart home adoption is that the smart device itself lacks users' trust based on its perceived reliability, performance and controllability. (See State of Play on pg18 [Barriers to Smart Home Adoption](#).)

While Matter may not have entered the general public's consciousness quite yet, it soon will because not only is it backed by the aforementioned heavyweight smart home technology platforms, there are another 340 or so companies behind it too, including wireless connectivity specialists like Nordic Semiconductor. This should provide Matter with enough promotional and marketing heft to ensure consumers shopping for smart home solutions bearing the 'Matter Certified' seal of approval will have



their minds put at rest over smart home reliability and performance concerns. "Matter has the power to create a more connected, safe and useful smart home," says Tobin Richardson, President and CEO of the CSA.

ACCESS ALL AREAS

Since its launch, ongoing revisions to the Matter specification have delivered improvements that have brought new layers of interoperability, simplicity, reliability and security, while unlocking new use cases and features for the future. While version 1.0 covered pioneering smart home tech such as lighting, home security, HVAC, televisions and window covers, Matter 1.2, introduced in October 2023, added support for a range of new categories such as refrigerators, dishwashers, smoke alarms, washing machines and robot vacuums. In turn Matter 1.3, released earlier this year, added ovens, laundry dryers, cooktops and extractor hoods.

The appliance support added in Matter 1.2 and Matter

1.3 was important not only because it expanded access to Matter to practically every corner of the smart home, it also provided the Matter Working Group a starting point to build out a set of foundational features (such as temperature setting and monitoring, and status notifications) applicable to nearly all appliances that will be supported in upcoming releases. This should provide confidence to OEMs that the future product development path will be smooth.

Updates have also introduced new features and core improvements that enhance the Matter end user experience. For example, Matter 1.3 now includes support for 'scenes' and 'command batching'. This enables users to create a desired state for devices, rooms or their whole home, by combining settings in devices that can be triggered with one command.

Alongside consumers' reliability and controllability worries, security also understandably looms as a perennial concern. Addressing these concerns, Matter embodies best practices around security. For example, each Matter

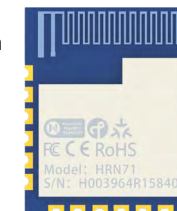


Matter has the power to create a more connected, safe and useful smart home

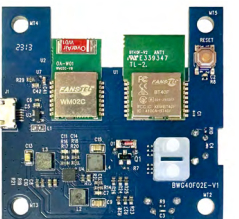


Tech Check

Hoorii Technology's Matter, LwM2M and Open Connectivity Foundation over Thread compatible module is designed for use in high-end and space-constrained smart home and lighting applications. Powered by Nordic's [nRF52840](#) SoC, for Matter applications the module uses the SoC's Thread connectivity for transport and Bluetooth LE connectivity for commissioning new devices to a network. Matter over Thread prototyping is supported by Nordic's [nRF52840.DK](#)



Fanstel's [WT02E40E Series modules](#) (shown here mounted top center of the development kit) integrate both Nordic's [nRF5340](#) SoC and [nRF7002](#) Wi-Fi 6 Companion IC, and ease development of new Matter smart home product designs. As most Matter applications require two antennas, the Fanstel series of modules offer multiple antenna options to flexibly meet the developer's application requirements



Feature: Smart Protection

device includes a unique identity, ensuring only the user's authentic and certified devices are permitted to join the network. Data is encrypted to protect confidentiality and access control policies ensure each device can only perform the operations it needs to perform.

Earlier this year the CSA also announced the release of their [IoT Device Security Specification 1.0](#), with the accompanying certification program and Product Security Verified Mark. The IoT Device Security Specification represents a significant advance in the standardization of IoT security, providing a comprehensive framework for manufacturers to ensure products are secure by design.

CHIPMAKERS KEEP PACE

Despite its many advantages, designing a Matter-compatible product will add complexity to product design, and require an upgrade in chip capability from silicon providers. For example, a Matter-compatible device requires both [Bluetooth LE](#) and [Thread](#) connectivity (in case of a Matter over Thread device) or [Wi-Fi](#) (for a Matter over Wi-Fi device) as well as enough computing power and memory to run the [Matter](#) protocol stack. For over-the-air device firmware updates (OTA-DFU) the solution will demand up to twice as much Flash memory compared with the application software alone, and there will come a time when smart home solutions will also need to leverage the capability of Machine Learning (ML), as well as meet



Tech Check

Tridonic's suite of Nordic [nRF52840](#) SoC-powered solutions is designed to make lighting installations compatible with Matter. The Wireless Matter Driver dims and switches LED strips, while the Push Button Coupler converts existing conventional switches into Matter-compatible smart-light switches. The Wireless Matter to DALI Active module and the Wireless Matter to DALI Passive module can be used to upgrade any DALI luminaire into a Matter-ready setup



stringent security requirements. But chipmakers have not stood still, and have been busy optimizing both hardware and software with the new standard in mind.

For instance, customers of Nordic are already actively developing Matter devices today using the company's [nRF52840](#) and [nRF5340](#) SoCs, which support Thread and Bluetooth LE. Nordic Wi-Fi products, for example the [nRF7001](#) and [nRF7002](#), also support Matter. The company also recently announced its fifth generation SoCs, the [nRF54H](#) and [nRF54L Series](#). Both new SoCs will provide a boost to the next generation of innovative Matter products by bringing more powerful processing and memory capabilities to the developer's technical armory. The [nRF54H20](#) integrates multiple Arm Cortex-M33 processors and RISC-V coprocessors. These ample computing resources can support edge processing and run sophisticated ML models. Such models can optimize smart-home product performance; for instance, making corrections to HVAC humidity settings because members of the household have upset the balance by all arriving home together at the same time.

The [nRF54H20](#) also features 2 MB of non-volatile memory and 1 MB RAM and features a new best-in-class multiprotocol radio. The radio delivers longer range and enhanced reliability, allowing consumers to extend their network of devices for stronger integration throughout the smart home, including outdoor areas.

Both [nRF54 Series](#) SoCs exceed the requirements of PSA Certified Level 3 (the highest in the PSA Certified IoT security standard) including secure boot, secure firmware update, secure storage and protection against physical attacks. That will make smart-home products built using the SoCs among the most secure devices on the market.

With these hardware and software improvements, and as the standard itself is tweaked to further improve interoperability, simplicity and reliability, device manufacturers can focus more on driving improvements in product quality and developing new features, and less on apps and architectures to support onboarding of devices to divergent ecosystems. When that day comes, the dream of the fully integrated [smart home](#) will finally be upon us.

State of Play

Barriers to smart home adoption

According to analyst, Statista, by 2028 there are expected to be over 785 million people living in smart homes worldwide. The arrival of Matter—an open-source connectivity standard uniting disparate ecosystems—will help accelerate smart home tech adoption, but developers will need to overcome existing consumer prejudices as highlighted by research from Reading University in the U.K.

Adoption Barrier	Suggested Response
Distrust and Resistance	Improve reliability, controllability and performance of devices
Limited Perception	Provide improved tech support, and increase consumer familiarity to smart homes
Financial Considerations	Reduce initial adoption costs to provide users with 'easy entry', provide business incentives
Privacy & Security Concerns	Improve tech to prevent leaking of private information, and publicize tech implementation
Technology Anxiety	Develop technologies based on social wellbeing, develop easy-to-use solutions
Negative Social Influences	Generate positive word of mouth, advertise social and wellbeing smart home benefits

Source: University of Reading, U.K.

Unifying the smart home market



LEARN MORE
nordicsemi.com/smart-home



Air Care

Through precision air quality monitoring, wireless IoT systems help clean up the air for a healthier environment

Outdoor air pollution tends to hog the headlines. But we spend far more time indoors—up to 90 percent for Americans, according to the U.S. Environmental Protection Agency—and significant health risks can originate if the air there is not clean. The U.S. National Institute of Environmental Health Services lists sources of indoor pollution originating from human activities within buildings, such as smoking, burning solid fuels, cooking, and cleaning; vapors from building and construction materials, equipment, and furniture; and biological contaminants, such as mold, viruses, or allergens.

