

WIRELESS QUARTER

Issue 1, 2025

COMPETITIVE EDGE:
EDGE AI TRANSFORMS
SPORTS TRACKING
INDUSTRY

ON THE MOVE:
WHERE NEXT FOR
MICROMOBILITY?

A Vision for Tomorrow's Wireless World

Nordic's CEO outlines
the future of wireless
connectivity



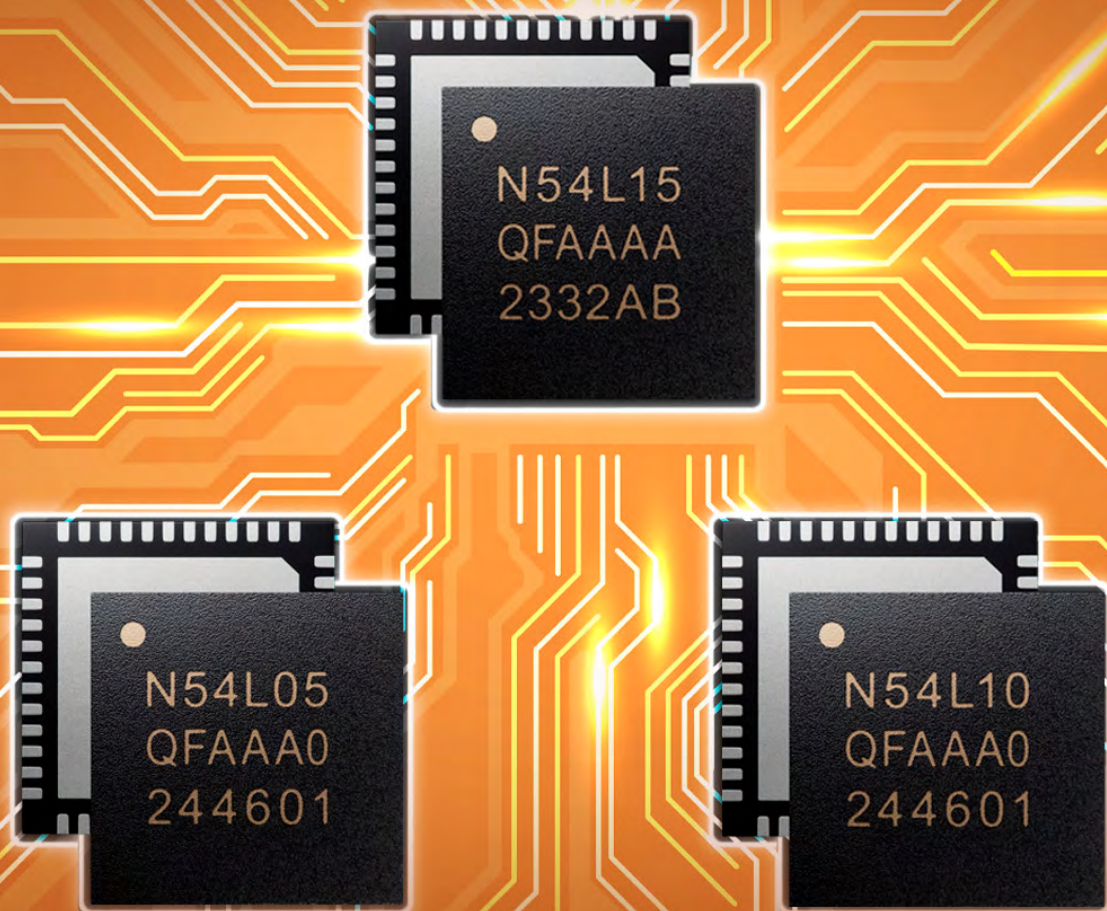
NEW nRF54L SERIES
ENHANCES EFFICIENCY

AI-POWERED WEARABLES
ON GROWTH CURVE

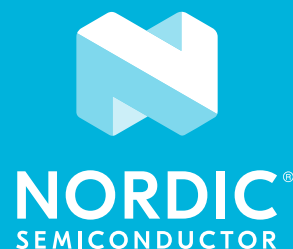
AN INTRODUCTION TO
CHANNEL SOUNDING



Next-generation wireless SoCs are here



START DEVELOPING WITH nRF54L15 DK
nordicsemi.com/nRF54L15DK



Welcome

Oyvind Strom
 EVP BU Short-Range



Next level wireless SoCs solve tomorrow's IoT challenges

2024 has been a pivotal year for Nordic Semiconductor. Since our new management team started work in January, we've sharpened our strategic focus, enhanced engineering execution and strengthened accountability across the organization (see cover feature pg12). The results are already evident: Nordic is not just keeping pace with the market – it's setting the standard.

In the company's strategic target markets—consumer, [connected health](#), industrial automation and [Edge AI](#)—the potential for short-range radio solutions is huge. Short-range wireless is the growth engine of Nordic and the foundation for the IoT and Industrial IoT. According to a selection of industry analysts, this market is expanding rapidly – [Bluetooth LE](#) alone is expected to grow at a 20 percent CAGR over the next five years, after reaching 1.8 billion chip shipments in 2024.

Nordic's R&D and engineering teams have worked hard to maintain the company's leading position in short-range wireless technology. The launch of three new devices in the nRF54L Series at Electronica in November last year, the [nRF54L15](#), [nRF54L10](#) and [nRF54L05](#), is a testament to Nordic's leadership and innovation. This next generation of wireless SoCs offers unparalleled performance and capability, meeting the different demands and needs of the broad market of IoT applications.

With the nRF54L Series and the upcoming nRF54H Series poised to offer even greater performance later this year, Nordic is redefining what's possible in Bluetooth LE and short-range wireless innovation.

Throughout this edition of WQ, you can read how the company's drive to innovate is paving the way for groundbreaking IoT solutions across consumer, healthcare and Industrial IoT. Nordic is not just leading the short-range wireless market, it's shaping the future of low power wireless connectivity across [cellular IoT](#), [Cloud services](#), low power [Wi-Fi](#) and [Power Management](#).



Nordic Semiconductor is not just keeping pace with the market – it's setting the standard

Contents

News	4
News Extra	8
Next generation nRF Series SoCs enhance efficiency	
Analysis	10
AI-powered wearables benefit consumers and industry	
Comment	11
The evolving face of Bluetooth	
Tomorrow's Wireless World	12
Nordic CEO Vegard Wollan on the future of wireless technology	
Competitive Edge	16
Edge AI is transforming sport tracking applications	
On the Move	20
Wireless solutions are powering the future of micromobility	
Nordic Inside	22
Monil Collar	
Case Study	24
Smart soil monitoring promotes precision agriculture	
Industry Viewpoint	25
Anders Spur, Watts	
Tech Zone	26
Product Focus	28
nRF9151 low power SiP	
nRF54L15 modules	
Tech Briefing	32
Introducing Channel Sounding	
Nordic Product Summary	34

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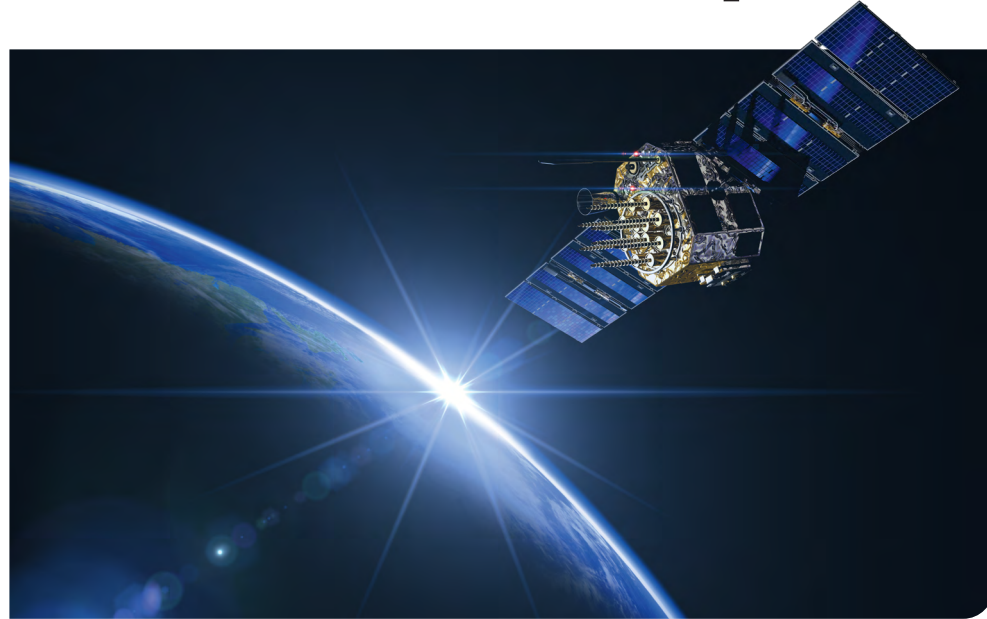
Cellular IoT

Iridium and Nordic Semiconductor to collaborate on Iridium NTN Direct chipsets

Leading provider of global voice and data satellite communications, Iridium Communications Inc., has announced a collaboration with Nordic Semiconductor. The collaboration covers early integration of its Iridium Non-Terrestrial Networks (NTN) Direct service into Nordic's [LTE-M/NB-IoT](#) SiPs.

Iridium NTN Direct is planned to be the world's first truly global NB-IoT service. The product of Iridium's Project Stardust initiative, Iridium is developing this capability in coordination with the 3rd Generation Partnership Project's (3GPP) recent decision to accept "Iridium enabling enhancements" in its next release. This would allow Iridium's satellite service to be accessible by any device with a 3GPP Release 19 compliant chipset. Nordic plans to incorporate the Iridium NTN Direct service's communication capability as part of its 3GPP release 19 NTN roadmap, taking advantage of the established reliability and operating experience of the Iridium network.

"Nordic Semiconductor is an industry leader that continues to be at the forefront of innovation with its low power LTE-M and NB-IoT modules and chipsets," says Bryan Hartin, Executive Vice President, Iridium. "The integration of Iridium NTN Direct into its



[SiPs] marks a new chapter in Nordic's storied history and will create a universe of consumer and industrial devices with the capability to stay connected from anywhere on Earth. We look forward to working with Nordic Semiconductor and them bringing both their SiP and device-side experience to the Iridium ecosystem."

"Iridium is a global leader in satellite

communications," says Oyvind Birkenes, Executive Vice Present for the Long-Range BU at Nordic Semiconductor.

"It is exciting that Iridium is taking the step to enable low cost, 3GPP standard NB-IoT modules and chipsets like Nordic's [nRF9151](#) to connect to its network of satellites. This helps bring the vision of universal connectivity for global and Massive IoT to life."

Audio & Music

TV audio streamer for Bluetooth LE/Auracast devices

Swiss embedded electronics designer, Arendi, has unveiled a Bluetooth LE Audio (LE Audio) and Auracast broadcast audio TV streamer. The streamer provides high quality audio from a TV, stereo, PC or similar device to an end user's Bluetooth LE- or Auracast-enabled headphones, speakers or hearing aids. The Arendi Auracast TV Streamer employs Nordic Semiconductor's dual core [nRF5340](#) SoC and [nRF21540](#) RF front-end module (FEM) to

deliver low power, long range, reliable wireless connectivity with improved audio quality. "Current TV streamers use proprietary RF links to respect the limited energy of a hearing aid battery," says Thomas Rupp, CTO, Arendi AG. "With the release of the Arendi Auracast TV Streamer, a manufacturer independent, Bluetooth LE solution is now available."

The nRF5340 SoC's dedicated application

processor provides ample computational resources to run the Arendi Auracast TV Streamer's audio codec. The inclusion of Nordic's [nRF21540](#) FEM in Arendi's TV streamer allows for higher transmission power (+ 20 dBm), resulting in longer range and more reliable transmission between the TV and the receiving device, even when the user, for example a wearer of hearing aids, turns their head away from the audio source.



Smart Home

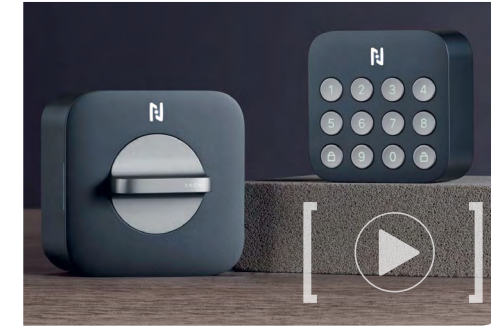
Matter over Wi-Fi smart lock provides remote access

Anona Security Technology Limited has released a [Matter](#) over Wi-Fi compatible smart lock. The smart lock can be installed on any door to provide remote wireless access to a premises for the homeowner or an approved visitor. The product integrates both Nordic Semiconductor's [nRF5340](#) SoC and [nRF7002](#) Wi-Fi 6 Companion IC to enable the device to be locked and unlocked using Bluetooth LE via an app on the user's smartphone, or using Matter over Wi-Fi between the smart lock and a compatible smart home ecosystem.

When the user is within Bluetooth LE range of their door, the smart lock can be unlocked via the Anona Security iOS or Android smartphone app.

The product also supports locking and unlocking manually using a keypad code and a mechanical thumb latch.

The smart lock is among the first smart devices to work with Matter via direct Wi-Fi connection, without the need for an additional Wi-Fi bridge. It is compatible with users' existing smart home systems, including Alexa, Apple Home and other smart devices compatible with Matter. With a built-in Wi-Fi



connection to the home access point (AP), the homeowner can relay the unlock request to the device from the app whether they are on their doorstep or operating it remotely.

"The nRF5340 gives us not only a world first multicore SoC, but also the Flash and RAM memory needed to support Matter, and class leading power consumption performance," says Yang Sheng, CTO, Anona Security Technology Limited. "The nRF7002 provides optimal coexistence with the nRF5340 and Bluetooth LE, as well as good performance on power consumption, connection stability and, of course, security."

Smart Home

Smart home solutions support affordable smart housing initiative

NousLogic has announced a suite of smart home health and remote monitoring solutions for an affordable housing initiative partnered with AIA (AI-transformative Accommodation) LLC in California, U.S. The advanced residential design project forms part of a collaborative program with the UCI (University of California, Irvine) Center for Real Estate at the Paul Merage Business School, to develop business plans for low cost, smart housing using automated services.