Many of these contaminants are impossible to detect without technology. Fortunately, the IoT now offers a solution enabling a more nuanced and timely response to potential hazards, especially cases of long term, low level exposure to pollution. Recent advances in wireless tech have helped create a variety of scalable solutions for indoor air quality measurement and monitoring. These advances allow the flexible placement of a wide array of sensors, independent of local IT networks. Combined with intelligent analysis, such data is enabling us to gain a better understanding of the factors influencing indoor air quality.

IT'S HEALTHY INSIDE

Foundational IoT tech such as [Bluetooth LE](#) suits compact, battery powered sensors sampling the air throughout a building while low-power [Wi-Fi](#) technology is a good option for air quality sensors that take advantage of existing Wi-Fi infrastructure. Both technologies can transmit data to suitably resourced Wi-Fi gateways which in turn can forward it to the Cloud for remote access. Alternatively, building wide Bluetooth LE networks can send data to cellular IoT gateways which can forward it to the Cloud independently of Wi-Fi – mitigating security concerns.

Because wireless solutions require no cabling, they are simple to integrate into new builds or retrofit into existing buildings. A lack of physical wires makes it easy to locate sensors strategically; for example, installing carbon monoxide sensors close to fossil-fuel heaters, or in rooms with poor airflow.

A key advantage of the new generation of sensors compared with traditional types is the continuous flow of data they provide. This enables identification of long term air quality trends leading to precise control. For example,

based on historical data, additional air purification could be automatically triggered over summer periods when pollen counts are known to be higher, or increased ventilation and heat could be triggered when cold and humidity combine to encourage mold growth.

[Edge computing](#) capabilities enable today's IoT devices to internally process the continuous stream of data and only forward results to a smartphone, gateway or directly to the Cloud when action to change humidity, temperature, ventilation or purification is necessary. This drastically reduces energy consumption and data charges.

The IoT can be integrated with smart air purification, filtration systems and intelligent HVAC (Heating, Ventilation, and Air Conditioning). This builds in flexibility; for example, when sensors detect carbon dioxide, volatile organic compounds (VOCs) or other contaminants in the air, integrated systems can automatically boost filtration.

CLEAN AIR BOOSTS EDUCATION

Commercial wireless air quality monitoring solutions entering the market are demonstrating positive results. In New Zealand, for example, research correlating learning improvements for students to the quality of their indoor environments led to the launch of the [Te Haratau project](#) – an initiative by the New Zealand Ministry of Education. AirSuite, an intelligent environmental solutions company, was born out of the Te Haratau project when the wider scope of the benefits of clean air beyond the education sector became clear.

"We found continuously monitoring a range of indoor environmental variables could result in [better] health, productivity and staff retention – potential benefits far too important for any organization to ignore," explains Peter Pooran, CEO of AirSuite.

In 2023, AirSuite launched an indoor monitor designed to detect and record a range of environmental variables that can affect the health and productivity of people in commercial, industrial and domestic settings. The [AirSuite Glance](#) employs a range of sensors to monitor carbon dioxide, VOCs, temperature and humidity (as well as sound, light levels and air pressure).

AirSuite uses Bluetooth LE connectivity provided by Nordic Semiconductor's [nRF52840](#) SoC to transmit the data directly to the user's smartphone every minute, and



the LTE-M or NB-IoT connectivity of the integrated Nordic [nRF9160](#) SiP sends relevant data to the Cloud at least every 15 minutes. Through the app and web platform, users can oversee and receive notifications when environmental metrics surpass or fall below predetermined thresholds.

"AirSuite Glance indicates invisible factors that contribute to sub-optimal conditions in a user's space and remind users of the unhealthy conditions they may have grown used to," says Pooran.

"Wireless connectivity can provide near real time responsiveness for air quality monitoring, which is necessary as environmental factors can change rapidly – for instance, increased carbon dioxide levels rising [from human breathing] in crowded meeting rooms," he says. "These alerts enable immediate interventions, which is not attainable through historical data analysis alone."

OPTIMIZING HEALTH

The next step for air quality monitoring is the introduction of a new generation of wireless SoCs— such as Nordic's [nRF54H20](#), a multicore, multiprotocol SoC—with ample resources to support Machine Learning (ML) (see pg12). Such SoCs can use air quality data gathered over long periods to train ML models. Those models are then applied to the sensors which can in turn help intelligently adjust building systems and HVAC for the optimum health and comfort of occupants.

Such equipment optimization reduces power consumption by avoiding unnecessary use while creating indoor environments that are finely tuned for occupants' wellbeing.

Further integration of ML into wireless air quality monitoring promises to offer enhanced predictive insights, facilitating informed decisions for even better health outcomes. The result will be IoT solutions that provide a breath of fresh air for everyone.

Nordic Inside:

Smart air quality monitoring

An indoor environmental and air quality solution developed by leading French IoT sensor specialist Adeunis is designed for use in smart buildings. The COMFORT and COMFORT Serenity devices employ temperature, humidity, carbon dioxide and VOC sensors, delivering near real time data to the Cloud. Powered by Nordic Semiconductor's [nRF9160](#) SiP, they provide cellular IoT connectivity supporting both NB-IoT and LTE-M networks.

"With our sensors, building supervisors gain access to data on potential exposure to high levels of carbon dioxide or VOCs," explains Catalina Raba Mora, RF Hardware Developer at Adeunis. "These can have detrimental health effects so monitoring and maintaining safe levels [is important]. Furthermore, our devices ensure optimal comfort for building occupants through precise temperature and humidity measurements."

Nordic's [nRF9160](#) SiP feature a 64 MHz Arm Cortex-M33 dedicated application processor that provides ample processing power to manage the suite of integrated sensors.

Once the device data is transmitted to the Cloud using the [nRF9160](#) SiP, users can review and manage the information via an intuitive app with NFC interface. The Cloud server can provide insights into the status of sensors, battery life, network quality and data reception. Users can delegate device management, remotely configure devices and take actions based on the collected data.

"The [nRF9160](#)'s support of both LTE-M and NB-IoT technologies in a single SiP offers unparalleled flexibility," says Mora. "Moreover, its exceptional low power capabilities were a decisive factor. With companies employing multiple sensors in each building, maximizing battery life was crucial. Our devices can achieve a remarkable battery lifespan of 15 years."



By the Numbers

11,000 liters of air are inhaled by the average person each day

Source: TheWorldCounts

6.7 million

Premature deaths annually due to air pollution, with more than 3.2 million of these stemming from indoor environments

Source: World Health Organization

6.9 billion

Global revenue of air quality monitoring system market by 2028

Source: Markets and Markets

Wearables

Festina Connected D watch

This connected watch delivers detailed health and fitness data using Nordic Bluetooth LE connectivity

[Wearable electronic devices](#) have quickly become an integral segment of the consumer electronics industry, and smartwatches and connected watches are one of the most popular wearables categories globally. According to Statista, 300 million smartwatches were shipped last year generating revenues of around \$45 billion

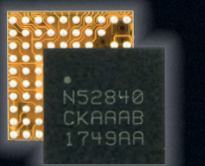
Festina Connected D is simultaneously both a traditional watch and an advanced health and fitness activity tracker which monitors the user's heart and daily activities, providing them with the means to better understand their health. It also features music and camera control, timers and alarms, phone finder, weather information, world time, 'If This Then That' (IFTTT) control, as well as a 'walk-me-home' security feature and workout tracking using connected GPS

The stainless steel Festina Connected D features a dial plate and watch hands with a cut-out for the OLED display. It integrates a heart rate sensor and accelerometer to track heart rate, VO₂ max, energy expenditure, activity, steps and sleep. The watch also employs Nordic Semiconductor's [nRF52840](#) SoC to provide [Bluetooth LE](#) wireless connectivity between the device and the user's smartphone, and to perform as the watch's application processor.

An English clockmaker called [John Harrison](#) invented the [marine chronometer](#) in the 18th century and solved the problem of calculating longitude at sea. Latitude could be determined through celestial navigation, but determining longitude was a significant challenge. Harrison's marine chronometer compared Greenwich Mean Time and the time at the current location, which alongside a nautical almanac and sight-reduction tables enabled the navigator to calculate the ship's longitude accurately. Today satellite navigation provides a simpler to use alternative

Scottish actor, film producer and Festina brand ambassador, Gerard Butler, is known for his rugged masculinity and charm on the big screen, but acting came later in life. Butler originally trained as a lawyer and worked in an Edinburgh law firm before winning his first professional acting job at the age of 27. Three years later he took Hollywood by storm. Today, the 25 films Butler has featured as leading actor in have earned a whopping \$2.1 billion in the worldwide box office

While the Festina Connected D is highly accurate, the prize for the world's most exact timepiece goes to an [optical lattice clock](#) developed by U.S.-based physicist [Juan Ye](#). While atomic clocks lose about a second approximately every 100 million years, Ye's clock only loses a second every 15 billion years. That also happens to be the approximate age of the universe, so if Ye's clock had been around during the big bang, it would only deviate by one second from today's time



Tech Check

The [nRF52840](#) SoC's 64 MHz, 32-bit Arm Cortex-M4 processor provides ample computational power to run complex sensor algorithms allowing the Festina watch to precisely track and calculate movement and activity data. The Arm TrustZone CryptoCell included on-chip ensures data security

Remote Monitoring

Modular IoT sensor platform lowers costs, speeds time-to-market

The Blockcraft IoT platform combines multiple sensors with Nordic's Bluetooth LE or cellular IoT tech into a plug-and-play IoT solution

The growing complexity of businesses' IoT demands has led many companies to opt for in-house custom solutions due to a lack of commercial-off-the-shelf (COTS) products. However, this approach can present considerable engineering challenges. For example, it can be difficult to ensure seamless interoperability between devices, particularly when combining assets operating across a range of wireless protocols.

According to IoT Analytics, 'protocol translation' consumes a substantial portion of contemporary IoT development efforts. For example, one industrial OEM's implementation of IoT technology required nearly four months to develop all the necessary protocol interoperability to ensure smooth operation between equipment and applications.

But now, Taiwanese IoT solutions company Brocere Electronics has launched a [COTS IoT sensor platform](#) that can be used to monitor a wide range of data including temperature, humidity, pressure, movement, light, sound, Time of Flight (ToF), Long wave Infrared (LWIR), CO₂ and Volatile Organic Compounds (VOC).

"The Blockcraft IoT Sensor has been designed as a modular solution which allows customers to quickly create and implement customized IoT solutions without repetitive design and product certification," explains Daniel Lai, Founder and CEO of Brocere Electronics. "The 'plug and play' design of the IoT sensor helps companies get systems to market quicker and at lower cost."

The Blockcraft solution includes a range of sensor modules to record the environmental data, as well as a network module to relay the data to the Cloud.

The IOT5 variant of the Blockcraft network module uses the LTE-M/NB-IoT capability of Nordic Semiconductor's [nRF9160](#) SiP to directly transmit data to the Cloud, while the IOT6 version leverages the Bluetooth LE connectivity of Nordic's [nRF5340](#) dual-core SoC to send data to a gateway, which subsequently relays it to the Cloud.

The nRF9160 was built for market-leading power efficiency under all network conditions, making it possible to create products that can operate solely on harvested solar energy. For its part, the nRF5340 features a dedicated application processor, while the second core is a fully programmable, ultra low power network processor. This dual processor architecture provides developers with the opportunity to maximize computational performance while keeping power consumption low.

Once the data is sent to the Cloud via either the nRF9160 or a gateway, users can access it using the Brocere web platform or smartphone app. The platform enables



an operator to view a dashboard of the sensor data or visualize their assets on a map.



Need to Know

Containing a rechargeable Li-ion 900 mAh polymer battery, the Brocere IoT device can be charged using a USB-C cable or the optional solar unit. The low power consumption of the nRF9160 SiP allows the module to operate autonomously using harvested solar energy alone

Seamless module connectivity

The Brocere IoT platform has already been used in a wide range of applications, including [smart electrical meters](#), smart lockers, e-bike tracking, indoor fire and wildfire monitoring and [smart agriculture](#) settings.

"One application example is the Blockcraft's use in refrigerated vehicles," says Lai. "Cold chain [logistics](#) is a market that has become increasingly important in recent years, relying on dependable temperature monitoring and data transmission. To meet these needs, the Blockcraft suite can check whether the vehicle door is open or closed, and monitor the temperature of the goods, helping to ensure they remain within the required temperature range." Lai says the product also tracks the location of the vehicle, using the nRF9160 SiP's combination of cellular network location data and GNSS trilateration.

"Each independent element of the device is also reusable and recyclable," explains Lai. "Modules can be reconfigured to create innovative products, while obsolete units can be recycled and repurposed for rental and maintenance markets. This helps minimize electronic



The IoT Sensor allows customers to quickly create and implement customized IoT solutions without repetitive design and product certification

waste and work towards carbon reduction goals in alignment with Sustainable Development Objectives."

Solar-harvesting capabilities

The Brocere solution also includes an optional solar unit, so the device can automatically recharge when used outdoors. The energy-efficient nRF9160 SiP ensures the Blockcraft system can run entirely on solar power. The low power consumption was one of the key drawcards for Brocere when choosing the Nordic SiP.

"[Another] of the most important reasons we selected the nRF9160 SiP was the Nordic [nRF Connect SDK](#) [Software Development Kit]," says Lai. "To achieve stable performance and low power consumption, we relied heavily on the core firmware to optimize our application software."

By combining various sensors, the Blockcraft system allows companies to quickly create a customized IoT solution with multiple wireless connectivity options – without the usual engineering hassles. Moreover, the modular solution offers unparalleled energy efficiency thanks to Nordic low power short-range and [cellular IoT](#) tech, extending battery life and enabling solar power operation.

Ulrikke Lien
CEO, Sensorita



IoT and ML disrupt waste management

Smart waste monitoring offers companies vital insights into container location and fill levels

Smart waste management is transforming how companies worldwide view their waste flow. By increasing the visibility of waste disposal units, wireless connectivity and the IoT are turning them into valuable assets designed to optimize logistics, inventory management and waste flow.

The waste management industry lacks the optimal digital tools, but that is now changing

My company, Sensorita, originally emerged from my university research, and was inspired by industry conversations that underscored the need for a solution to measure waste levels in open containers – an increasingly challenging task as waste management companies expand, and their disposal systems become more complex.

Despite the crucial role of the industry in the circular economy, it still operates in a largely analog manner. From tracking how many containers a company has, to managing complex recycling material flows, the waste management industry lacks digital tools, but that is now changing.

Since refuse containers are often mobile and situated in areas without access to wired connectivity, integrating robust and reliable wireless transmission is crucial to monitor their location and

status. For example, our Sensor1 employs cellular connectivity for both precise position monitoring and the transmission of this information to the Cloud. Without this monitoring and communication, administration of these assets becomes problematic, leading to unnecessary pickups and increased CO₂ emissions.

The power of ML
Advancements in battery life and computational efficiency for running radar on IoT devices has enabled the development of cost-effective sensors with long lifetimes and the durability needed for rugged waste management environments.

Additionally, Machine Learning (ML) has become increasingly valuable to the waste management sector. Specially trained algorithms enable companies to interpret the data they collect, providing valuable insights to enhance logistics and planning. ML can help companies calculate fill levels and predict optimal emptying schedules, as well as oversee container IDs, locations, bin types and waste categorization.

The continued development of this technology holds significant potential for the future of the

industry, especially as we're currently only tapping into a fraction of the data acquired by our [Sensor1 devices](#). Our focus for the future is on deepening our comprehension of field operations and developing a complete digital twin for every waste container.

The use of the IoT in creating smart waste management systems is helping drive innovation, cultivate new business models and improve how waste producers and waste management companies operate. That is good news for the industry and also for the environment.



[Tech Zone]

An in-depth look at Nordic's wireless solutions

Cloud Services

Nordic announces general availability of nRF Cloud Device Management Services

Nordic Semiconductor has announced a significant expansion of its [Cloud services](#) with the general availability of [nRF Cloud Device Management](#). The new device management service joins the existing location and security services to complete the nRF Cloud suite. This launch marks the first time a one-stop solution for the deployment and management of IoT devices at scale is available for IoT developers and businesses.

nRF Cloud Device Management provides tools for onboarding, configuration, monitoring and firmware-over-the-air (FOTA) updates, for comprehensive

management of IoT device fleets across their lifecycle.

The tools also facilitate sensor data collection services and enable technicians to ensure fleets remain up-to-date and operate at peak efficiency. Further benefits of the service include significant cost savings, reduced time-to-market, scalability and future-proofed IoT deployments.