The three NousLogic solutions are all based on Nordic Semiconductor's [nRF52840](#) SoC. The nRF52840 supervises each device's integrated sensors and provides Bluetooth LE wireless connectivity for communication and device commissioning. In addition, the solutions support the use of [Amazon](#)

[Sidewalk](#)'s long range CSS/LoRa. The technology is a low data rate, wireless protocol providing connectivity to devices outside the range of a home Wi-Fi network, or that depend on a nearby mobile phone or proprietary gateway for a Cloud connection.

"The simplicity and versatility of these combined technologies enabled us to quickly launch innovative solutions for three distinct markets: assisted living remote monitoring services; a cardiac wearable sensor patch with [Edge AI](#) capability; and an automated, utility reader for smart city applications," explains Hoang Nhu, CEO of NousLogic.

"Unlike other wireless standards, an Amazon Sidewalk-based product offers a true plug-and-play solution for users, supporting long range, smart city applications."



In Brief

NORDIC APPLAUDS TSMC FAB LAUNCH IN GERMANY



Nordic Semiconductor joined industry leaders at the [launch](#) of TSMC's first European semiconductor fab in Dresden, Germany.

While not directly involved in the facility's development, Nordic recognizes the critical role this new fab will play in strengthening the resilience of Europe's semiconductor supply chain. This marks a significant milestone for the European semiconductor ecosystem, bringing advanced manufacturing closer to fabless European companies like Nordic. TSMC is a long standing fabrication partner of Nordic. The \$10 billion fab is co-funded by the EC, German government and a group of European semiconductor companies.

PROJECT TO 'SLICE' NETWORKS FOR EFFICIENCY



The University of Nebraska-Lincoln's School of Computing Assistant Professor Qiang Liu has received a grant from the National

Science Foundation, to help develop an autonomous wireless network resource allocation method called "slicing-as-a-service". While most existing network slicing solutions are coarse grained and cannot tackle many network orchestration issues relating to responsiveness, cost-efficiency and autonomy, Liu's project uses automated network slicing and allows mobile applications to be supported at a very low cost. The project also makes network automation more intelligent and accessible.

TIME RECOGNIZES NORDIC FOR SUSTAINABILITY



Nordic Semiconductor has been [named](#) by *TIME* magazine as one of the "World's Most Sustainable Companies". Nordic's greenhouse gas reduction

achievements; increasing conversion to recycled plastic use in manufacturing component reels; and dedication to its sustainability principles have made the top 500 list for World's Most Sustainable Companies, designated by *TIME* and research partner, Statista, from more than 5,000 eligible companies worldwide. The criteria devised by *TIME* and Statista to recognize companies that prioritize sustainability is designed to promote corporate responsibility and advance sustainable practices.

Connected Health

Cellular IoT wearable helps people with neurodegenerative diseases



U.S. technology company, Saluswear Corp, has launched a wearable device designed to give people with neurodegenerative diseases such as Alzheimer's and dementia a greater degree of independence and security. The Saluswear GPS device also provides peace of mind to carers and family members.

Offering a miniaturized 25 by 38 millimeter form factor, Saluswear GPS is an unobtrusive device that can be waist- or lanyard-worn, or placed inside a bag. It employs Nordic Semiconductor's nRF9160 SiP to provide cellular connectivity between the wearable and the Cloud, enabling carers to instantly locate the whereabouts of the individual via their smartphone or a website. In addition to near real time location tracking, additional features include fall alerts, a step tracker and 'Safe Zone' geofencing.

"The Saluswear GPS device is for users that either don't like to carry a smartphone, or don't know how to use one, as can often be the case with older people living with a neurodegenerative disease," says Chris Rotberg, CEO, Saluswear Corp. "The cellular connectivity and GPS connectivity provided by Nordic's nRF9160 SiP negates the need for the wearer to carry a smartphone, and ensures family, friends and caregivers can still pinpoint their location around the clock."

The nRF9160 SiP's Arm Cortex-M33 application processor supervises the on-

board accelerometer that detects movement and falling. This allows the Saluswear wearable to not only track the user's steps to ensure they are getting sufficient exercise, but also to detect a potential fall.

The Saluswear GPS device employs a 300 mAh lithium cell, providing at least 10 days of power between recharge. The extended battery life is thanks in part to the integration of Nordic's nPM1300 Power Management IC (PMIC), and the nRF9160 SiP's PSM and eDRX power-saving modes that allow the device to sleep for longer periods of time.

Automotive

Motorcycle HUD provides riders with navigation prompts

German motorcycle accessories company TILSBERK has launched a wireless display for attachment to the user's motorcycle or scooter helmet to provide important information for riders without taking their eyes off the road. The TILSBERK Heads-Up Display (HUD) is easily attached and detached from the helmet and is connected to the user's smartphone using Bluetooth LE connectivity provided by Nordic Semiconductor's nRF52840 SoC.

Once connected to the user's smartphone the virtual display presents key riding metrics, including navigation prompts, lane indicators, speed limits, speed warnings, incoming calls, compass readings, smartphone charging status and time. It also offers both a satellite navigation system and a comprehensive tour planning tool. Riders can configure this layout and plan navigation routes using the corresponding TILSBERK app.

"By eliminating the need to glance down at traditional displays, this product significantly enhances concentration levels and safety while riding," explains Mirko Zabel, Team

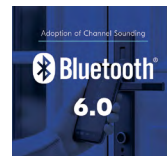


Leader Marketing at TILSBERK. "It ensures that you still have a full view of the surroundings throughout the ride. Additionally, because the display situates the information approximately ten meters ahead of the rider, it reduces the need for motorcyclists to refocus their eyes, allowing for uninterrupted attention to the road ahead."

"The Bluetooth LE connectivity is essential to the design of this device, as it removes the need for permanent installation, and enables the rider to quickly transfer the display between helmets," says Zabel.

Bluetooth LE

Bluetooth 6.0 Channel Sounding supported by nRF54 Series SoCs



Following the Bluetooth SIG's official adoption of Channel Sounding as part of Bluetooth 6.0, Nordic Semiconductor has announced its support for the technology in the nRF54L and forthcoming nRF54H Series SoCs. Channel Sounding enhances how Bluetooth LE devices measure distance and detect presence, extending the technology's flexibility and promising a new range of applications (see pg32).

As a global leader in low power wireless IoT connectivity and the market-share leading supplier of Bluetooth LE solutions, Nordic has been fast to integrate Channel Sounding into its nRF54 Series. This underscores Nordic's commitment to adopting advanced technologies that improve how devices connect and interact. The nRF54L and

forthcoming nRF54H Series will take full advantage of the capabilities offered by Channel Sounding, enabling developers and manufacturers to create more advanced, secure and efficient wireless products.

"The Bluetooth SIG's adoption of Channel Sounding significantly enhances the precision of previous Bluetooth distance measuring techniques and encourages innovation across the Bluetooth device ecosystem. Nordic is excited by the possibilities the technology opens up for its customers," says Oyvind Strom, EVP BU Short-Range at Nordic. "Nordic's plan to support Channel Sounding in its latest generation SoCs will enable developers to build a range of innovative distance and presence detection applications and get them quickly to market."

By the Numbers

\$127.9 million in revenue

Nordic Semiconductor has reported Q2 2024 revenue of \$127.9 million, which was a year-on-year decline of 17 percent from \$154.2 million in Q2 2023 but a strong increase of 72 percent from Q1 2024. The sequential improvement reflects higher demand from both key customers and the broad market, as well as seasonal effects. The adverse effect of distributor inventory adjustments on reported revenue was also significantly lower than in the previous quarter.

Modules

Multisensor platform monitors intrinsic movement of devices

German company Sensry has launched a new Kallisto universal multisensor platform. The product can be used to monitor intrinsic movements of devices as well as a wide range of environmental conditions and air quality. The Kallisto SY021-PCB multisensor module extends the capabilities of its predecessor with local sensor data storage, which enables long term monitoring without using the Cloud.

The module combines Nordic Semiconductor's nRF52840 SoC with a set of sensors and firmware, simplifying the configuration, installation and operation of the platform. The nRF52840 runs the Zephyr-based multisensor firmware, which is used to configure the different sensors and to control various streaming and logging options.

A spectrum of 20 quantities intended to be

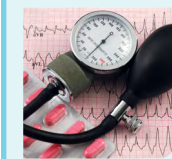
measured can be simultaneously detected at configurable sensitivities and sampling rates, and processed via the onboard nRF52840 SoC's Arm Cortex-M4 processor with floating point unit (FPU). The SoC performs as the Kallisto SY021-PCB's application processor and supports the Zephyr real time operating system (RTOS). The nRF52840 is also used to retrieve and preprocess sensor data before it is streamed via Bluetooth LE connectivity to a gateway or an industrial PC.

The module also integrates Nordic's nPM1100 Power Management IC (PMIC). This allows the multisensor unit to be powered by USB or a connected battery, which can be charged by USB as well or via wireless charging.



In Brief

SYSTEM HELPS CONTROL HIGH BLOOD PRESSURE



A study has found that almost three-quarters of adults with treatment-resistant high blood pressure, including those with chronic kidney

disease, were able to improve control of their blood pressure within 12 months when using a Bluetooth LE-enabled remote monitoring system coupled with pharmacist interactions. Through the ConnectedCare365 Hypertension Management program, up to 74 per cent of participants were able to get their blood pressure below 140/90 mm Hg within one year, according to preliminary research presented at the American Heart Association's Hypertension Scientific Sessions 2024.

NUMBER OF CONNECTED IOT DEVICES GROWS



The number of connected IoT devices is expected to grow 13 percent in one calendar year, from 16.6 billion at the end of 2023 to 18.8 billion by

the end of 2024, according to IoT Analytics' State of IoT Summer 2024 report. The research shows 51 percent of enterprise IoT adopters plan to increase their IoT budget in 2024, with 22 percent of companies expecting a higher than 10 percent budget increase compared to 2023. The number of connected IoT devices is estimated to grow to 40 billion by 2030. Global IoT connectivity is dominated by Wi-Fi, Bluetooth and cellular IoT, which together make up 77 percent of all IoT connections.

NORDIC EXTENDS SUPPORT FOR SMART AGRICULTURE



Nordic Semiconductor has extended its support to the smart agriculture sector with membership of IoT4Ag, a U.S. National Science Foundation

(NSF) Engineering Research Center. IoT4Ag's mission is to promote IoT technologies for precision agriculture that can address the global challenge of food, energy and water security. As a member of the organization, Nordic will take a seat on IoT4Ag's Industrial Practitioner Advisory Board (IPAB) to provide strategic guidance on the organization's goal of developing and deploying precision agriculture technologies. Wireless IoT tech that is inherently low power and easily scalable will be key to growth in this sector.

Bluetooth LE

Nordic's next gen SoCs bring enhanced efficiency and processing to IoT applications

The nRF54L15, nRF54L10 and nRF54L05 wireless SoCs redefine Nordic's leadership in ultra-low power wireless connectivity for the IoT

Bluetooth LE is booming with the Bluetooth SIG reporting that some 1.5 billion chips supporting the tech shipped during 2023. And it's not just the number of chip shipments that impresses; developers continue to come up with ever more advanced applications leveraging wireless connectivity.

To meet the demands of these and future applications, Nordic has launched its nRF54L Series of wireless SoCs, including the previously announced nRF54L15, and the new nRF54L10 and nRF54L05. The company says this advanced product series sets new industry standards, offering significantly enhanced efficiency, exceptional processing power and versatile design options to meet a growing range of Bluetooth LE and IoT applications.

"The launch of the nRF54L Series wireless SoCs establishes Nordic, already the world's leading supplier of Bluetooth LE solutions, firmly at the forefront of low power wireless technology," says Oyvind Strom, EVP BU Short-Range with the company. "Expanding the product series with the nRF54L10 and nRF54L05, alongside the nRF54L15, allows us to support a wide range of Bluetooth LE and IoT applications with greater flexibility and exceptional energy efficiency."

The nRF54L SoCs integrate a 2.4 GHz radio, microcontroller (MCU) capabilities memory and peripherals onto a single chip, supporting applications from simple, high volume products to more demanding and advanced designs. Key applications include wearables, smart rings, gaming controllers, HID devices, medical devices, smart home appliances and IIoT products. The nRF54L15 is suited to more demanding applications, while the nRF54L10 and nRF54L05 target high volume applications and cost sensitive IoT devices.

Built for tomorrow

The new products include Nordic's proprietary IP such as low-leakage RAM and advanced radio technology, while security is prioritized by design, integrating features such as Arm TrustZone isolation, tamper sensors and hardened cryptographic accelerators.

The ultra-low power capabilities and processing efficiency of the nRF54L Series have been boosted by a pioneering transition to wafer fabrication company TSMC's 22ULL technology - which uses the 22 nm process node for manufacturing.

To meet the needs of the widest range of IoT applications, the nRF54L Series supports [Bluetooth LE](#), [Bluetooth Mesh](#), [Thread](#), [Matter](#), Zigbee, [Amazon Sidewalk](#) and 2.4 GHz proprietary protocols, with enhanced



The nRF54L Series brings enhanced efficiency and processing to advanced IoT applications such as HIDs

This advanced product series sets new industry standards, offering significantly enhanced efficiency, exceptional processing power and versatile design

capabilities such as up to 4 Mbps data rate. The series is also designed to support Bluetooth 6.0, including Bluetooth [Channel Sounding](#) (see pg32).

The nRF54L Series SoCs are based on an Arm Cortex-M33 processor clocked at 128 MHz and an ultra-low power 2.4 GHz radio. They are designed to support advanced application software and wireless protocol stacks on a single chip, reducing the need for external microcontrollers or additional memory.

The nRF54L15 offers the largest memory capacity with 1.5 MB non-volatile memory (NVM) and 256 KB RAM, making it suitable for the most demanding applications. The nRF54L10 provides a mid-range option with 1.0 MB NVM and 192 KB RAM, while the nRF54L05 is optimized for less demanding, cost sensitive applications, and features 0.5 MB NVM and 96 KB RAM.

Now with RISC-V

In addition to its range of memory options, the product series integrates a low power RISC-V coprocessor, supporting advanced application requirements without additional external components.

Developers can get started on nRF54L Series projects with the [nRF54L15 DK](#) (Development Kit). The DK comes with an ecosystem of software that quickly enables development and proof of concepts, and is combined with detailed documentation, hands-on online courses and leading technical support.