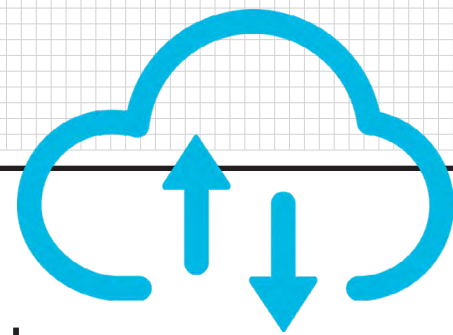
In addition to Device Management, the nRF Cloud suite comprises the already available Location Services and Security Services. The location services leverage Nordic's advanced location technologies, including single-cell (SCCELL), multi-cell (MCELL), assisted GPS

(A-GPS), predicted GPS (P-GPS) and Wi-Fi location features. The services ensure that devices provide accurate location data with minimal power consumption.

The global availability, power efficiency and usage flexibility of the services offer a robust foundation for location based IoT solutions.

nRF Cloud Security Services offer ready-to-use secure identity and provisioning solutions while eliminating the complexity and cost associated with creating proprietary secure infrastructure.

Lifetime security ensures IoT devices remain protected from commissioning to decommissioning.



Asset Tracking

nRF Connect SDK supports Google's Find My Device network

Nordic Semiconductor has collaborated with design partner Google to embed support for Google's Find My Device network and unknown tracker alerts into the [nRF Connect SDK](#). The Nordic announcement coincides with Google's official announcement of the technologies for native [Bluetooth LE](#) tracking using Android mobile devices.

"This is a key development because it allows Nordic's nRF52 and [nRF53 Series](#) customers to build innovative device finding products for the global Android ecosystem," says Kjetil Holstad, EVP Strategy and Product Management with Nordic.

"Some of our key partners have already taken advantage of the embedded support in the SDK and are ready to introduce commercial solutions, and many

other customers can soon follow suit."

The embedded developer software in the nRF Connect SDK allows third-party device manufacturers to build products using Google's Find My Device network and unknown tracker alerts services. Several Nordic key partners have already built commercial nRF52 Series-based device

finding products compatible with the Google services ahead of Google's official launch.

Google's Find My Device network allows Android users to locate important everyday items, for example, pocketbooks, keys and luggage. Unknown tracker alerts, a built-in protection of Google's Find My Device, help to protect user safety by alerting them if an unfamiliar Bluetooth tag is detected to be moving with them.



Internet of Things

Modules power industrial designs



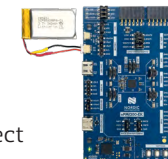
Taiwan-based technology company and Nordic Semiconductor module partner, Quanta Storage Inc., has launched a combined Bluetooth LE and Wi-Fi module. The product is designed to make the development of next generation smart home, wearable and industrial IoT products easier. The WF60LCANI08 module integrates both Nordic's [nRF5340](#) SoC and the [nRF7002](#) Wi-Fi 6 Companion IC—as well as an on-chip antenna—in a compact 20 by 20 by 2.4 mm form factor, ideal for space-constrained IoT designs.

Nordic's nRF5340 integrates dual Arm Cortex-M33 processors providing a high performance application processor alongside a fully programmable, ultra low power network processor. The nRF7002 Companion IC brings low power and secure Wi-Fi to the IoT, providing dual band (2.4 and 5 GHz) connectivity, and a seamless interface to the nRF5340's processor.

Power Management

Collaboration simplifies accurate fuel gauging

Nordic Semiconductor and Renata SA, a supplier of battery solutions, have announced a partnership enabling customers to select Li-Poly batteries that have already been profiled to operate with the [nPM1300 Power Management IC's](#) (PMIC) highly accurate fuel gauge. This circumvents the battery profiling stage, accelerating time-to-market.



The nPM1300 PMIC offers unique system management features including battery fuel gauging. The fuel gauging combines hardware and software to provide higher precision than voltage-based techniques but without the complexity, cost and power drain of a coulomb counter.

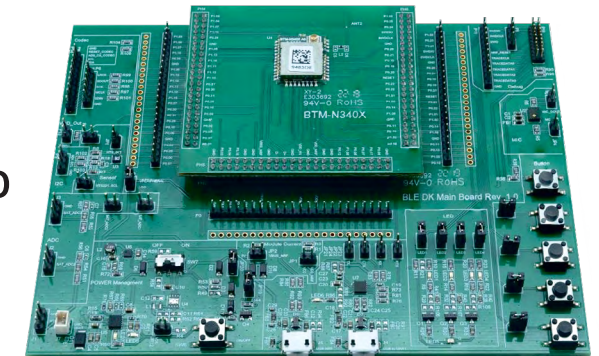
Now, through the partnership with Renata Batteries, Nordic is able to offer a range of pre-profiled battery models that are ideally suited to power Nordic's nRF52, [nRF53](#) and [nRF54](#) Series SoCs, as well as the [nRF91](#) Series SiPs – thus speeding-up the design cycle.

Audio & Music

Module provides advanced Bluetooth LE Audio connectivity

Wireless communications company Rayson Technology has released a multiprotocol module based on Nordic Semiconductor's [nRF5340](#) SoC. The SoC is designed for advanced [Bluetooth LE Audio](#) applications, as well as sophisticated metering, wearable, smart home, industrial and medical use cases. Measuring just 16.5 by 13.0 by 2.5 mm, the BTM-N340X module supports LE Audio and its Low Complexity Communication Codec (LC3), which together enable higher quality, lower power wireless audio streaming compared with existing Classic Bluetooth audio solutions.

The module employs the nRF5340 SoC's dual Arm Cortex-M33 processors – providing a high performance application processor alongside a fully programmable, ultra low power network processor. The application core manages the LC3 codec, while the



Bluetooth LE protocol is supervised by the network processor. The module's ultra-low power consumption is made possible due to the nRF5340's power-optimized multiprotocol radio, which offers a TX current of 3.4 mA (0 dBm TX power, 3 V, DC/DC) and RX current of 2.7 mA (3 V, DC/DC).

"The BTM-N340X module aims to provide enhanced audio experiences via Bluetooth LE Audio," says Bob Wu, CTO at Rayson Technology.

"It enables one device to stream audio to multiple pairs of wireless headphones, and can facilitate audio broadcasts through public address systems, such as in airports and museums. This module is also compatible with smart speakers and home audio systems."

The future of Power Management



nPM1300 Power Management IC

Stop using five or six separate chips in your power management design!

nPM FAMILY

START YOUR DEVELOPMENT TODAY
nordicsemi.com/nPM1300



Product Focus

nRF7002 Wi-Fi Companion IC

Offering low power, advanced security and seamless wireless coexistence

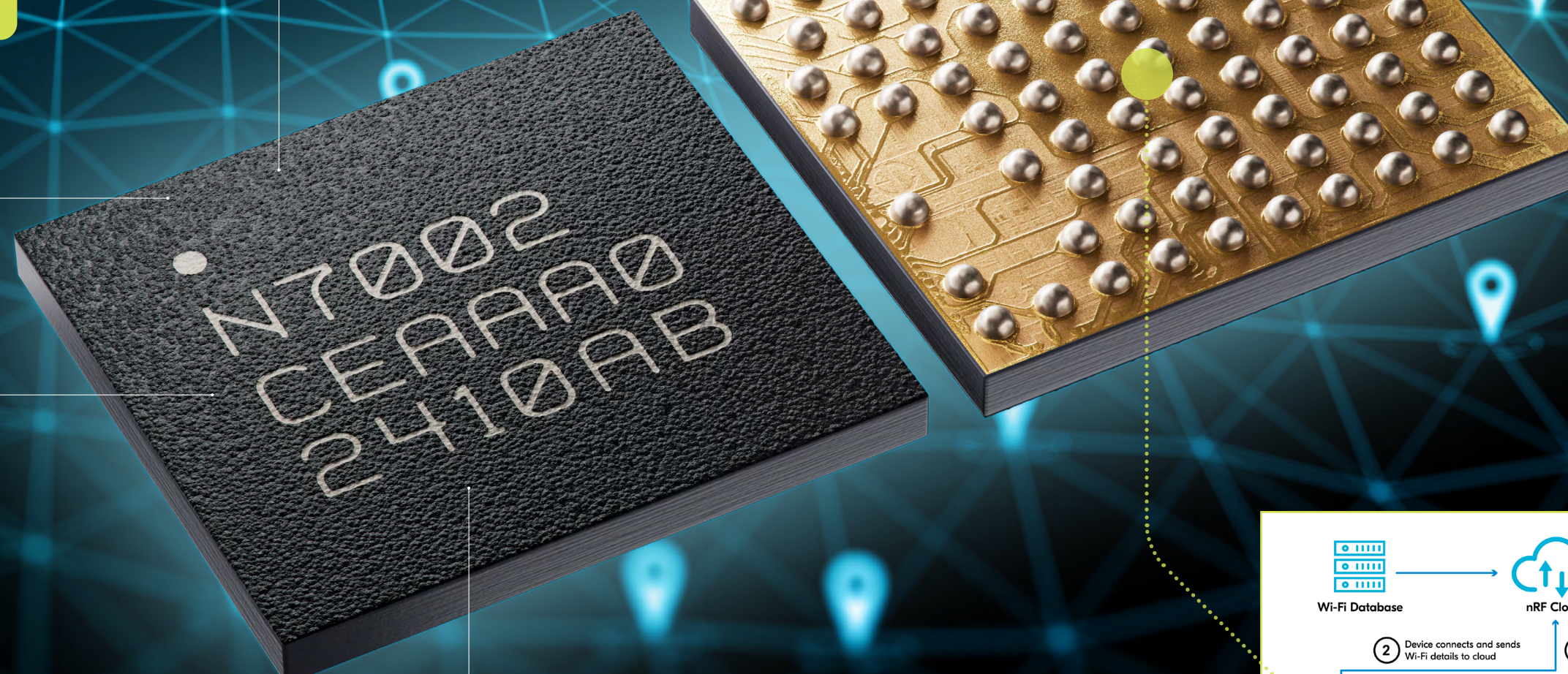
The **nRF7002** Wi-Fi Companion IC is a 2.4 and 5 GHz Wi-Fi 6, low power and cost-effective connectivity solution. It brings the latest Wi-Fi tech to products, allowing them to benefit from the higher speeds, greater range and enhanced reliability offered by the latest Wi-Fi standard

The nRF7002 provides seamless Wi-Fi connectivity and Wi-Fi-based locationing (SSID sniffing of local Wi-Fi hubs)

Nordic's Wi-Fi 6 Companion ICs with an nRF5340 SoC host support all the protocols used in **Matter**, a unifying smart home standard. Matter uses Bluetooth LE for commissioning, Thread for low power mesh and Wi-Fi for high-throughput

The nRF7002 features a dual-band radio with low power consumption for extended battery life. The IC also has advanced security features to help protect user data

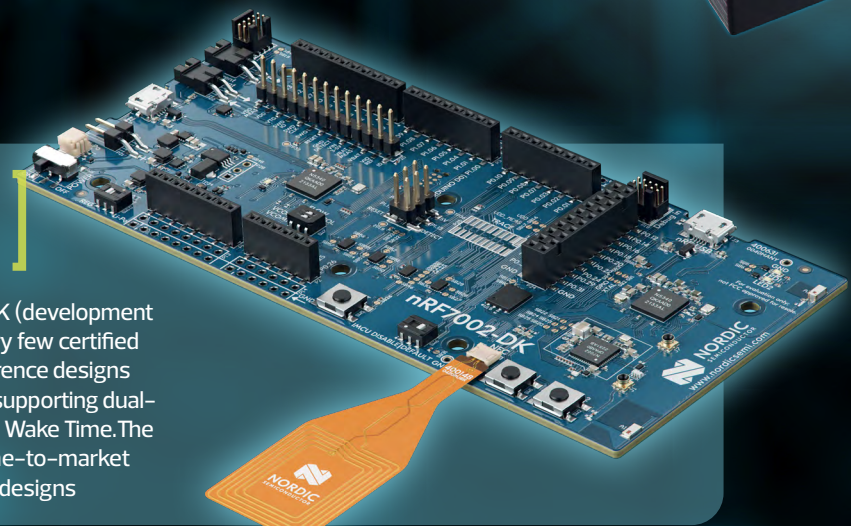
Nordic's Wi-Fi solutions seamlessly integrate into any application. Wi-Fi is incorporated into Nordic's **nRF Connect SDK** for optimal integration with all the firm's SoCs and SiPs



The nRF7002 targets battery-powered Wi-Fi IoT applications enabled by the Wi-Fi 6 version of the tech

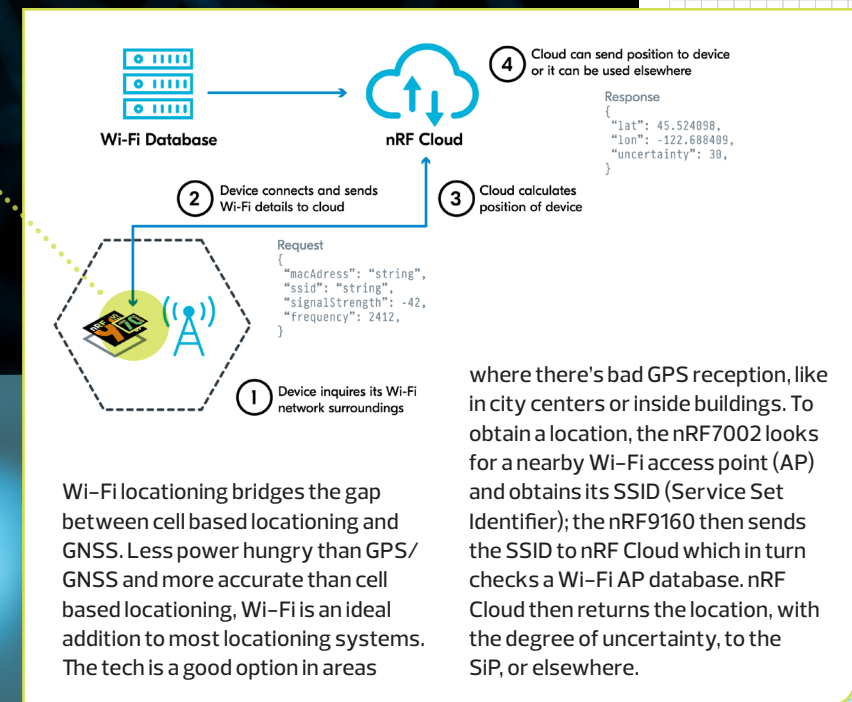


The nRF7002 DK (development kit) is one of very few certified embedded reference designs on the market, supporting dual-band and Target Wake Time. The DK shortens time-to-market for Wi-Fi based designs



Optimized asset tracking

Tracking items over long periods and across large distances is challenging. The powerful combination of Nordic's nRF Cloud with an nRF9160 cellular SiP and nRF7000 Wi-Fi companion IC is the ideal solution for **asset tracking**



Wi-Fi locationing bridges the gap between cell based locationing and GNSS. Less power hungry than GPS/GNSS and more accurate than cell based locationing, Wi-Fi is an ideal addition to most locationing systems. The tech is a good option in areas

where there's bad GPS reception, like in city centers or inside buildings. To obtain a location, the nRF7002 looks for a nearby Wi-Fi access point (AP) and obtains its SSID (Service Set Identifier); the nRF9160 then sends the SSID to nRF Cloud which in turn checks a Wi-Fi AP database. nRF Cloud then returns the location, with the degree of uncertainty, to the SiP, or elsewhere.



Tech Spec

Compliance
IEEE 802.11a (Wi-Fi 2)/b/g/n/ac (Wi-Fi 5)/ax

Package
6 by 6 mm QFN

Features
Low power, good coexistence with Bluetooth LE, TWT

Development tools
nRF7002DK, nRF7002EK, nRF7002EB

Applications
Asset tracking, smart home, industrial

The Future of Multiprotocol SoCs

Nordic has previewed its new flagship SoC, the nRF54H20, a highly integrated solution engineered for tomorrow's most complex IoT applications

Back in 2012, Nordic Semiconductor's nRF51 Series marked a seminal moment for Bluetooth LE SoCs. The chip was one of the first highly integrated Bluetooth LE devices, bringing together Arm Cortex-M processing power, Flash and RAM, a class leading 2.4 GHz radio and a host of useful peripherals on the same slice of silicon. And, because of Nordic's ultra low power heritage, all this came with class-leading low power consumption.