Next-level wireless SoCs

Integrated multipurpose MCU

New ultra-low power radio

2x processing power

3x processing efficiency

MADE FOR DEVELOPERS

GET STARTED
nordicsemi.com/nRF54L15-DK

Wearables

AI-powered wearables benefit consumers and industry alike

The evolution of AI-capable Bluetooth SoCs promises new markets and enhances consumer experiences through wearable tech

The next era of wearable devices will incorporate the power of AI. The AI-based tech sector is expanding beyond fitness trackers and smartwatches to include intelligent assistants, smart clothing, smart jewelry, VR headsets and health monitoring devices. Such products will be capable of processing large volumes of data in near real time, allowing users to make faster and more informed decisions.

Market forces and forecasts

The latest research indicates AI-powered wearable technology is gaining traction. New data from analyst Grand View Research shows the global wearable AI market size—valued at \$21.2 billion in 2022—is expected to reach \$166.5 billion by 2030. In its *Wearable AI Market Size, Share & Trends Analysis Report*, the analyst suggests the significant growth in this market can be attributed to the “exponential rise of emerging technologies” – including the integration of AI and ML algorithms, as well as 5G smartphone adoption.

Factors driving market growth include continuous R&D by key players in the wearable AI market, and the adoption of technologically advanced [wearables](#) employing AI across various industry verticals.

“The increased adoption of smart wearables enabled with AI is due to the advancement of IoT, integration of wireless technology and the increasing popularity of smartwatches among millennials and Gen Z ... many key players in the market are targeting Gen Z by introducing AI-enabled wearable products,” the report states.

Amongst the healthy competition, the smartwatches segment accounted for the largest revenue share of over 30.2 percent in 2022, according to Grand View Research. Moving forward, the firm predicts growing consumer health consciousness will further boost demand for wireless sports and fitness tracking devices. However, smart earwear is expected to exhibit the fastest CAGR over the forecast period – in part attributed to the increased purchase of AI-enabled headphones by millennials and Gen Z.

From an application perspective, the consumer electronics segment accounted for the largest revenue share, owing to the increasing demand for smart wearables to track health vitals. The [healthcare](#) segment is expected to register the fastest growth rate from 2023 to 2030, according to the Grand View Research report.

In terms of operations, the ‘on-device’ AI segment dominated the market over Cloud-based AI with a share



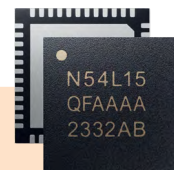
AI/ML algorithms can be trained to detect patterns in biometric data, such as heart rate, blood pressure and oxygen saturation levels

of 58.0 percent in 2022 and is expected to continue that trend. This dominance is attributed to fast computing requirements, demand for low latency devices and reduced dependency on Cloud-based AI.

Key challenge for developers

Despite the forecast growth, a significant challenge for developers remains the trade-off between the computational power of compact, lightweight AI wearables and the associated impact on device battery life. To address this challenge, power consumption can be optimized by creating application code to support streamlined usage, and processing only vital data by computing as close to the edge as possible – in other words, performing ‘[Edge AI](#)’.

Through Edge AI and Machine Learning (ML), swathes of raw local sensor data can be converted into precise, relevant and meaningful insights, or alternatively used to provide actual feedback or instructions. For example, AI/ML algorithms can be trained to detect patterns in biometric data, such as heart rate, blood pressure and oxygen saturation levels, before wireless connectivity allows a healthcare wearable to send real time health risk alerts to smartphones and tablets.



Need to Know

Nordic Semiconductor’s new [nRF54](#) Series SoCs have been designed for applications that demand a high level of processing power, excellent energy efficiency, as well as state-of-the-art security capabilities



Many key players in the market are targeting Gen Z by introducing AI-enabled wearable products

Paweł Kanafek

Senior Product Marketing Engineer, Nordic Semiconductor

Bluetooth evolves to meet new application demands

Recent enhancements to popular short-range tech include Channel Sounding

Together with its membership, the Bluetooth SIG has consistently adapted the technology to meet new demands. Higher throughput and longer range were introduced with Bluetooth 5.0, and more recently, Bluetooth Mesh added large scale wireless networking—for applications such as professional smart lighting deployments—to the topologies the technology can support. This was followed by [LE Audio](#) which brings high quality sound and features such as Auracast broadcast audio to the next generation of wireless audio (see [WQ Issue 2, 2023 pg12](#)).

It’s an exciting time for [Bluetooth LE](#), the world’s most popular short-range radio technology. And as the leading supplier of Bluetooth LE solutions that makes it an exciting time for Nordic Semiconductor too.

When you consider the capabilities of Bluetooth today, it’s amazing to think that back in 1999, the original specification was simply targeted at point-to-point wireless connections.

Nordic first became involved with Bluetooth during the development of the Low Energy version from

Now, the latest version of the technology, Bluetooth 6.0, introduces [Channel Sounding](#). The technology enables secure fine ranging between two Bluetooth devices and promises many new innovative wireless proximity and distance ranging applications (see [pg32](#)).

Each time Bluetooth is enhanced, Nordic has quickly followed, enabling developers to create innovative applications

Each time Bluetooth is enhanced, Nordic has quickly followed with solutions enabling developers to create innovative applications leveraging the new functionality. The company’s latest generation of Bluetooth SoCs, the [nRF54](#) Series, is no exception. The products are designed to support [Bluetooth Mesh](#), [LE Audio](#) and [Channel Sounding](#) straight out of the box (see [pg8](#)). And developers can be assured that when the Bluetooth SIG introduces further Bluetooth enhancements, Nordic will be among the first semiconductor companies to launch solutions to support them.

around 2006 onwards. The company played a key part in the development of the LE part of the Bluetooth Core Specification – formally introduced as a hallmark element of Bluetooth 4.0 in 2009. The interoperability issues had been ironed out by then and the tech became one of the fastest growing wireless connectivity solutions ever.

Nordic launched its [nRF51](#) Series SoCs in 2012 and followed that up with the hugely successful [nRF52](#) Series a few years later. Since then, the company has shipped billions of Bluetooth LE SoCs to thousands of customers and has been designed in to around 40 percent of certified Bluetooth products each year. That share is far ahead of any competitor.



Tomorrow's Wireless World

After 20 years in the vanguard of low power wireless tech, Nordic Semiconductor is setting itself up to meet future opportunities. The company's CEO, Vegard Wollan, explains how



“ To retain our position as a leader we need to shorten the time it takes to capitalize on the work of our R&D department by bringing products to market faster



In Short
After a tough 2023, Nordic is positioning itself to drive growth and return to profitability

The company will focus on high growth potential market sectors including healthcare and the IIoT
New product launches are being accelerated, starting with the nRF54L Series SoCs and nRF9151 SiP
The ability to perform ML on low power, embedded devices that can run on batteries will transform the IIoT

During 2023, the worldwide semiconductor industry suffered significant headwinds. According to World Semiconductor Trade Statistics (WSTS), an organization that tracks chip billings, the global industry shipped close to \$527 billion compared to \$574 billion in 2022, a decline of 8.2 percent^[1].

After a period of growth over several years, Nordic Semiconductor was not immune to the economic challenges. But the company wasn't about to stand still. "We knew the market would eventually recover, that's the cyclical nature of our business," says Vegard Wollan, Nordic's CEO. "But rather than bet on the upturn's timing, we focused on the things we could do something about." It's the kind of challenge that semiconductor-industry veteran Wollan relishes. The co-inventor of AVR microcontroller architecture, he has an impressive resume. It includes Atmel, where Wollan built a \$1 billion revenue business as VP and General Manager of the Touch and MCU Business Unit, helping with the establishment of Mywo and a stint as CEO of TouchNetix, a global innovator in touch technologies. Wollan then [became Nordic's CEO](#) in January 2024, following in the steps of Sverre-Tore Larsen who had held the role for twenty years.

Wollan says the company's targets are to improve return on investment, drive growth and get back to profitability. But he plans to do this without changing the company's long term strategy. "We continue to aim to be the leader in wireless connectivity, to excite developers and engage with large, medium and small customers," he says.

Nordic has a 40-year history and two decades of expertise in low power wireless connectivity. (See [WQ Issue 4, 2023 pg10](#).) The company is the leader in [Bluetooth LE](#), a key tech for the IIoT, and is emerging as an important player in [cellular IoT](#) (LTE-M and NB-IoT), low power [Wi-Fi](#), [smart-home](#) technology, [Matter](#) and [power management](#).

In recent years the company has expanded its product portfolio to target the key foundational IoT standards-based technologies. nRF52, nRF53 and nRF54 Series SoCs serve Bluetooth LE, [Bluetooth Mesh](#), [Thread](#), Zigbee and other short-range protocols; nRF91 Series SiPs are aimed at kilometer-plus range cellular IoT applications; nRF70 Series Companion ICs are Wi-Fi chips for smart home applications or for Wi-Fi locationing in asset tracking devices; and the nPM Series of power management ICs (PMICs) offer a commercial option for optimizing energy consumption in IoT end-products.

BIRTH OF THE BUSINESS UNITS

Each of Nordic's product families is at a different stage of maturity and makes a different contribution to the company's revenue. The current growth engine of Nordic's business is short range wireless technology which features the market leading nRF52 and nRF53 Series, and the recently launched nRF54 Series. Cellular IoT is scaling up, while Wi-Fi and PMICs are early stage businesses.

Wollan realized that because each of the product families was at a different stage, each needed to be managed differently. So he created four new business units (BUs) and brought in experienced managers to head them up. The BUs are Short-Range (managed by Oyvind Strom, with 25 years' experience in the semiconductor sector and

formerly CEO of Sentinel Software); Long-Range (Oyvind Birkenes, another industry veteran and a former CEO of Airthings); Wi-Fi (Joakim Ferm, who has been with Nordic since 2008); and PMICs (Kjetil Holstad, who is also Nordic's EVP Strategy and Product Management and has been with the company for nine years). (See [sidebars](#).)

"Each business must be managed differently because they are at different stages and thus need different execution strategies," says Wollan. "But there's an overarching approach that will guide all four BU managers. Much of this approach is based on asking customers what they really need to succeed. This has influenced the product roadmap and helped us sharpen priorities with some projects gaining resources and others taking a lower profile. We've also improved engineering execution."

Wollan says the Long-Range BU will scale due to a sharper focus on target markets such as tracking, smart metering and Industrial IoT (IIoT). "We'll introduce new products with a higher value proposition," he explains. "This started with the [nRF9151](#) SiP which was launched in August." (See [WQ Issue 1, 2024 pg8](#).)

The company is aiming to establish a revenue base of greater than \$100 million for the Long-Range BU and attain profitability by 2028. The target for the Wi-Fi BU is a \$50 million revenue stream and profitability by 2028. Wi-Fi revenue will be helped in part by enabling customers working on Linux and Zephyr designs.

Nordic Viewpoint:

Oyvind Strom
EVP BU Short-Range



Oyvind Birkenes
EVP BU Long-Range



Short-range growing from strength-to-strength

Short-range wireless has been Nordic Semiconductor's main growth engine, and over two decades, we have built global leadership in Bluetooth LE. This leadership and our investment in tech puts us in a unique position to grow further as the industry grows.

Nordic is now in a situation where we have done the heavy lifting on tech development and can utilize our engineering resources to launch products at a much higher pace than in previous years. I am, therefore, proud to see our three newly launched devices in the nRF54L Series now available, allowing us to address a broader market with the next generation wireless SoCs.

With the nRF54L Series, we have more than doubled the processing performance compared to the nRF52 Series whilst reducing energy consumption for both processing and radio operations. The nRF54H Series increases processor performance five times while the processor is six times more energy efficient.

Customers buying our SoCs also benefit from a huge ecosystem of software that quickly enables them to do proofs-of-concept and develop their products. This, combined with our innovative support and hands-on online courses, guides our customers to success every step of the way. So why is all this important? Because it means end products can be more energy efficient, have new features, support more applications, and be smaller in size, and this is what gets engineers and consumers excited.

Cellular IoT with everything

Cellular IoT networks are experiencing rapid growth and product companies are increasingly choosing cellular connectivity for IoT because it offers reliable, secure global coverage and direct Cloud connectivity without local gateways.

With cellular IoT, products can connect to the Cloud automatically, which enhances the end-user experience (UX) and results in more engaging products. For brands selling IoT enabled devices, it provides consistent data collection from all field units, supporting analytics driven UX improvements and seamless over-the-air updates.

As cellular IoT costs fall, the market will expand to many applications, and Nordic is poised to capitalize. Cost, power consumption and ease-of-use are critical factors, and Nordic has addressed these with the nRF9151 SiP, the industry's smallest and lowest power cellular IoT solution. The nRF9151 also offers lower cost, higher performance and greater integration than competing modules.

The growth of cellular IoT will be driven largely by asset tracking and utility metering. As costs decrease, asset tracking will expand from high value items to lower cost assets. Likewise, the utility metering sector is moving toward cellular IoT.

With the nRF9151 SiP, Nordic has overcome price and usability barriers, delivering a complete solution from silicon-to-Cloud. This approach makes it easy for customers to use cellular IoT.

The PMIC BU has similar targets to the Wi-Fi BU. “We have world leading competence in power management and want to supply solutions that allow engineers to control the entire energy path from battery to antenna,” says Wollan.



Tech Check

The **nRF54L15** wireless SoC is an ultra-low power solution with an Arm Cortex-M33 processor, new best-in-class multiprotocol radio and advanced security features. nRF54L Series takes the popular nRF52 Series to the next level with excellent processing power and efficiency, expanded memory and new peripherals, all in a more compact package

ACCESSING UNTAPPED POTENTIAL

For Nordic to reach its revenue target depends on selling solutions into growth sectors. The company has identified four key areas that offer “huge untapped potential”. Hybrid working is one. Employees require more connectivity to enable them to be productive no matter where they are. **Connected health** is another. Certain applications such as drug delivery (for example, insulin pumps) and personal sensors (such as continuous glucose monitors) rely on wireless connectivity and are set to be very big markets.

“There is major disruption coming to IIoT with applications including building infrastructure, machine monitoring and asset tracking,” says Wollan, highlighting the third area that Nordic sees as offering big opportunities. “So many businesses are yet to embark on their digital journey and still others have been unable to do so due to lack of appropriate technology.”

Finally, there's AI and Machine Learning (ML) which Nordic classes collectively as **'Edge AI'**. Wollan explains that Nordic plans for solutions at the edge of the network that will be much faster, smarter and more powerful. He says that Edge AI is being incorporated into products on the roadmap to give customers the capabilities they need for a new generation of IoT end products.

TURBOCHARGING THE GROWTH ENGINE

The outlook for the Short-Range BU is bright with some analysts predicting up to 20 percent growth for Bluetooth LE and Thread solutions. Nordic plans to remain the market leader in this area by adopting a dual approach targeting high volume customers and the broader market.

One key advantage the company has is that it develops solutions with giant global key customers which then are offered to Nordic's small and medium sized customers.

“To retain our position as a leader we need to shorten the time it takes to capitalize on the work of our R&D teams by bringing products to market faster,” says Wollan. “More than that, these solutions must feature groundbreaking technology to enable new applications and business opportunities to outclass the competition in terms of performance and power consumption.”

True to his word, the CEO accelerated the introduction of the nRF54L Series to November last year with the nRF54H Series to follow this year. These products are the next generation of Nordic's ultra-low power wireless SoCs and will be compatible with Bluetooth 6.0 (see *this issue pg8*) and a novel new feature called Bluetooth **Channel Sounding**

References:

1. WSTS Historical Billings Report: <https://www.wsts.org/67/Historical-Billings-Report>

2. Global Semiconductor Sales Increase 23.2% in Q3 2024 compared to Q3 2023; Quarter-to-Quarter sales up 10.7%; <https://www.semiconductors.org/global-semiconductor-sales-increase-23-2-in-q3-2024-compared-to-q3-2023-quarter-to-quarter-sales-up-10-7>



“The hardware is only half of the offering; Nordic's software is class-leading and a major part of the company's success

which improves distance ranging precision (see *pg32*).

The hardware is only half of the offering; Nordic's software is class leading and a major part of the company's success. Things will be no different for the nRF54 Series. The software is easily accessible through Nordic's **nRF Connect SDK** – something of which Wollan is proud.

“I had a discussion recently with an engineer from one of our key customers and she said that in the past building a specific function into one of our chips took around 1000 lines of code,” he explains. “Now with the nRF Connect SDK she said she was able to add the same functionality with less than ten lines of code.”

SUSTAINABLE, LEADING-EDGE TECH

The nRF54 Series' roadmap defines the launch of up to four new products every year. The first two products in the respective series—the **nRF54L15** and **nRF54H20**—have been sampled by over 200 customers each and the feedback and response has been very positive.

“It will take time for the nRF54 Series to ramp up,” cautions Wollan, “it needs to be designed into customers products and then volumes need to grow before the sales of the SoCs have a significant impact on Nordic's revenues. Existing nRF52 Series and nRF53 Series will continue to play a significant role, and from 2026 onwards the nRF54 will contribute notable revenues reflecting our long term growth ambitions for the short-range business.”

The nRF54 Series is also significant to Nordic because it is the first product to be fabricated using a 22-nanometer wafer process node. The process brings key advantages, such as enabling more transistors per unit area for better performance from more compact devices and even lower power consumption.

Reduced energy requirements and the extended battery life that it brings underscores Nordic green credentials (for example, the company was recently **recognized** as a global sustainability leader by *TIME* magazine). Longer battery

life lowers maintenance requirements and reduces battery waste, benefiting the environment.

The move to the 22-nanometer manufacturing process has also allowed Nordic to source wafers from two fabricators, TSMC and Global Foundries, which positions the company for additional supply chain resilience. Such resilience avoids the wafer constraint problems which are still a potential challenge for many of Nordic's competitors.

Since his arrival, Wollan has put in place a strategy which he says will provide the platform for “Nordic 2.0”, a company founded on decades of engineering expertise and sales success but one revitalized to face the challenges of an increasingly competitive world.

“We're now on an ambitious growth journey and the target at the group level is to deliver annual revenue increases of 20 percent throughout the decade,” the CEO says. “We'll get back to our former level of profitability through a clear and well-communicated strategy, operational agility and capitalizing on innovation.”

The semiconductor market's rebound will in part help fuel these ambitions. The Semiconductor Industry Association (SIA) reported that global semiconductor sales were \$166.0 billion for Q3 2024, an increase of 23.2 percent compared to the Q3 2023^[2]. “Quarter-to-quarter sales [increased] at the largest rate since 2016,” said SIA President and CEO John Neuffer in a statement.

And the launch of the nRF54L15 wireless SoC, together with sister products the nRF54L10 and nRF54L05, generated considerable excitement at **Electronica**, the European exhibition held towards the end of 2024, demonstrating that Nordic is introducing the innovative products developers demand.

With both of these positive developments, plus an extensive and innovative product roadmap, rapid product launches, continued commitment to R&D, world-class technical support, expert engineering staff and experienced management team, Nordic Semiconductor is well positioned to succeed.

Nordic Viewpoint:

Kjetil Holstad
EVP Strategy and Product Management



Joakim Ferm
SVP BU Wi-Fi

Geir Langeland
EVP Sales & Marketing



Early stage technologies set to boom

The IoT is about a lot more than connectivity. That's why Nordic has added more compute capability to its chips, more security, enhanced the software, and added AI and Machine Learning (ML) solutions.

The result is that Nordic has grown from a Bluetooth LE company to an end-to-end IoT provider.

This includes power management. Our customers continuously remind us of the need to account for energy consumption all the way from battery-to-antenna. Now our power management IC (PMIC) solutions help minimize the power consumption of our SoCs as well as take the customer's entire system into account to prolong battery life.

Wi-Fi is another early-stage business for Nordic. There's a strong overlap between Bluetooth, cellular and Wi-Fi among our customers. The nRF70 Series is a Companion IC for the nRF52, nRF53 and nRF91 Series. Soon, the nRF54 Series and the Wi-Fi Companion chips will prove to be a unique combination. We have already seen our customers designing-in Wi-Fi with all product combinations.

Now we're working on the next generation product series. This will marry the performance of Wi-Fi with Nordic's ultra-low power heritage. The new series will leverage the best of the nRF54 Series architecture and combine it with a new low power Wi-Fi 6E radio.

While PMICs and Wi-Fi are currently early stage businesses, they are set to quickly grow.

Expanding Nordic's reach

To succeed in its strategic markets—including healthcare and Industrial IoT (IIoT)—Nordic must supply its customers with not just chips and software, but complete solutions.

To do this, we support a wide range of wireless tech, such as Bluetooth LE, Thread, cellular IoT, DECT NR+, low power Wi-Fi and Matter. These enable the world's largest IoT ecosystems powered by Amazon Sidewalk, Apple Find My and Google's Find My Device, among others.

Ease-of-use is a crucial factor for all our customers, and our software solutions play a major role in our success. Nordic takes responsibility for all the essential building blocks from the battery or sensor to the antenna all the way up to the Cloud, including the processing and power management. With this end-to-end approach, customers gain full visibility and control over each component, ensuring the entire solution is optimized for simplicity, energy efficiency and the lowest possible total cost-of-ownership.

Nordic's valued module partners are key to meeting customer requirements. With tested and pre-certified modules, customers can significantly accelerate their time to market. We work closely with our distribution and module partners to ensure customers quickly have access to the latest Nordic technology. For example, our module partners have already started to release products that incorporate the nRF54 Series SoCs (see *pg30*).

Competitive Edge

By transforming performance data into actionable insights through Edge AI, sports tracking solutions assist athletes to reach their full potential

In Short

A technology-based approach to analyzing sports performance can take away the guesswork, narrow the margin for error and deliver positive outcomes

Tools like inertial sensors, anchor devices and location services form systems that measure various aspects of sport and activity in near real time

The ultimate game-changer comes in the form of Edge AI predictive modeling and data-driven analytics

The difference between winning and losing in the business of modern era sport can come down to the finest of margins. It's not a stretch to say results are routinely decided by milliseconds, millimeters or blink-and-you-missed-it moments of brilliance that ultimately define the contest.

But even precise metrics like speed and distance are still quite rudimentary in nature, at best telling us what happened, as opposed to why it happened and how it could be improved. The real gains are made by understanding sports performance at a much deeper, more nuanced level.

Traditional methods of analyzing athletic performance often relied on manual observation and subjective assessment, but such practices can fall short on their own. The sheer volume of data generated during a training session or game can make it difficult to identify patterns and extract meaningful insights while also avoiding biases.

A technology-based approach can take away the guesswork, narrow the margin for error and ultimately deliver positive outcomes. Advanced analytics ensure no limit to the amount of information that might benefit athletes, coaches, sporting teams, media companies and spectators. And since such information is power, increasingly the data is essential to anyone seeking a competitive advantage. A lucrative market has built up around sports data with a key part of the solution being the



latest wireless tech-based sports tracking solutions. These enable gathering of increasingly custom in-depth data to provide real time insights in pursuit of one overarching goal – immediate, sustainable improvement.

MEANINGFUL METRICS

While it's useful to monitor how fast an athlete moves or a player throws a ball—for example, an elite baseball pitcher can hit speeds up to 174 km/hr—dozens of other datapoints must combine to build a unique profile of an individual's abilities. Examples in each sport might include the athlete's body movement during key actions, or the position, launch angle, spin rate and acceleration rate of the bat or ball at various game stages.

It is technology that makes these metrics readily available. Tools like inertial sensors, anchor devices and location services form systems that measure the parameters in near real time. The high volume of raw data generated can be processed and analyzed using algorithms running on the sensor or wearable's integrated wireless device before the information is forwarded—using low latency wireless connectivity—to an app on the user's smartphone or a web-based dashboard on their laptop.

TRACK THAT

There are already various types of sports analytics solutions designed for different purposes. Ball tracking technology, for example, delivers data on the trajectory, spin and bounce of the ball, helping to measure the quality and accuracy of passes and shots, or evaluate defensive and offensive positioning.

Imagine an ultra-compact advanced tracking solution embedded inside a basketball, capable of crunching endless location and movement data to immediately provide tailored insights not only on where to shoot from, but how the individual player takes the shot or passes and dribbles more effectively based on their control of the ball.

Athlete tracking technology, meanwhile, provides insights on the precise position, movement and activity of the players themselves to help measure their performance,



fitness, workload and tactical decision-making.

Moreover, wearable tech attached to the wrist, chest or other parts of the body enables a much deeper dive into data, potentially revealing key information about an athlete's heart rate variability (HRV), VO2 max (the maximum rate of oxygen consumption attainable during physical exertion), muscle fatigue, lactic acid, power output and other important physical parameters. Developers of continuous glucose monitoring (CGM) devices—traditionally medical devices for diabetics—are also starting to market their technology for sports; blood sugar levels give athletes an indication of whether they need to consume food for energy to continue performing.

Such insights can provide a better understanding of how an athlete responds to training, whether they are overtraining and what they need to recover properly and prevent injury.

In the case of basketball, body-worn sensors and predictive models are being used to track specific metrics such as the balance of the body to indicate the likelihood of a player being injured, based on their individual movement patterns and workload. And in soccer, for instance, clubs worldwide have invested heavily in wearable tech to track and monitor data such as players' fatigue during training, as well as in-game positioning and distance covered. Elsewhere, the Association of Tennis Professionals (ATP) has taken the availability of data a step further, launching a performance analytics platform called 'Tennis IQ' that democratizes access to cutting-edge information for players on the ATP Tour.

One prominent example is the Nordic-powered Apex Series, used by a host of major international sporting

organizations including English Premier League football clubs. Developed by Northern Ireland-based data-tracking solutions company, [STATSports](#), the Apex device is embedded in a custom lightweight vest worn by the athlete. It integrates a range of sensors including a high impact accelerometer, gyroscope, magnetometer and augmented GNSS. These sensors provide comprehensive data including factors such as heart rate, total distance covered, current and maximum speed, number of sprints, accelerations, impacts, dynamic stress load and step balance. The solution employs Bluetooth LE connectivity, provided by a Nordic SoC, to wirelessly sync the sports-specific metrics to smartphones and tablets for coaches to make informed decisions during a match or training session.

Meanwhile, in 2022, Nordic ultra-low power wireless technology was designed into a revolutionary sensor-based system for all levels of basketball. Developed to enhance the experience of the game both on and off the court, the ShotTracker solution delivers advanced statistical data and insights for a basketball team – providing instant access to zone charts, shot maps, box scores and more.

The system comprises a connected basketball, a wearable sensor attached to each player to track their location and movement, and sensors installed above the court to map the facility in three dimensions.

Historically Nordic's solutions have been designed into Adidas footballs, Wilson American football products, and even badminton rackets. Today the company's biggest customers in the sports analytics sector are found in the cycling, rowing and running sectors.



Tech Check

Since running AI and ML applications successfully on battery-powered wireless chips requires powerful computational capabilities at modest power consumption levels, Nordic's [nRF54H20](#) Series wireless SoCs offer a new generation of Arm Cortex-M33 processing for powerful computing at ultra-low power consumption

PREDICTIVE POWER

The ultimate game-changer in the sports sector comes in the form of predictive modeling and data-driven analytics performed at the edge (a term used to determine data-driven decisions as close as possible to the integrated sensors themselves).

When relevant data is not only crunched but analyzed and interpreted using the power of 'Edge AI' algorithms, sports analysts can take advantage of even more precise and personalized insights. Adding AI and Machine Learning (ML – an application of AI that allows computers to learn without direct programming or instruction) to the mix allows, for example, a sports wearable with the same sensors as before to now continuously monitor several performance parameters simultaneously, uncovering otherwise hidden but meaningful patterns in the process.

By analyzing both historical data and real time sensor information, statistical models can pinpoint factors that have a major impact on the way athletes prepare, perform, recover and repeat, not to mention identify opposition strategies and gauge overall team dynamics. Even when important data is not limited to only two key components (like the player and the ball), such as in motorsports, where various moving parts must be monitored and optimized simultaneously, AI/ML-based analytics can be a driving force behind the evolution of a sport. McLaren Racing's Formula 1 team, for example, uses edge computing to process the one terabyte plus of data generated by upwards of 300 sensors embedded in each of its cars, helping to facilitate its in-race strategy.



The ultimate game-changer in the sports sector comes in the form of predictive modeling and data-driven analytics performed at the edge



Integrating ever more advanced SoCs alongside enhanced AI/ML capabilities will enable Edge AI devices to handle significantly more of the processing burden. The benefits of Edge AI include savings on transmit power, extended battery life and reducing the costs associated with employing big data centers, as well as making data more secure and private because it remains on the device itself.