Still, skeptics wondered who would use such a powerful device, but innovative designers soon put them in their place, coming up with myriad 'accessories'—peripheral devices such as heart rate monitors, speed and distance sensors and early wearables wirelessly sharing data with a smartphone host—and inventing an entirely new product category in the process.

Following the nRF51 Series launch Nordic became the market share leader in Bluetooth LE and, through the introduction of the nRF52 and nRF53 Series SoCs, has maintained that position, shipping billions of SoCs in the process. While Bluetooth LE remains a key wireless tech, today's Nordic SoCs support multiple short-range wireless protocols, including Thread, Zigbee and ANT. And the product focus has extended dramatically too, to encompass IoT applications in the home, factory, office, hospital and sports field.

From the start, Nordic's strategy has been to provide developers with lots of processing power, memory, radio link budget and peripherals, in the most energy-efficient and compact package possible, together with a comprehensive suite of development tools, and then let clever engineers create completely new applications. Now the company is about to do it again with the introduction of the nRF54H Series, starting with the [nRF54H20](#).

A new SoC architecture

Key IoT applications such as [Bluetooth LE Audio](#), [Matter](#) and [Edge AI](#) are processor intensive. With a single processor core that demands a constant trade-off between performance and power consumption, Nordic addressed that compromise with its pioneering multicore solution, the nRF5340, pairing a dedicated application processor with a low power network core. One core rapidly performs complex algorithms before returning to a low power sleep mode while the other then efficiently sends data across the network, extending battery life. The concept has been taken a step further with the multicore nRF54H20. The SoC features a new hardware architecture, in part comprising multiple Arm Cortex-M33 processors and multiple RISC-V coprocessors. The processors are clocked at up to 320 MHz and each core is optimized for a specific type of workload.

The SoC's dedicated application processor features double the processing power (2x CoreMark) of the application processor in Nordic's advanced dual-core SoC, the nRF5340. The nRF54H20's computing resources are supported by integrated memory comprising 2 MB non volatile memory and 1 MB of RAM. The result is the optimum trade-off between processor power for the most complex IoT applications and ultra low power consumption for long battery life. (See panel on page 30 *Power to Burn*.)

The nRF54H20 features several new digital and analog interfaces, including a high performance external memory interface (400 MBps), high-speed USB (480 Mbps), two I3C peripherals, a CANFD controller, and a 14-bit ADC. These advanced interfaces are in addition to many other analog and digital interfaces integrated on the nRF54H20.

The SoC also features an all-new multiprotocol 2.4 GHz



Nordic's strategy has been to provide developers with lots of processing power, memory, radio link budget and peripherals, in the most energy-efficient package possible, and then to see what innovations they develop



radio which is the first in the world to offer -100 dBm RX sensitivity when receiving a 1 Mbps Bluetooth LE signal. Combined with up to 10 dBm TX power, the nRF54H20 offers an ample link budget for enhanced robustness and longer range. The radio RX current consumption is as low as 2.0 mA (3V, DC/DC). For applications that are mainly receivers, such as earbuds and wearables, this low energy consumption allows for more compact batteries or extended battery life.

The SoC was built with [security](#) foremost. It is engineered to comply with PSA Certified Level 3, the highest level in the Platform Security Architecture (PSA) Certified IoT security standard. The product supports security services such as Secure Boot, Secure Firmware Update and Secure Storage. It has cryptographic accelerators that are hardened against side channel attacks and tamper sensors that detect an attack in progress and take appropriate action.

Built for complex applications

It is difficult to imagine many of the applications to which the nRF54H20 will be applied. But the SoC is likely to be the foundation of a new wave of revolutionary IoT end-products in applications such as Bluetooth LE Audio (LE Audio), Edge AI, predictive maintenance and healthcare. And it will also be capable of powering applications that are impossible with current wireless tech.

LE Audio is the next generation of wireless streaming and promises higher quality sound or longer battery life depending on the application. By selecting the nRF54H20, developers of LE Audio solutions from earbuds to hearing aids will be able to introduce products that consume less energy, are more compact and quicker to bring to market.

The nRF54H20 redefines the trade-off between processing power and power consumption. That makes the SoC a good solution for running Edge AI or advanced ML on battery-powered SoCs. Edge AI enables data processing and informed decision making without recourse to Cloud

servers or human assistance. The SoC can support TinyML, a streamlined form of Machine Learning (ML) supplied by Nordic design partner, Edge Impulse. (See [pg12](#).)

Support for TinyML and Edge AI will enable the nRF54H20 to support key factory automation options such as predictive maintenance. By using ML algorithms and edge processing, a Bluetooth LE motion sensor will learn to discern a normal machine vibration from one caused by wear. Unusual vibrations would then trigger a notification across the network for the machine to receive preventative maintenance ahead of a costly and disruptive breakdown.

The trade-off between processing power and power consumption will also make the nRF54H20 a compelling solution for the [next generation of wearables](#). One application example is healthcare wearables designed for human activity recognition (HAR). HAR enables a wearable to determine both specific ambulation activities (whether the wearer is walking or jogging, for example) and functional activities (whether they have brushed their teeth, washed their hands or prepared food).

To get such a complete wellbeing picture requires combining data streams from multiple sensors, and that demands a SoC capable of sensor fusion. Sensor fusion enables the chip to determine which data points from which sensors correspond to the same activity or health concern, and which do not. Assessing such activities and then making inferences can help discern an individual's health and wellness and help prevent chronic illness.

But these application examples are merely extensions of current technologies enhanced by leveraging the extra processing power and energy efficiency of the nRF54H20. Things will get much more interesting when developers apply the SoC to brand new applications.

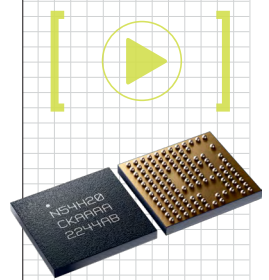
A Nordic webinar entitled Nordic's Bluetooth Low Energy solution: The go-to choice for developers is available from tinyurl.com/y6uu8sc7

Security		
Arm® Cortex®-M33 256 MHz	Arm® Cortex®-M33 320 MHz DVFS	2 MB NVM (Non-Volatile Memory)
		1 MB RAM
4 th gen Radio 10 dBm TX power -100 dBm RX sens. (1 Mbps Bluetooth LE)	RISC-V	RISC-V
	Peripherals	
	GPIOs	

The nRF54H20 SoC features multiple Arm Cortex-M33 processors and multiple RISC-V coprocessors optimized for specific types of workloads

Power to Burn

Proven by the standardized EEMBC ULPMark-CM benchmarking, the processing efficiency of the nRF54H20's application processor outclasses competing general purpose microcontrollers and wireless SoCs on the market. EEMBC ULPMark-CoreMark (ULPMark-CM) benchmarks the processor configured either for maximum processing efficiency or performance, using CoreMark as the workload. When configured for maximum processing efficiency, the nRF54H20's application processor achieved a ULPMark-CM score of 170 with 515 CoreMark. When configured for maximum processing performance, the results were ULPMark-CM score of 132 with 1292 CoreMark. The scores show the application processor in the nRF54H20 offers a unique combination of processing efficiency and performance. Most processors are optimized for one of these attributes, but with nRF54H20 developers can take advantage of both, by dynamically changing between configurations. The nRF54H20 employs the proven capabilities of an application processor designed for heavy processing with minimum power consumption. The other processors in the SoC can assist with application processing, such that the overall processing performance of the SoC can be even higher.