DECISION-MAKING DEMANDS

Demand for advanced sophisticated sports analytics solutions is placing increasing pressure on the wireless SoCs that power the sensors and wearables. Supporting wireless connectivity and supervising a host of sensors that can generate a plethora of datapoints is one thing. But making sense of all that data in context and quickly enough to enable rapid and effective decision-making demands a SoC with serious processing heft, and the ability to perform ML and sensor fusion that forms part of Edge AI.

ML algorithms optimize the ability to deal with large volumes of data and extract relevant information from large datasets. To get a complete picture requires combining different data streams from multiple sensors, and that requires a SoC capable of sensor fusion so it can filter information and determine which data points from all the different sensors correspond to the same activity, and which do not.

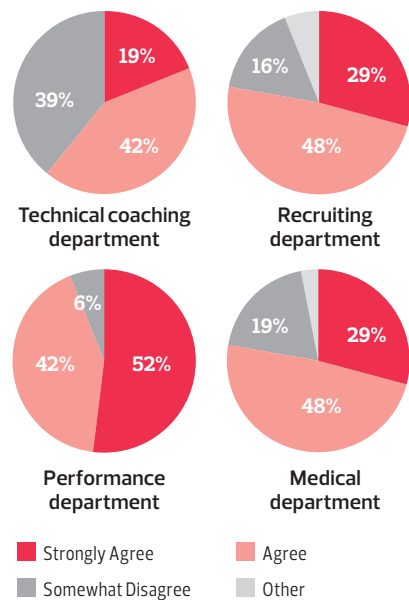
By employing Edge AI on a Nordic Semiconductor nRF54H Series SoC, for example, the local processing will use less power than sending data over the air, allowing a sports analytics device to have longer operation and smaller battery size. And with data being processed locally in real time, there's no requirement for bandwidth to send raw data, while no time is wasted waiting for a response from the Cloud.

These technological advances auger well for the future of sport. To gain a competitive edge, leading athletes, coaches and teams will turn to solutions employing the power of Edge AI. With the systems in place to deliver more powerful insights through more advanced data analytics, athletic achievement is set to scale new heights.

State of Play

Winning Position

A 2024 survey explored the use and value of data analytics in the football industry by asking practitioners at professional football clubs around the world about their operational frameworks and practices. Respondents were asked how much the use of data guided decision-making in their various football departments. Most respondents agreed and strongly agreed with the statement, 'information generated from data guides decision-making' in their technical (~61%), recruiting (~77 percent), performance (~94 percent), and medical (~77 percent) departments.



Information generated from data guides decision-making in the technical coaching department, recruiting department, performance department and medical department:

Source: Football Performance and Science Department, Aspire Academy



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+

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On the Move

Wireless solutions are powering the future of micromobility

Urban transport is undergoing an above-ground revolution. Driven by smart connectivity solutions, the technology-based [electric mobility](#) (e-mobility) market—encompassing electric bikes (e-bikes), electric scooters (e-scooters), and other lightweight electric transport, as well as electric vehicles (EVs) requiring charging infrastructure to stay in motion—is drastically boosting transportation efficiency in global cities.

Flexible, cost-effective, and eco-friendly 'last mile' alternatives to traditional commuting are being enabled by shared micromobility technologies. Rentable e-bikes and e-scooters, for example, now make it faster, cheaper, healthier, and more convenient, efficient and environmentally friendly for people to travel the final section of a journey. What's more, these solutions enable commuters to avoid private and public transport, reducing both traffic congestion and carbon footprints.

DRIVING POTENTIAL

The key to efficient e-mobility is advanced low power wireless connectivity. For example, [cellular connectivity](#) allows users to find available bikes and scooters nearby using smartphones, and wireless technology forms a reliable and secure link between the mobiles and the vehicles' locks, enabling access to the machines.

Advanced micromobility solutions often benefit from employing long range wireless technology, such as cellular IoT, with [Bluetooth LE](#) as a connectivity backup and for local provisioning. Notably, the low power consumption of wireless technologies ensures these vehicles stay connected for long periods when powered by batteries so users can always find them.

Cellular IoT provides wireless connectivity between, for example, e-bikes/e-scooters and the Cloud, enabling vehicle location tracking among other features. An integrated cellular IoT device can be used to monitor the location and condition of a vehicle (for example, whether the tires are underinflated), periodically reporting to a Cloud server.

Low power cellular IoT makes use of mature city cellular infrastructure to enable operators to keep track of their bike fleet condition. A network of short range wireless sensors enabled by Bluetooth LE monitors lights, drivetrain and brakes with the data forwarded to the Cloud by cellular IoT connectivity. The impact is significant; for example, in the

past few years European micromobility provider Voi has used cellular IoT connectivity to bring new features and services that increase e-bike and e-scooter motor performance by 35 percent and increase the vehicle's lifespan to five years. This is achieved by leveraging onboard and remote diagnostics to prioritize and predict the need for maintenance and repairs.

When building an innovative cellular IoT e-mobility solution, low power consumption is a key consideration because e-vehicles need sufficient battery life for multiple journeys before being recharged. There are several things an application developer can do to increase battery life, such as reduce the frequency of cellular IoT device communication with the Cloud. Battery life can also be greatly impacted by the accuracy of the measurement of the vehicle's location—with higher precision costing more energy. Sometimes high precision is required—for instance, to pinpoint the location of a nearby e-bike so that a user can easily find it—but if the service provider itself only needs to know whether an e-bike is in a general area, there's little point in expending energy to locate the device to just a few meters of precision.

To assist developers in trading off battery life against location accuracy, Nordic's [nRF Cloud Services](#) solution offers several techniques for use with the company's [nRF91 Series](#) SiP. For example, if the location of an e-bike must be determined with an accuracy down to a few meters, GNSS can be used. However, if power consumption is more critical the nRF91 SiP and [nRF Cloud](#) can revert to cellular locationing with an accuracy of a few hundred meters.

EV CHARGING AHEAD

It's not only micromobility that's shifting the gears of urban transport. Reliable, secure wireless connectivity also enhances the value proposition of EV charging stations. For example, data can be gathered on the availability and condition of charging sockets. When this data is relayed to a central platform, it can help staff respond to disruptions or problems remotely. By seamlessly integrating cellular IoT, Wi-Fi and Bluetooth LE, developers can create charging solutions that meet the evolving needs of the EV industry.

With EV charging stations becoming a critical element driving the mainstream adoption of EVs, EV charging companies are leaping into action. According to global telco infrastructure firm Ericsson in its [Connected EV Charging](#) report, cellular IoT streamlines the orchestration,



administration and maintenance of EV charging stations, decreasing annual monitoring costs by 15 percent, primarily because of remote monitoring replacing physical inspections. By implementing cellular IoT, mid-size EV charging providers can increase revenue by 40 percent according to the Ericsson research.

E-MOBILITY ADVANCEMENT

Nordic's cellular IoT solutions provide a powerful option for developers in the e-mobility sector looking to combine low power consumption with small size and high performance. The nRF91 Series incorporates an application processor, Flash and RAM, LTE-M/NB-IoT modem and GNSS into a single package. This high level of integration simplifies design, improves efficiency and saves space. And efficient operation extends battery life or allows for the use of more compact batteries for the same battery life.

The latest addition to the nRF91 Series, the [nRF9151](#), sets a new standard for highly integrated, low power consumption and compact SiP solutions specifically designed for cellular IoT applications. The high efficiency and reduced dimensions of the nRF9151 SiP allow manufacturers of e-mobility applications to build lightweight, compact devices with long range and robust wireless connectivity, powerful processing capabilities and large memory capacity, and which can run for extended periods on a single battery charge.

This lowers the maintenance requirements for e-mobility service providers because they don't have to recharge or change device batteries frequently. And as one of the most secure low power SiPs on the market, the nRF9151 is also an ideal connectivity solution for e-mobility applications because it helps to safeguard valuable e-transport assets.

Tomorrow's e-mobility solutions will help extend micromobility to an even wider population—an outcome that benefits both cities and their inhabitants.

Nordic Inside:

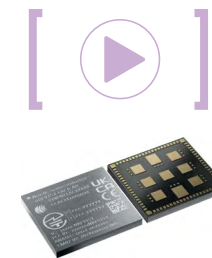
Electric bike controller transmits riding metrics

An electric bike (e-bike) computer developed by Taiwan-based company Foxconn Interconnect Technology combines a traditional bike display with a controller, allowing the rider to both view riding metrics and shift between assistance levels, including a 'walking mode' for when the bike is being pushed.

Designed to be mounted on the handlebars of the e-bike, the compact [Xion E-Bike HMI System](#) incorporates a high luminance and high contrast display with wide view angle for increased visibility while biking.

The device employs the Bluetooth LE connectivity of Nordic Semiconductor's [nRF52840](#) SoC to transmit data, including the rider's speed and range, to the corresponding app on the user's smartphone or tablet. The Xion E-Bike HMI System is overseen by the nRF52840 SoC's Arm Cortex-M4 processor which provides ample computational power to supervise the device's functionality. The device is hardwired to the bike's battery, so it does not need to be recharged. This also enables it to record the bike's current charge level on the display.

"The SoC was selected due to its generous 1MB Flash memory and 256 KB RAM," says Joseph Wang, CTO at Foxconn Interconnect Technology. "We chose to work with Nordic largely due to its excellent software reference code, the helpful application engineers and the fast response times."



Tech Check

Nordic's nRF9151 SiP offers class-leading performance and supports LTE-M/NB-IoT and DECT NR+. Compared to its predecessor, the nRF9161, it boasts a significant footprint reduction of 20 percent and brings additional support for Power Class 5 20 dBm output power, which provides great design flexibility

By the Numbers

13 million
Electric vehicles sold globally in 2023

Source: Statista

61%
Potential reduction in CO₂ emissions by replacing car rides with electric scooters

Source: International Transport Forum

36 million
Connected EV charging points in Europe and North America by 2028

Source: Berg Insight

Smart Agriculture

Monil Collar

This bovine wearable delivers a sustainable farming solution by creating a virtual fence and delivering precise cattle position monitoring

If you thought the [wearables](#) market segment was all about smartwatches and activity trackers for humans, think again. The animal wearables sector was worth an estimated \$3 billion last year, and while that may be dominated by the pet market, animal agriculture technology is garnering increased interest and attention in the drive for sustainable farming



The Monil Collar can be comfortably fitted to the neck of grazing cattle and employs Nordic Semiconductor's nRF9160 SiP and nRF52833 SoC to provide cellular IoT and Bluetooth LE connectivity respectively. This wireless connectivity enables farmers to establish virtual fences and then monitor cattle in near real time to ensure they stay within the set boundaries. Integrated sensors also allow farmers to remotely review data that could indicate concerns for livestock wellbeing



The [Monil Collar](#) integrates a range of sensors. For example, the integrated IMU can confirm if an animal is stationary for an extended period which might indicate injury. The product employs the [nRF9160](#) SiP to collect and process sensor data. The LTE-M/NB-IoT modem transmits the data and animal's location to the Cloud, where it can then be accessed by the farmer via the app



Once fitted to the animal's neck, farmers can use a smartphone app to define the grazing area. When a cow approaches the virtual boundary, the collar emits a sound. If the cow ignores the sound, a gentle electrical pulse is applied. After three rounds of sounds and pulses, the system stops and the farmer gets a notification the cow has escaped. A training period of up to 10 days enables cows to understand the signals and thereafter graze within the planned and unfenced areas

Farmers at Anna Creek Station in South Australia could well benefit from cattle tracking technology. At nearly 24,000 square kilometers, the world's largest working cattle station is roughly the same size as the Italian island of Sicily, or the U.S. state of New Hampshire. Despite its size, the property only has 9,500 head of cattle, providing the herd no shortage of places to hide. While the cattle were originally mustered by stockmen on horseback, today light aircraft are used for locating animals before being rounded up by farm hands on motorbikes

Cows have highly developed senses. You can't sneak up on a cow because the eyes on the side of their heads give them a field of vision of more than 300°, increasing to nearly 360° when they have their heads down to graze. In addition to panoramic vision, their hearing and sense of smell is also highly sophisticated. Cows are believed to be able to pick up sounds between 16 to 40,000 Hz, while their 1,071 olfactory receptors enable them to detect odors up to 8 km away

Arguably the two most famous cows in history are Elsie the Cow and [Pauline Wayne](#). Elsie served as the daisy necklace-wearing marketing icon of Borden Dairy Products in the late 1930s and early 1940s, and was awarded no fewer than three honorary university degrees. Pauline Wayne meanwhile was the last cow to graze on the White House lawn during President Taft's administration from 1910-1913. Small bottles of her milk were sold as souvenirs for 50 cents apiece, around \$17 in today's money



Tech Check

Powered by a Li-poly battery, the device can be recharged using harvested solar energy, and Monil Collars can retain more than 90 percent battery life after four months continuous use, even in shorter autumn daylight hours. The ultra-low power consumption of the nRF9160 SiP was crucial for the device's ability to operate on solar power

Smart agriculture

Smart soil monitoring solution ensures optimal conditions for plant growth

Wireless technology is enabling food growers to optimize resource use and minimize waste

From the 1960s, high-yielding varieties of wheat spread quickly across Asia, followed by improved strains of rice. At the same time, farmers rapidly increased their use of mineral fertilizers, pesticides and irrigation. The gains were dramatic: over a period of 30 years, the volume of world agricultural production doubled. The 'Green Revolution' helped avert major food shortages and promoted rapid economic growth in China, Southeast and South Asia.

But the revolution was not without its environmental cost. For example, in some regions, water was being pumped out of the ground for irrigation faster than it could be replenished. Second, widespread use of just a few high-yielding varieties of wheat and rice led to the loss of traditional varieties and increased vulnerability to pests and diseases. Finally, the misuse of fertilizers and pesticides sometimes outweighed their advantages.

Today, more [sustainable agriculture techniques](#) are in vogue. Chief among these is 'precision agriculture'; the technology ensures ideal growth conditions by applying resources like water and fertilizer at the perfect time, significantly improving crop yields. In turn, precision agriculture enables growers to optimize resource use and minimize waste.

Precision agriculture depends on the IoT; the data used to determine the best time to water and feed plants comes from wireless sensors used to monitor soil conditions. One example is Canadian technology company Ginkgo Sustainability's soil monitoring solution, SoLiNQ.