Tech Check

The nRF54H20 supports all Bluetooth 5.4 features, Bluetooth LE Audio, Bluetooth mesh, Thread, Matter, and other short range wireless protocols. The radio RX current is as low as 2.0 mA resulting in major energy savings and longer battery life

Nordic Product Guide

This handy summary describes all of Nordic's IoT solutions



Full product details at: www.nordicsemi.com/Products

RF SoCs and SiPs

	nRF 91 SERIES		nRF 53 SERIES	nRF 52 SERIES							
	nRF9161	nRF9160	nRF5340	nRF52840	nRF52833	nRF52832	nRF52820	nRF52811	nRF52810	nRF52805	
WIRELESS PROTOCOL	LTE-M / NB-IoT	3GPP rel14	3GPP rel13								
	DECT NR+	●									
	GNSS	●	●								
	BLUETOOTH LOW ENERGY			●	●	●	●	●	●	●	●
	BLUETOOTH 5.3			●	●	●	●	●	●	●	●
	LE AUDIO			●							
	DIRECTION FINDING			●							
	2 Mbps			●	●	●	●	●	●	●	●
	LONG RANGE			●	●	●	●	●	●	●	●
	BLUETOOTH MESH			●	●	●	●	●	●	●	●
	THREAD			●	●	●	●	●	●	●	●
	MATTER			●	●	●	●	●	●	●	●
	ZIGBEE			●	●	●	●	●	●	●	●
	ANT			●	●	●	●	●	●	●	●
2.4 GHz PROPRIETARY			●	●	●	●	●	●	●	●	
NFC			●	●	●	●	●	●	●	●	
TYPE	SYSTEM-ON-CHIP (SoC)										
	SYSTEM-IN-PACKAGE (SiP)	●	●								
CORE SYSTEM	CPU	64 MHz Arm Cortex-M33	64 MHz Arm Cortex-M33	128 MHz Arm Cortex-M33 + 64 MHz Arm Cortex-M33	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4
	FPU	●	●	●	●	●	●	●	●	●	●
	DSP INSTRUCTION SET	●	●	●	●	●	●	●	●	●	●
	CACHE	●	●	●	●	●	●	●	●	●	●
	MEMORY	1MB Flash, 256 KB RAM	1MB Flash, 256 KB RAM	1MB Flash, 512 KB RAM + 256 KB Flash, 64 KB RAM	1MB Flash, 256 KB RAM	512 KB Flash, 128 KB RAM	512 KB or 256 KB Flash, 64 KB or 32 KB RAM	256 KB Flash, 32 KB RAM	192 KB Flash, 24 KB RAM	192 KB Flash, 24 KB RAM	192 KB Flash, 24 KB RAM
CLOCKS	64 MHz / 32 kHz	64 MHz / 32 kHz	128 MHz / 64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	
SECURITY	ARM TRUSTZONE	●	●	●							
	ARM CRYPTOCELL	310	310	312	310						
	ROOT-OF-TRUST	●	●	●	●						
	SECURE KEY STORAGE	●	●	●	●						
PSA CERTIFICATION		Level 2	Level 2	Level 1							
RADIO	LTE-M/NB-IoT/GPS MODEM	●	●								
	CERTIFIED LTE BANDS	1-5, 8, 12-14, 17-20, 25-26, 28, 65, 66, 85	1-5, 8, 12-14, 17-20, 25-26, 28, 66								
	FREQUENCY	700-2200 MHz	700-2200 MHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz
	MAXIMUM TX POWER	23 dBm	23 dBm	3 dBm	8 dBm	8 dBm	4 dBm	8 dBm	4 dBm	4 dBm	4 dBm
	RX SENSITIVITY	-108 dBm (LTE-M), -114 dBm (NB-IoT), -155 dBm (GPS)	-108 dBm (LTE-M), -114 dBm (NB-IoT), -155 dBm (GPS)	-98 dBm (1Mbps)	-95 dBm (1Mbps)	-96 dBm (1Mbps)	-96 dBm (1Mbps)	-95 dBm (1Mbps)	-97 dBm (1Mbps)	-96 dBm (1Mbps)	-97 dBm (1Mbps)
ANTENNA INTERFACE	50 Ω single-ended	50 Ω single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	
PERIPHERALS	HIGH SPEED SPI			●	●	●					
	TWI, SPI, UART	4xTWI/SPI/UART	4xTWI/SPI/UART	4xTWI/SPI/UART +TWI/SPI/UART	2xTWI/SPI, SPI, 2xUART	2xTWI/SPI, SPI, 2xUART	2xTWI/SPI, SPI, UART	2xTWI/SPI, UART	TWI/SPI, SPI, UART	TWI, SPI, UART	TWI, SPI, UART
	QSPI			●							
	USB			●							
	PWM	4	4	4	4	4	3		1	1	
	PDM	●	●	●	●	●	●	●	●	●	●
	I2S	●	●	●	●	●	●	●	●	●	●
	ADC, COMPARATOR	ADC	ADC	●	●	●	●	COMP	ADC, COMP	ADC, COMP	ADC
	TIMER, RTC	3, 2	3, 2	3, 2 + 3, 2	5, 3	5, 3	5, 3	4, 2	3, 2	3, 2	3, 2
	TEMPERATURE SENSOR	●	●	●	●	●	●	●	●	●	●
CERTIFICATIONS	nordicsemi.com/9161cert	nordicsemi.com/9160cert	CE, FCC	CE, FCC	CE, FCC	CE, FCC	CE, FCC	CE, FCC	CE, FCC	CE, FCC	
OPERATING TEMPERATURE	-40 to 85°C	-40 to 85°C	-40 to 105°C	-40 to 85°C	-40 to 105°C	-40 to 85°C	-40 to 105°C	-40 to 85°C	-40 to 85°C	-40 to 85°C	
SUPPLY VOLTAGE RANGE	3.0 to 5.5 V	3.0 to 5.5 V	1.7 to 5.5 V	1.7 to 5.5 V	1.7 to 5.5 V	1.7 to 3.6 V	1.7 to 5.5 V	1.7 to 3.6 V	1.7 to 3.6 V	1.7 to 3.6 V	
DEVELOPMENT KITS	nRF9161DK	nRF9160 DK, Nordic Thingy:91	nRF5340 DK, nRF5340 Audio DK, Nordic Thingy:53	nRF52840 DK, nRF52840 Dongle	nRF52833 DK	nRF52DK, Nordic Thingy:52	nRF52833DK	nRF52840 DK	nRF52DK	nRF52DK	
PACKAGES	10x16x1.04 mm LGA	10x16x1.04 mm LGA	7x7 mm aQFN94 (48 GPIOs), 4.4x4.0 mm WLCSP95 (48 GPIOs)	7x7 mm aQFN73 (48 GPIOs), 6x6 mm QFN48 (30 GPIOs), 3.5x3.6 mm WLCSP94 (48 GPIOs)	7x7 mm aQFN73 (42 GPIOs), 5x5 mm QFN40 (18 GPIOs), 3.2x3.2 mm WLCSP (42 GPIOs)	6x6 mm QFN48 (32 GPIOs), 3.0x3.2 mm WLCSP50 (32 GPIOs)	5x5 mm QFN40 (18 GPIOs), 2.53x2.53 mm WLCSP44 (18 GPIOs)	6x6 mm QFN48 (32 GPIOs), 5x5 mm QFN32 (17 GPIOs), 2.48x2.46 mm WLCSP33 (15 GPIOs)	6x6 mm QFN48 (32 GPIOs), 5x5 mm QFN32 (17 GPIOs), 2.48x2.46 mm WLCSP33 (15 GPIOs)	2.48x2.46 mm WLCSP28 (10 GPIOs)	



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HIGHLIGHTS

- The power of cellular IoT in LPWAN applications
- Adding Device Firmware Update support in nRF Connect SDK
- NR+ is real and here
- Adding battery charging and fuel gauging to your nRF52 Series project

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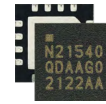


PMICs		nPM FAMILY		
		nPM1300	nPM1100	nPM6001
FEATURES	TYPE	●	●	●
	BUCK REGULATOR	2	1	4
	BATTERY CHARGER	●	●	
	LDO	2		2
CHARGER	LOAD SWITCH	2		
	TERMINATION VOLTAGE	3.5 to 4.45 V	4.1 to 4.2 V or 4.25 to 4.35 V	
	MAX CHARGING CURRENT	800 mA	400 mA	
	POWER PATH MANAGEMENT	●	●	
POWERRAILS	THERMAL PROTECTION	●	●	
	BATTERY COMPATIBILITY	LiFePO4, Li-Ion, LiPo	Li-Ion, LiPo	
	INPUT VOLTAGE	4 to 5.5 V	4.1 to 6.7 V	3 to 5.5 V
	USB COMPLIANCE	Type-C	●	
SYSTEM MANAGEMENT	REGULATED OUTPUT VOLTAGE	1 to 3.3 V	1.8 to 3 V	0.5 to 3.3 V
	MAX CURRENT PER BUCK	200 mA, 200 mA	150 mA	550 mA, 200 mA, 150 mA, 150 mA
	SYSTEM MONITORING	System-, input bus- and battery-voltage; battery-current and -temp; die temp		
	FUEL GAUGE	●		
SYSTEM MANAGEMENT	HARD SYSTEM RESET	●		
	TIMED WAKE-UP	●		
	WATCHDOG TIMER	●		●
	SHIP MODE / HIBERNATE	●	●	●
	BROWN-OUT DETECTOR	●	●	●
	LED DRIVERS, GPIOs	3, 5	2, 0	0, 3
	CONTROL INTERFACE	TWI	Pin-configurable	TWI
	REGULATORY COMPLIANCE	CE, JEITA, RoHS	CE, JEITA, RoHS	CE, RoHS
	OPERATING TEMPERATURE	-40 to 85°C	-40 to 85°C	-40 to 85°C
	EVALUATION KITS	nPM1300EK	nPM1100EK	nPM6001EK
PACKAGE OPTIONS	5x5 mm QFN32, 3.1x2.4 mm WLCSP	4x4 mm QFN24, 2.1x2.1 mm WLCSP	2.2x3.6 mm WLCSP	

Range Extender nRF21540

Description: The nRF21540 is an RF front-end module (FEM) that improves range and connection robustness for Nordic's nRF52, nRF53 and nRF54 Series SoCs. The nRF21540 is a complementary device operating as a 'plug-and-play' range extender with the addition of just a few external components. The nRF21540's 13 dB RX gain and low noise figure of 2.7 dB, coupled with up to +21 dBm TX output power, ensure a superior link budget boosting the range of supported SoCs by between 6.3 and 10x. The RF FEM suits all applications that require increased range and/or robust coverage. In demanding RF environments, or where the application is operating close to the range limit, it can be more energy efficient to use the nRF21540 than continuously resend packets.

Operation: The nRF21540 supports Bluetooth LE, Bluetooth mesh, Matter, Thread, Zigbee and 2.4 GHz protocols. The RF FEM's TX output power is dynamically adjustable and can be set to comply across all geographical regions. The RF FEM can be used with Nordic's extended temperature-qualified nRF5340, nRF52833 and nRF52820 SoCs in industrial applications.



Tech Spec

Output power
Adjustable in small increments up to +21 dBm

Receive gain and noise figure ratings
13 dB receive gain.
2.7 dB noise figure

Input supply
1.7 to 3.6 V

Package
4 by 4 mm QFN16

Development bundle
nRF21540 DK and nRF21540 EK. The EK is a shield for use with nRF52 and nRF53 Series DKs

Applications
Asset tracking, smart home, industrial, toys, audio

Cloud Services nRF Cloud Services

Description: nRF Cloud Services are optimized for Nordic's low-power IoT Devices. nRF Cloud Services consist of nRF Cloud Location Services, and Device Management and Security Services. Both Device-to-Cloud or Cloud-to-Cloud use cases are supported. CoAP and MQTT protocols are both supported.

Services: nRF Cloud Location Services include Assisted GPS, Predictive GPS, Wi-Fi, single-cell and multi-cell, and supply accurate and power-efficient location data for IoT devices employing nRF91 Series products. The Wi-Fi feature requires a Wi-Fi scanning IC, such as one of the nRF70 Series companion ICs. Each location feature has accuracy and power efficiency benefits, so switching between different location services during operation can be useful. nRF Cloud also includes a firmware-over-the-air update function, whereby the nRF91 Series' modem firmware, middleware and/or application firmware can be updated.



Tech Spec

Location services

A-GPS, P-GPS, Wi-Fi, Single-Cell, Multi-Cell

Additional features
Device-to-Cloud and Cloud-to-Cloud use cases

CoAP, MQTT and REST API support

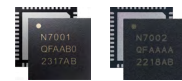
Supported products
nRF9160, nRF9131, nRF9161 SiPs, nRF7000, nRF7001, nRF7002 companion ICs

Applications
Industrial, smart appliances, asset tracking, RTLS

Wi-Fi 6 companion ICs nRF70 Series

Description: The nRF70 Series comprises three Wi-Fi companion ICs. The nRF7001 offers low-power 2.4 GHz connectivity, while the nRF7002 operates in both the 2.4 and 5 GHz bands. The nRF7000 is designed purely for active and passive scanning of Wi-Fi networks. These ICs ensure excellent coexistence with Bluetooth LE devices, advanced power saving with TWT and OFDMA for efficient uplink and downlink communication.

Operation: The nRF70 Series companion ICs provide low power, secure Wi-Fi connectivity as well as Wi-Fi assisted location based on Service Set identifier (SSID) scanning. The nRF70 Series accompany Nordic's nRF52 and nRF53 Series Bluetooth LE SoCs, and the nRF91 Series cellular IoT SiPs. The nRF70 Series can also be used as companion ICs in applications hosted by non-Nordic products. For non-Nordic host products, Nordic supplies the appropriate Linux drivers via the GitHub developer platform (github.com).



Tech Spec

Compliance

nRF7001: IEEE 802.11b (Wi-Fi 1)/g (Wi-Fi 3)/n (Wi-Fi 4)/ax (Wi-Fi 6)
nRF7002: IEEE 802.11a (Wi-Fi 2)/b/g/n/ac (Wi-Fi 5)/ax

Package
6 by 6 mm QFN

Features
Low power, good coexistence with Bluetooth LE, TWT

Development tools
nRF7002 DK, nRF7002 EK, nRF7002 EB

Applications
Asset tracking, smart home, industrial

Fourth generation SoCs nRF54H20

Description: The nRF54H20 is a revolutionary multiprocessor and multiprotocol SoC for Bluetooth LE (supporting all Bluetooth 5.4 features), LE Audio, Bluetooth Mesh, Thread, Matter, ANT+ and 2.4 GHz proprietary protocols with a new 4 Mbps throughput option.

Technical details: The nRF54H20 features multiple processors optimized for specific types of workloads. The application processor was tested with ULPMark-CoreMark and outclassed other wireless SoCs and low-power general purpose MCUs both in processing performance and efficiency. The nRF54H20's radio offers long range and improved robustness with 10 dBm TX power, 100 dBm RX sensitivity for Bluetooth LE and -104 dBm for 802.15.4. In addition to remarkable processing power, ample memory and best-in-class radio, the SoC is also equipped with advanced peripherals and state-of-the-art security features, including physical protection. The nRF54H20 will enable developers to build revolutionary IoT products, with simpler designs, reduced sizes, longer battery life and the ability to perform more advanced tasks, including the execution of machine learning models.



Tech Spec

Processing

Multiple Arm Cortex-M33 processors (clocked up to 320 MHz), Multiple RISC-V coprocessors

Memory

2 MB non-volatile memory, 1 MB RAM

Advanced peripherals
High-speed USB (480 Mbps), CAN FD controller, 2x I3C, 14-bit ADC

Security

Designed for PSA Certified Level 3 IoT security standard

nRF54L15

Description: The nRF54L15 is an ultra low power multiprotocol SoC for Bluetooth LE, Bluetooth Mesh, Thread, Matter, ANT+ and 2.4 GHz proprietary protocols with a new 4 Mbps throughput option. The nRF54L Series enhances the popular nRF52 Series with greater processing power and efficiency, more memory, security and new peripherals - all in a more compact package.

Technical details: nRF54L15 doubles the processing power of the nRF52840 SoC while reducing power consumption. This processing efficiency, combined with a low power consumption radio and low sleep currents, extends battery life or allows for a reduction in form factor by using smaller batteries. Larger memory enables multiple RF protocols to run concurrently and aids firmware update functionality. The radio brings lower latency and longer range with up to 8 dBm TX power and -98 dBm RX sensitivity for 1 Mbps Bluetooth LE. The nRF54L15 offers security services such as Secure Boot, Secure Firmware Update and Secure Storage. It is designed for PSA Certified Level 3.



Tech Spec

Processing

128 MHz Arm Cortex-M33 processor

Memory

1.5 MB non-volatile memory, 256 KB RAM

New peripherals

Global RTC, 14-bit ADC, Software-defined peripheral enabled by a RISC-V coprocessor

Security

Designed for PSA Certified Level 3 IoT security standard



Are you ready?



Compact SoCs with
superior processing power,
a generous amount of memory
and excellent efficiency

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