Business intelligence lowers costs

The SoLiNQ solution is made up of multiple SoLiNQ Sensors powered by Nordic Semiconductor's [nRF52840](#) SoC, and a SoLiNQ Hub gateway. The SoC not only provides wireless connectivity between sensors and the gateway but also supervises the sensors and collates their data. The gateway is based on [Nordic module partner](#) Ezurio's Sentries MG100 Gateway2019 and is also supervised by the Nordic SoC. Data is transmitted via the gateway to the Cloud, where users can access it using the SoLiNQ web application.

"Each SoLiNQ sensor measures soil moisture, air temperature, humidity and other variables to create a detailed survey of the current conditions," says Sean Militello, Director of Technology and Innovation at Ginkgo Sustainability. "Together, they provide a clear and accurate picture of environmental health.

"The solution provides our customers with transparent,



scientifically sound, actionable business intelligence that lowers their costs," says Militello. "Our goal is to allow more companies to enact and support sustainable practices. We also want to help the agriculture industry improve resource usage, crop quality and yields."



Need to Know

Each SoLiNQ sensor measures soil moisture, air temperature, humidity and other variables to create a detailed survey of the current conditions. A Nordic nRF52840 SoC provides wireless connectivity between sensors and a gateway as well as supervising the sensors and collating data

Mitigating climate change

Analysis helps growers better understand their data to make informed decisions. It can also assist in mitigating the impacts of climate change by enabling growers to adapt crop treatment as weather patterns change. In the case of the SoLiNQ web application, analysis is achieved using methods developed by the company's academic partners.

Alpha testing of SoLiNQ, using Ginkgo Sustainability's third-generation sensors, was able to successfully collect and transmit detailed data about local environments. "Based on these readings, our academic partners were able to confirm the accuracy of our methodologies for various types of [agriculture]," says Militello. "The web application was also able to accurately integrate sensor data with third-party environmental information, predicting soil moisture correctly 70 percent of the time." Militello explains that upcoming beta testing will use



Precision agriculture ensures ideal growth conditions by applying resources like water and fertilizer at the perfect time, significantly improving crop yields

fourth generation sensors, featuring improvements based on lessons learned from the alpha test. "Given the current performance of these new sensors in our labs, we expect the predictive accuracy of the system as a whole to improve by 12.5 to 15 percent," he says.

Ultra-low power functionality

The sensors use a 3000 mAh battery, allowing them to remain in the field for at least 18 months before requiring a recharge, thanks in part to the ultra-low power consumption and fully automatic power management system of the Nordic SoC. Although the gateway typically runs using mains power, users can also purchase a Smart Power Selector Peripheral and a small solar panel. This setup allows the device to switch to solar power when available, conserving energy.

Growing conditions can vary from field-to-field but without detailed information, farmers are forced to manage all crops the same way. The result is varied yields across the farm. Precision agriculture, powered by networked wireless sensors, provides for fine-grained detail. That allows farmers to optimize growing conditions on a field-by-field basis. In this case the result is greater flexibility, enhanced yields and better use of resources.

Anders Spur

Director of Product Development, Watts



Smart meters provide clear picture of energy usage

Wireless tech enables smart meters to help consumers and companies manage energy usage

Rising power prices and a growing focus on sustainability are fueling a surge of interest in the energy monitoring sector. At the same time, a combination of EU regulatory mandates and the utility industry's need for greater grid visibility has spurred the widespread deployment of [smart energy meters](#) across Europe. These meters are transforming how distribution networks are managed, helping utilities improve efficiency, tariff structures and settlement accuracy.

However, data collected by smart meters is by default not typically accessible to end users, as these meters are owned and operated by Distribution System Operators (DSOs).

In certain European countries information is sometimes shared through centralized hubs, but access is often delayed.

technical experts but to everyone with a smartphone.

Devices like the [Watts Live](#) connect directly to a user's electricity meter, using [Bluetooth LE](#) to provide insights into energy usage and efficiency via their smartphone. From there, the data can be sent over a local Wi-Fi network to the Cloud, enabling easy access to detailed metrics. For applications where Wi-Fi isn't available—such as in public infrastructure—the company is also developing a LoRaWAN-enabled version.

Harnessing wireless connectivity

Data sourced from national hubs has typically focused on facilitating settlements, often leaving valuable technical data behind.

In-home smart energy monitoring solutions now offer a powerful alternative, delivering

in-depth energy consumption data to consumers while also addressing more technical aspects, like household phase distribution. Additionally, these devices can help solve issues in the electricity grid, helping to manage load distribution between phases as the adoption of distributed energy resources—such as solar panels—grows.

By helping homeowners understand their energy usage, these solutions enable actionable advice on how to reduce consumption. Our analysis shows that active users save an average of eight percent energy consumption.

Looking ahead, we expect the adoption of smart energy monitoring solutions to continue to accelerate, driven by technological advancements, regulatory evolution and a deepening commitment to sustainability and the environment.

Wireless technology is changing the landscape, opening the door to real-time energy insights for consumers

Wireless technology is changing the landscape, opening the door to real time energy insights for consumers. Our company, Watts, originated from the smart meter rollout, as data collected from hundreds of thousands of smart meters provided unprecedented insights into energy usage. Our aim was to make this valuable information accessible not just to



[Tech Zone]

An in-depth look at Nordic's wireless solutions

Modules

Wi-Fi 6 module delivers high throughput, low power connectivity

Wireless solutions company Raytac has launched a range of Wi-Fi modules designed to deliver high throughput, low power wireless connectivity for developers of Industrial IoT, smart home, healthcare, consumer electronics and automotive products.

The AN7002Q series pre-certified modules integrate Nordic Semiconductor's [nRF7002](#) Wi-Fi 6 Companion IC, and are designed for use alongside Raytac's existing Bluetooth LE MDBT53 series of modules, which use Nordic's [nRF5340](#) multiprotocol SoC. Together the modules simplify development of dual Wi-Fi and Bluetooth LE solutions.

"Raytac designed the AN7002Q and MDBT53 as separate but compatible modules," says Lyon Liu, President of Raytac. "This approach provides greater flexibility for customers, allowing them to maneuver and figure out the placement of the two modules to maximize RF performance. Furthermore, if customers implement our bundle and later decide to upgrade the Bluetooth LE module to one based on Nordic's [nRF54 Series](#) they can do so seamlessly, without further management."

Measuring just 10.7 by 17.1 by 2.2 mm, the compact AN7002Q module offers three antenna options—u.FL connector, PCB antenna and chip antenna—providing



the developer with design flexibility depending on the range requirements of their application.

The nRF7002 provides low power, secure Wi-Fi for the IoT, offering dual-band (2.4 and 5 GHz) connectivity and a seamless interface with the nRF5340 SoC's host Arm Cortex-M33 application processor on the MDBT53 series. The nRF7002 also supports Target Wake Time (TWT), a key Wi-Fi 6 power-saving feature. The nRF70 Series can also be used as Companion ICs with non-Nordic products.

Modules

Modbus module delivers mesh networking for industrial control applications

Swedish technology company LumenRadio has released a globally certified wireless module designed to simplify Modbus and remote terminal unit (RTU) installations by eliminating the need for traditional control cables. Available in two versions (the W-Modbus OEM Module supporting one Modbus client, and the W-Modbus PRO OEM Module supporting up to 16 Modbus clients), the module can be integrated by OEMs into end devices. They provide hassle-free wireless Modbus connectivity to customers across the HVAC, building and industrial automation sectors.

Integrating Nordic Semiconductor's multiprotocol [nRF52840](#) SoC, the module replaces physical control cables with a wireless mesh network built on

LumenRadio's MiraOS embedded operating system and MiraMesh technologies.

MiraMesh is a proprietary self-healing and -organizing mesh protocol on top of which W-Modbus and custom-developed firmware is implemented. MiraOS and MiraMesh are supervised by the nRF52840 SoC's powerful Arm Cortex-M4 processor.



The module can be integrated into any Modbus RTU device via a UART interface and configured either as a gateway or as a node, with the ability to connect up to 100 nodes within a network. The Nordic SoC's

multiprotocol capability enables the module to run both the LumenRadio mesh protocol and Bluetooth LE concurrently. Bluetooth LE provides smartphone connectivity so the user can monitor and troubleshoot the device via a smartphone app.

Cellular IoT

nRF9151 available and in production

Nordic Semiconductor has announced the availability of its smallest and lowest power SiP – the [nRF9151](#), and its associated [nRF9151 Development Kit](#) (DK). The nRF9151 is a fully integrated, pre-certified SiP featuring an application core for extensive application development or use as a standalone cellular modem. This simplifies the development and deployment of scalable products across massive IoT markets, including industrial automation, asset tracking, smart city, smart metering and smart agriculture. Furthermore, the nRF9151 has a country of origin that is not subject to U.S. tariffs.

The nRF9151 represents a significant technical advance, offering a cost-effective and globally accessible solution. The solution includes hardware with a programmable application processor, software, [Cloud services](#), development tools and world-class support.

Wi-Fi

CSP version of nRF7002 introduced

Nordic Semiconductor has announced the launch of a Wafer-Level Chip Scale Package (WLCSPP) version of its nRF7002 Wi-Fi 6 Companion IC. The new package option offers the same functionality as the [nRF7002](#) QFN variant but with a footprint reduction of over 60 percent – making the WLCSPP the ideal choice for efficient, size constrained designs for next generation wireless devices such as wearables.

The nRF7002 WLCSPP supports advanced Wi-Fi 6 capabilities including OFDMA and Target Wake Time (TWT), providing robust and efficient wireless connectivity. The IC is optimized for ultra-low power operation, ensuring longer battery life.

The nRF7002 Wi-Fi 6 Companion IC seamlessly integrates with Nordic's award-winning [nRF91 Series](#) SiPs, nRF52 and [nRF53 Series](#) multiprotocol SoCs, and the new nRF54 Series. This integration ensures developers can access [the full potential of Wi-Fi 6](#) – including higher data rates, increased capacity and improved power efficiency.

Modules

Matter 1.3 certified module enables smart smoke detectors to trigger alarms

Nordic Semiconductor design partner HooRii Technology has launched a Matter 1.3 certified module. The module enables smart smoke and carbon monoxide (CO) detectors to trigger audible alarms and send near real time notifications to connected devices within a [Matter](#) ecosystem in the event of an emergency. The HooRii Smoke & CO Alarm module is designed for use by IoT device OEMs, and incorporates Nordic's [nRF52840](#) SoC. The multiprotocol SoC is suitable for developing products for a Matter connected home using [Thread](#) connectivity for transport and [Bluetooth LE](#) connectivity for commissioning new devices to a network.

"The HooRii Smoke & CO Alarm solution, with Matter 1.3 and Nordic technology, offers superior safety, integration and user experience for modern smart homes," says Ethan Liu, CTO, HooRii Technology. "For manufacturers the module optimizes design and development, and reduces time-to-

market. For consumers it delivers enhanced safety, seamless integration with their other smart home devices, as well as reliable connectivity and minimal maintenance."

The module is provided in two versions, one with a built-in antenna (measuring 12 by 10 mm), the other with support for an external antenna (10 by 10 mm).

Both versions integrate photoelectric sensors for smoke detection and electrochemical sensors for CO detection, with rapid data processing provided by the Nordic SoC's Arm Cortex-M4 processor.

"The [nRF Connect SDK](#)'s support for the Matter and Thread made it easier to integrate our AT Command functionality with the device's communication stack, ensuring seamless operation within a broader smart home ecosystem," says Liu.

"The SDK's comprehensive documentation and example projects also accelerated our development process."



Catch all the latest Nordic webinars on-demand

HIGHLIGHTS

- Exploring the nRF54L Series: Next-level wireless SoCs
- Meet the nRF9151 SiP for cellular IoT
- Easy fuel-gauging for any battery-powered Zephyr RTOS application

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Product Focus

nRF9151 low power SiP

The **nRF9151** is a highly integrated and compact SiP, specifically designed for cellular IoT and DECT NR+ applications

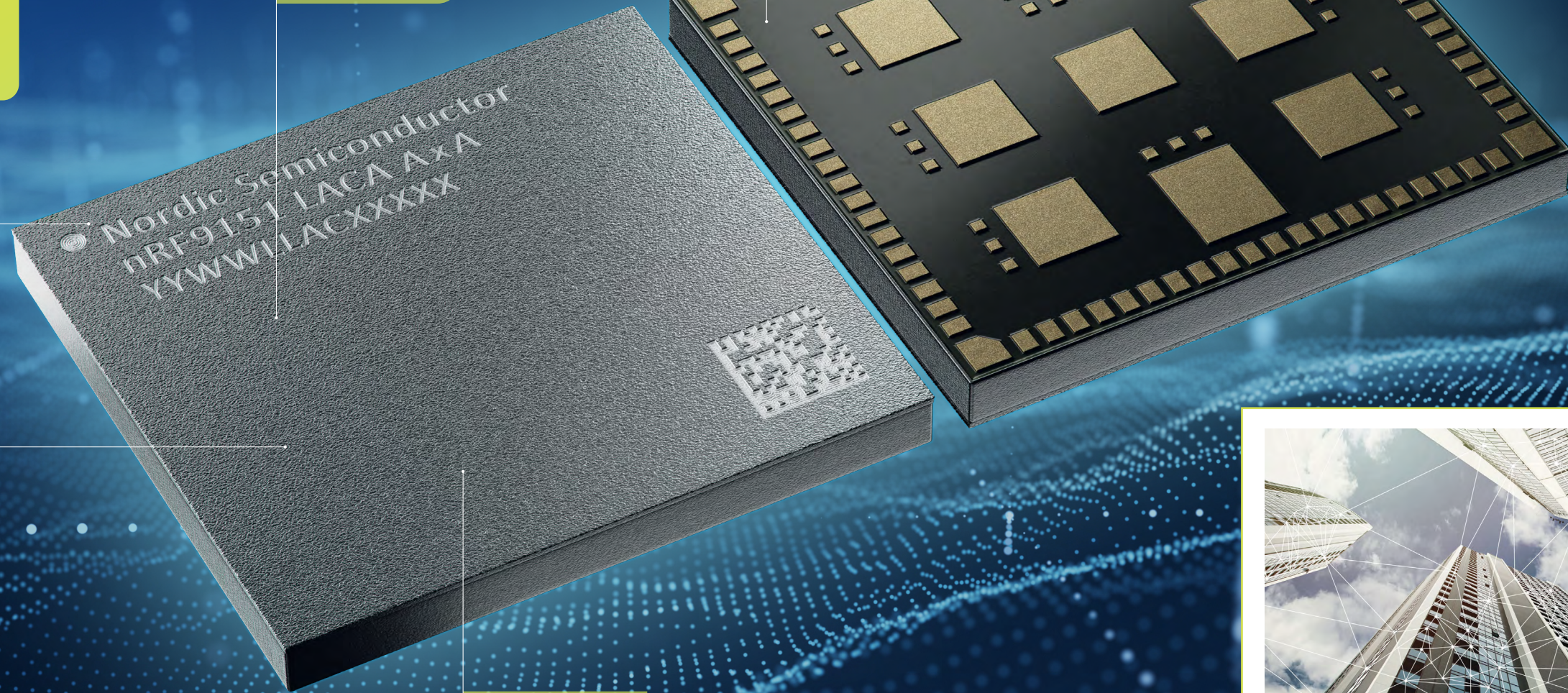
The nRF9151 offers high performance and versatility. It supports 3GPP release 14 LTE-M/NB-IoT and **DECT NR+**. The SiP features an integrated wireless modem, low power LTE technology, advanced processing capabilities and robust security features

The product is an ideal cellular IoT solution for key IoT applications including **asset tracking**, **smart metering** and **medical devices**

The SiP is classified U.S. tariff-free country of origin. Its integrated modem enables global connectivity without regional limitations

The nRF9151 features a 64 MHz Arm Cortex-M33 dedicated programmable application processor and 1 MB Flash plus 256 KB RAM

The SiP measures just 12 by 11 by 1 mm. Compared to its predecessor (**nRF9161**), this is a significant footprint reduction of 20 percent



The nRF9151 now supports Power Class 5 20 dBm output power, complementing the existing Power Class 3 23 dBm, providing design flexibility by easing the requirements for battery-powered products



Built for DECT NR+

The nRF9151 SiP features 1.9 GHz DECT NR+ band support. It is supplied with an NR+ radio protocol stack, **enabling massive mesh applications** that prioritize reliability, secure connections, long range and scalability



The PHY layer in DECT NR+ reuses tech from cellular radios, with reliability proven by billions of devices already in the field. NR+ supports point-to-point and star topologies, and a mesh topology with self-healing properties. Each node can function as an access point with a direct connection to the Internet, and nodes can change roles. This property eliminates single

points of failure and autonomously resolves high-traffic situations. NR+ operates on the global and license-exempt 1.9 GHz DECT band, which cuts deployment costs. The range and dense topology properties of NR+ make it highly scalable with up to 1 million devices per square kilometer. The tech promises over 99.99 percent packet delivery and one-millisecond latency between devices on the radio interface.



Tech Spec

Processing
64 MHz Arm Cortex-M33 dedicated application processor

Memory
1 MB Flash + 256 KB RAM

Modem
Multimode LTE-M/NB-IoT with DECT NR+ support and GNSS. 700-2200 MHz LTE band support

Development tools
nRF9151DK

Applications
Asset tracking, smart metering, portable medical devices, IIoT

nRF54L15 SoC modules

Nordic's [module design partners](#) have introduced solutions based on the next generation [nRF54L15 SoC](#)

While RF hardware design tools have made it easier to design new IoT products, there are still some design decisions left for the developer. Such decisions include antenna selection and layout, impedance matching, power regulation and management, and EMI mitigation. And once the design is complete, there's the requirement for certification.

Using a pre-certified module allows the developer to [accelerate the development process](#) as all the tricky design questions have been answered and certification is complete. The time saved during the project cycle allows the development team to focus on other parts of the design such as innovative firmware and compelling product features.

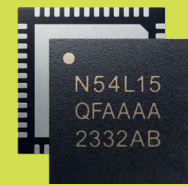
Modules can be used as the foundation of a product for its entire lifecycle. Alternatively, the products can be used as a jump-start for rapid development for IoT

devices that will later transition to a SoC-based design.

Module makers have deep engineering experience which results in products with optimal RF performance and a range of size, cost and performance options. For example, module makers have access to specialist packaging tech such as wafer level chip scale packages (WLCSF) to shrink the area needed for the SoC. The module makers are also adept at positioning the passive components, RF Front End, [Power Management IC](#) (PMIC) and chip antenna into the smallest area for the most compact product.

Moreover, module makers are quick to embrace the latest SoCs from Nordic so the designer can be assured of the best performing chip for the job.

Nordic Semiconductor collaborates with dozens of module makers through its [Nordic Partner Program](#). The partnership now extends to the next generation nRF54L15 SoC. Some of the latest products are shown here but these are just the first of many. Others partner products are due soon. The result will be a selection of nRF54L15 modules suitable for the widest range of IoT applications. For more information visit: www.nordicsemi.com/Resources/Nordic-Partners/Third-party-modules



The nRF54L15 SoC integrates MCU functionality with an Arm Cortex-M33 processor running at 128 MHz, doubling the processing power of the nRF52840 while tripling processing efficiency.

The nRF54L15 achieves its processing performance through Nordic's proprietary technologies, a unique design approach and a pioneering progression to the 22 nm process node



Fanstel's BM15C, BM15E, and BM15M



Fanstel has announced a series of certified modules based on Nordic's nRF54L15 SoC. The modules deliver enhanced functionality, longer battery life and reduced product size for advanced IoT devices.

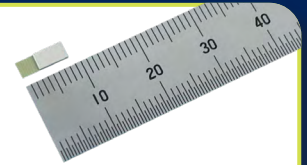
The BM15C, BM15E and BM15M modules support Bluetooth LE, Bluetooth Mesh, Thread, Matter, Zigbee, Amazon Sidewalk and 2.4 GHz protocols with up to 4Mbps throughput. The modules will also support Bluetooth 6.0 features including Bluetooth Channel Sounding.

The modules take advantage of the nRF54L15 SoC's Arm Cortex-M33 processor clocked at 128 MHz, and an ultra-low power multiprotocol

2.4 GHz radio. The SoC provides enlarged memory up to 1.5 MB NVM and 256 KB RAM, enabling support for advanced application software and RF protocol stacks on a single chip, and eliminating the need for external MCUs or memory. An integrated RISC-V coprocessor runs software-defined peripherals and handles time-critical tasks. The modules offer features and interfaces supported by the nRF54L15 including NFC, SPI, I2C, 32 GPIOs and an extending operating temperature range of -40 to +105 °C. They are also designed to meet PSA Certified Level 3 security requirements including hardware Root-of-Trust with Arm TrustZone.

The modules offer features and interfaces supported by the nRF54L15 including NFC, SPI, I2C, 32 GPIOs and an extending operating temperature range of -40 to +105 °C. They are also designed to meet PSA Certified Level 3 security requirements including hardware Root-of-Trust with Arm TrustZone.

KAGA FEI's ES4L15BA1



KAGA FEI claims its ES4L15BA1 is the world's smallest Bluetooth 6.0 compliant module to feature a built-in PCB antenna. The module is based on the WLCSF variant of Nordic nRF54L15 SoC. The ultra-compact module offers a 3.25 by 8.55 by 1 mm form factor, is pre-certified in the U.S., Canada and Japan, and enables developers to rapidly develop and commercialize new Bluetooth LE IoT devices.

The ES4L15BA1 module is designed for use in space-constrained medical, healthcare and Industrial IoT solutions, as well as in small, thin or pen-shaped devices or wearables such as smart glasses. The nRF54L15

SoC's upcoming support for Bluetooth Channel Sounding will provide the module with greatly improved reliability and accuracy in distance measurement applications enabling, for example, products requiring enhanced security based on distance information, such as unlocking devices based on their proximity. The -40° to 105° C operating range makes the module suitable for industrial equipment used in tough environments.

The nRF54L15 SoC features an Arm Cortex-M33 processor and an ultra-low power multiprotocol 2.4 GHz radio. The SoC also offers enlarged memory up to 1.5 MB NVM and 256 KB RAM.

Ezurio's BL54L15 Series



Wireless tech firm, Ezurio (formerly Laird Connectivity), has released a family of Bluetooth LE modules based on Nordic Semiconductor's next generation, low power multiprotocol SoC, the nRF54L15. The modules enable designers to bring products to market faster, while delivering high levels of performance, security and ultra-low power consumption. The modules suit industrial, medical and commercial applications.

The BL54L15 Series features the QFN48 package of the nRF54L15 SoC. It has 31 GPIOs and comprises two module variants that have either an integrated PCB trace antenna or a MHF4 connector on board.

Both modules come in a 14 by 10 mm form factor.

The BL54L15µ Series utilizes the WSCLP package of the nRF54L15 SoC. It features 32 GPIOs and comprises two module variants that have either an integrated chip antenna or a trace pad for external antenna support. The modules come in a compact 6.3 by 7.9 mm form factor.

The modules are optimized for high-performance, ensuring secure, robust and efficient wireless connectivity with support for the latest Bluetooth standards and secure programming options.

All variants come with full regulatory certifications, pre-certified antennas and supporting development kits.

u-blox's NORA-B2 Series



u-blox has announced a series of professional grade, multiprotocol modules designed to help companies across a broad spectrum of IoT market segments bring wireless products to market faster. The NORA-B2 modules are built on Nordic's next generation nRF54L15 SoC, and provide a cost-effective entry point for wireless connectivity for IoT applications.

The NORA-B2 series comprises the globally certified NORA-B201 and NORA-B206 modules, both based on the nRF54L15 SoC.

The SoC integrates a 128 MHz Arm Cortex-M33 processor, a RISC-V coprocessor, and an ultra-low power multiprotocol 2.4 GHz radio. The SoC's 1.5 MB

NVM and 256 KB RAM can run multiple wireless protocols concurrently, including Bluetooth LE, Bluetooth Mesh, Thread, Matter, Zigbee, Amazon Sidewalk and 2.4 GHz proprietary protocols.

The NORA-B201 comes in a 10.4 by 11.2 by 1.9 mm form factor and provides an antenna pin for applications requiring a customized antenna solution. The NORA-B206 comes in a 10.4 by 14.3 by 1.9 mm form factor and has a high-performance patented PCB antenna.

Both modules offer additional features and interfaces including NFC, SPI, I2C, 31 GPIOs and 14-bit ADC. They operate over a -40 to +85 °C temperature range.

MinewSemi's ME54BS01



Global IoT module supplier, MinewSemi, has announced a Bluetooth LE module based on Nordic's nRF54L15 Series of wireless SoCs. The ME54BS01 module is suitable for industrial automation, healthcare and smart home IoT applications, and provides developers with a step change in performance and security over previous modules.

The pre-certified ME54BS01 has a 23.2 by 17.4 by 2 mm form factor and features Nordic's nRF54L15 SoC. The SoC integrates a 128 MHz Arm Cortex-M33 processor, a RISC-V coprocessor and an ultra-low power multiprotocol 2.4 GHz radio. It includes a high performance PCB antenna, supports industrial-grade

temperature ranges (-40° to 85° C or -40° to 105° C), and provides a rich set of peripherals as well as 19 GPIOs. The generous 1.5 MB NVM and 256 KB RAM is capable of running multiple wireless protocols concurrently, including Bluetooth LE, Bluetooth Mesh, Thread, Matter, Amazon Sidewalk and 2.4 GHz proprietary protocols.

The nRF54L15 SoC ensures the ME54BS01 offers high IoT security, integrating features like Arm TrustZone isolation, tamper sensors and hardened cryptographic accelerators. This provides improved protection for security conscious applications and enables developers to easily build secure IoT products.

Raytac's AN54L15Q



Raytac has announced a fully pre-certified module series based on Nordic's nRF54L15 SoC, promising developers low power, high performance hardware, enhanced radio capabilities and a user-friendly design that will greatly simplify development.

The AN54L15Q module series is targeted at high growth markets including wearables, healthcare and medical devices, Industrial IoT, smart home, automotive and consumer. The module series offers three antenna variants—ceramic chip, PCB and u.FL connector—and supports Bluetooth LE, Bluetooth Mesh, Thread, Matter, Zigbee, Amazon Sidewalk and 2.4 GHz

protocols with up to 4Mbps throughput. The series will also support Bluetooth 6.0 features including Bluetooth Channel Sounding.

The AN54L15Q module takes advantage of the nRF54L15 SoC's Arm Cortex-M33 processor clocked at 128 MHz, and an ultra-low power multiprotocol 2.4 GHz radio. The SoC provides up to 1.5 MB NVM and 256 KB RAM, enabling support for advanced application software and protocol stacks on a single chip. The SoC features an integrated RISC-V coprocessor.

For security the SoC features Arm TrustZone isolation, tamper sensors and hardened cryptographic accelerators.

Bluetooth Channel Sounding unlocks new distance ranging applications

A new feature of Bluetooth enhances distance ranging – opening up many new device positioning and location service applications

Complementing its widespread use in [healthcare](#), consumer, [audio](#), industrial and numerous other applications, [Bluetooth LE](#) has established itself as a pervasive and reliable technology upon which to build device positioning solutions. The widespread and mature short-range wireless technology can be used to detect and report the presence of another device in proximity, to estimate the distance between devices and to calculate the direction in which another device can be found. Now the most recent update to the Bluetooth Core Specification (detailing Bluetooth 6.0) adds a new distance ranging feature called [Bluetooth Channel Sounding](#). The technology enables secure fine ranging between two Bluetooth devices and promises many new innovative wireless proximity and distance ranging applications. Moreover, Channel Sounding is expected to be widely adopted in mobile phones and a broad range of other battery-powered Bluetooth LE products.

This article explains Channel Sounding and how [developers can use Nordic SoCs and development tools to build new distance ranging applications](#).

Channel Sounding enables secure fine ranging between two Bluetooth devices and promises many new wireless proximity and distance ranging applications

An introduction to Channel Sounding

Bluetooth LE has long incorporated device positioning and location services technology. For example, the Find Me Profile was included as part of the Bluetooth Core Specification when Bluetooth LE was first released (as a hallmark element of Bluetooth 4.0).

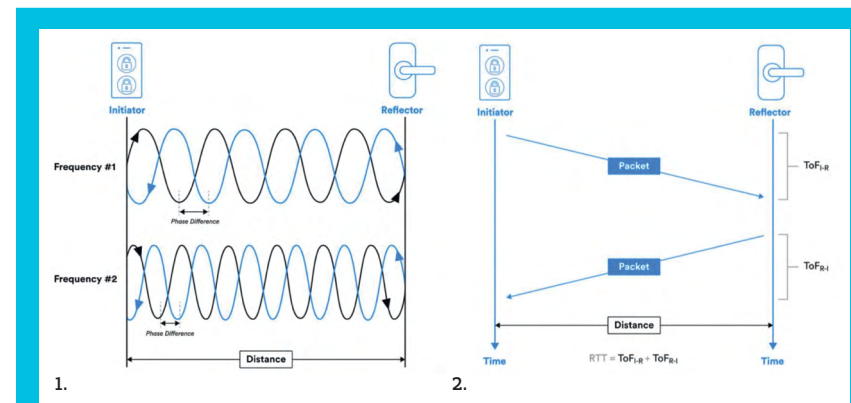
Later, as beacons became a popular Bluetooth LE application, a value in the Bluetooth specification known as 'TX Power' provided a reference power level at a distance of one meter from the beacon or other transmitting device. RF signals attenuate approximately inversely proportionally to the square of the distance from the transmitter. Therefore, with knowledge of the TX Power value, a measured Received Signal Strength Indicator (RSSI) could be used as a coarse ("close", "connected" or "out of range") estimate of the distance between the beacon or other transmitter and receiver.

Then in 2019, [Bluetooth Direction Finding](#) was introduced as part of Bluetooth 5.1. The technique enables applications to accurately calculate the direction of a received signal using phase measurements made by the Bluetooth LE controller. Two methods were defined, Angle of Arrival (AoA) and Angle of Departure (AoD).

For several key reasons, Channel Sounding now brings a simple and reliable solution for distance ranging applications. First, it is standardized and interoperable. Second, it can be supported by very simple devices or as an addition to a more advanced product without extra hardware costs and with a minimal software footprint. Third, power consumption is as low as regular data transfer over Bluetooth LE. Finally, Channel Sounding supports various hardware and software configuration options for accuracy, latency, security and power consumption.

The Bluetooth specification for Channel Sounding defines new features of the radio (PHY), features of the controller, security measures and procedures needed to collect raw measurement data. However, the conversion of raw data into the resulting distance measurement using dedicated algorithms is performed at the application level and is outside the scope of the specification. The configuration of the measurements and the algorithms can be adjusted to balance the required accuracy, latency, security and power consumption of the application.

The technology underpinning Channel Sounding is complex but is founded on either Phase-Based Ranging (PBR) or Round-Trip Timing (RTT). PBR is based on the phase-shift of a signal sent by an Initiator device and returned by a Reflector device across multiple frequencies. The raw data-to-distance conversion uses



Precision distance ranging

Phase-based ranging (PBR) uses an Initiator and a Reflector to perform distance ranging. The Initiator sends a signal of a known frequency which is then returned by the Reflector. The phase difference between the transmitted and received signal is measured. The process is then repeated using a signal of a different frequency. With knowledge of the phase differences and the differences between the frequencies, a dedicated algorithm reveals the distance between Initiator and Reflector. (Figure 1.) Round-trip timing (RTT) works by measuring the time it takes for a packet to travel between Initiator and Reflector and back, then multiplying the round-trip time by the speed of light (C), and finally dividing by two. A known amount of time is subtracted from the overall time-of-flight to account for the time taken for the Reflector to receive and then retransmit the packet. (Figure 2.)

Source: bluetooth.com



Smart locks will benefit from Channel Sounding because presence detection will be improved, and the locks will be better protected against man-in-the-middle and relay attacks

dedicated algorithms and is performed at the application level. The RTT technique is based on the time it takes for radio packets to travel back and forth between Initiator and Reflector. RTT acts as a secure distance bounding technique to cross check PBR, and the algorithms used to calculate the distance are simpler than those used for PBR. (See panel: Precision distance ranging.)

Powering new applications

Like all Bluetooth LE enhancements, Channel Sounding will lead to many applications that are hard to imagine – but there are a few examples that do come to mind. One example is improved [tags](#).

Today's tag solutions work well but problems can arise when the vibration or sound they emit when activated is muffled by sofa cushions or blankets. Channel Sounding will enable accurate 'hot-cold' proximity alerts over long distances to overcome the limitations of sound or vibration alarms.

Another application that will gain an advantage from Channel Sounding is the smart lock. Presence detection of the person wishing to activate the lock will be improved and smart locks will benefit from robust protection against man-in-the-middle and relay attacks.

Appliances will also be enhanced by the technology. Presence or distance contextualization will promote significant improvements in user experiences. For example, physical context information provided by Channel Sounding will be useful when interfacing with multiple devices, as well as assisting safety features that activate control functions only when the user is near the device.

Bluetooth LE is already in extensive use for asset tracking location services. However, Channel Sounding will bring greater precision, reliability and convenience to asset tracking applications without adding significant complexity and cost.

Developer support for Channel Sounding

Nordic's new fourth generation wireless SoCs, [the nRF54L and nRF54H Series](#), will support Bluetooth 6.0 and Channel Sounding in addition to Bluetooth LE, [Bluetooth Mesh](#), [Zigbee](#), [Thread](#), [Matter](#), [Amazon Sidewalk](#) and [proprietary 2.4 GHz](#) protocols.

Development support for the nRF54 Series will be through an update to Nordic's unified and scalable software development kit, the [nRF Connect SDK](#). The SDK offers developers an extensible framework for building size-optimized software for memory constrained devices or complex software for more advanced applications.

While Bluetooth Channel Sounding will provide a good basis for PBR- and RTT-based proximity and distance ranging applications there is a proprietary alternative. The [Nordic Distance Toolbox](#) (NDT) offers PBR and RTT-based advanced distance measurements and proximity sensing capabilities for developers that need these capabilities outside the Bluetooth ecosystem or would like to implement related applications on selected Nordic nRF52 and [nRF53](#) Series SoCs.

The accompanying software library for the nRF Connect SDK includes an algorithm that accurately determines the distance between two NDT-enabled devices, significantly enhancing accuracy compared to solutions based solely on the relatively coarse distance estimates offered by RSSI. There is a sample in the nRF Connect SDK that demonstrates the functionality of NDT.

The asset tracking market alone was valued at \$21.25 billion in 2023. According to *Fortune Business Insights*, it is projected to grow to \$59.64 billion by 2032. And many other applications will also be supported by advanced distance measurements and proximity sensing capabilities.

With the advent of Bluetooth Channel Sounding as a feature of Bluetooth 6.0, developers now have a powerful new tool to help them build winning applications for booming markets such as asset tracking and security.



Tech Check

The [nRF54L15](#) is Nordic's fourth generation wireless SoC and features a 128 MHz Arm Cortex-M33 processor, 1.5 MB NVM and 256 KB RAM. In addition to Bluetooth LE and Bluetooth Mesh the SoC also supports Channel Sounding

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

	nRF91 SERIES	nRF70 SERIES	nRF54H SERIES	nRF54L SERIES	nRF53 SERIES	nRF52 SERIES	
	nRF91 Series	nRF70 Series	nRF54H Series	nRF54L Series	nRF53 Series	nRF52 Series	
IC TYPE	Wireless SiP	Wi-Fi Companion IC	Wireless SoC	Wireless SoC	Wireless SoC	Wireless SoC	
ICs	nRF9161, nRF9160, nRF9151, nRF9131	nRF7002, nRF7001, nRF7000	nRF54H20	nRF54L15, nRF54L10, nRF54L05	nRF5340	nRF52840, nRF52833, nRF52832, nRF52820, nRF52811, nRF52810, nRF52805	
WIRELESS	LTE-M, NB-IoT, NON-TERRESTRIAL NETWORKS (NTN), DECT NR+, GNSS	Yes					
	DUAL-BAND Wi-Fi 6		Yes (with host)	Yes (with nRF70 Series)	Yes (with nRF70 Series)	Yes (with nRF70 Series)	
	Wi-Fi LOCATIONING	Yes (with nRF70 Series)	Yes (with host)	Yes (with nRF70 Series)	Yes (with nRF70 Series)	Yes (with nRF70 Series)	
	BLUETOOTH LOW ENERGY 6.0			Yes	Yes	Yes	
	BLUETOOTH CHANNEL SOUNDING			Yes	Yes		
	BLUETOOTH LE AUDIO			Yes		Yes	
	BLUETOOTH MESH, ZIGBEE, THREAD, MATTER, AMAZON SIDEWALK, NFC			Yes	Yes	Yes	Yes
	ESB AND 2.4 GHz PROPRIETARY PROTOCOLS			Yes up to 4 Mbps	Yes up to 4 Mbps	Yes up to 2 Mbps	Yes up to 2 Mbps
	MCU FUNCTIONALITY	PROCESSOR	64 MHz Arm Cortex-M33	2x Arm Cortex-M33, up to 320 MHz	128 MHz Arm Cortex-M33	2x Arm Cortex-M33, up to 128 MHz	64 MHz Arm Cortex-M4
RISC-V COPROCESSOR			320 MHz FLPR, 16 MHz PPR	128 MHz FLPR			
NVM		1MB	2 MB	Up to 1.5 MB	1MB + 256 KB	Up to 1MB	
RAM		256 KB		1MB	Up to 256 KB	512 KB + 64 KB	Up to 256 KB
STANDARD PERIPHERALS AND INTERFACES		Yes	High-speed SPI/QSPI	Yes	Yes	Yes	Yes
HIGHLIGHTED DIGITAL INTERFACES				480 Mbps USB, CAN-FD		12 Mbps USB	12 Mbps USB
SECURITY		ISOLATION	TrustZone		Secure Domain and TrustZone	TrustZone	TrustZone
	CRYPTOGRAPHIC ACCELERATOR	Yes		Yes with side-channel leakage protection	Yes with side-channel leakage protection	Yes	
	TAMPER DETECTORS			Yes	Yes		
GPIOs	32		64	Up to 32	48	Up to 48	
PACKAGE TYPES	LGA	QFN, WLCSP	WLCSP	QFN, WLCSP	aQFN, WLCSP	aQFN, QFN, WLCSP	
MINIMUM PACKAGE SIZE	11x7x1mm	3.8x3.4 mm	4.7x4.3 mm	2.4x2.2 mm	3.5x3.6 mm	2.5x2.5 mm	
COMPATIBLE PMICs	nPM1300, nPM6001	nPM6001	nPM1300, nPM1100, nPM6001	nPM1300, nPM1100, nPM6001	nPM1300, nPM1100, nPM6001	nPM1300, nPM1100, nPM6001	
nRF Cloud SERVICES	Yes	Yes					

PMICs

nPM FAMILY

	nPM1300	nPM1100	nPM6001	
TYPE	PMIC			
FEATURES	BUCK REGULATOR	2	1	4
	BATTERY CHARGER			
	LDO	2		2
	LOAD SWITCH	2		
	TERMINATION VOLTAGE	3.5 to 4.45 V	4.1 to 4.2 V or 4.25 to 4.35 V	
CHARGER	MAX CHARGING CURRENT	800 mA	400 mA	
	POWER PATH MANAGEMENT			
	THERMAL PROTECTION			
	BATTERY COMPATIBILITY	LiFePO4, Li-Ion, LiPo	Li-Ion, LiPo	
POWERRAILS	INPUT VOLTAGE	4 to 5.5 V	4.1 to 6.7 V	3 to 5.5 V
	USB COMPLIANCE	Type-C		
	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 MANAGEMENT	SYSTEM MONITORING	System-, input bus- and battery-voltage; battery-current and -temp; die temp		
	FUEL GAUGE			
	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 Device Management enables an IoT data-as-a-service model. It acts as the single entry-point for all device data, scaling across different devices and applications. Device management includes a firmware-over-the-air (FOTA) update function, whereby modem and/or application firmware can be updated. Device management keeps IoT products in the field operating at their best to ensure the data continues to flow. The data collect feature allows devices to send both operational and application data to nRF Cloud, utilizing a unified interface that ensures the lowest power and simplest implementation.

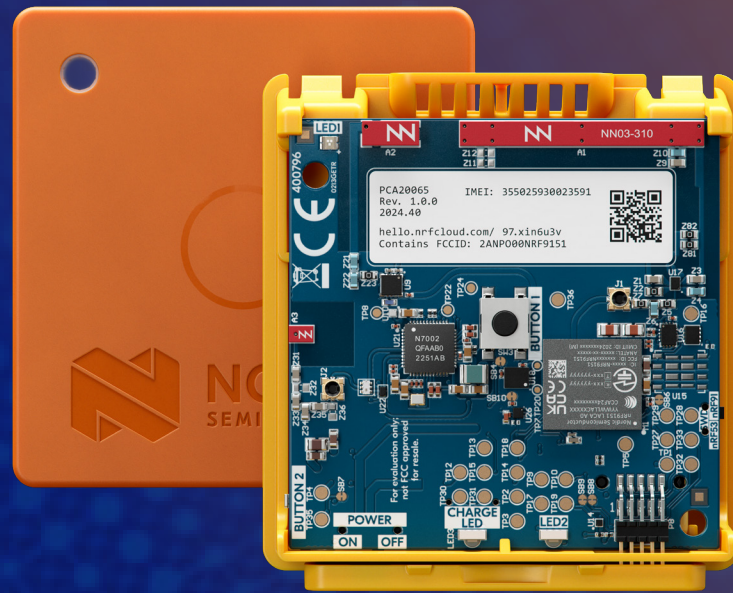
nRF Cloud Security Services provide a secure and unique identity for devices that can be used for authentication. Nordic's nRF91 Series SiPs have a cryptographically provable unique identity to verify origin during end-product manufacturing. Secure provisioning then enables an IoT device to be configured remotely with the required credentials and custom configurations. This eliminates the need for customer credential management or the need to generate keys on the factory floor – simplifying and lowering the cost of manufacture. Remote secure provisioning enables the manufacture of generic products that can be deployed and provisioned anywhere. And nRF Cloud Security Services ensure devices stay secure after deployment with the capability to rotate keys, rollout new certifications or clean credentials and configurations.

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**
nRF9131, nRF9151, nRF9160, nRF9161 SiPs, nRF7000, nRF7001, nRF7002 Companion ICs
- Applications**
Industrial, smart appliances, asset tracking, RTLS

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