



WIRELESS QUARTER

WAREHOUSE RAVE:
LOGISTICS EMBRACES THE IoT
TO MEET BOOMING DEMAND

THE DIGITAL AGED:
NEXT GEN WEARABLES
MAINTAIN SENIORS'
INDEPENDENCE



WQ Special Report

How the IoT Can Help Save the World

Wireless tech supports
major carbon saving
initiatives aimed at
limiting global warming

NORDIC TEAMS UP
WITH AMAZON

CONNECTIVITY DRIVES
EV INFRASTRUCTURE

AN INTRODUCTION TO
LOW POWER WI-FI





Unifying the smart home market



LEARN MORE
nordicsemi.com/matter

Welcome

Kjetil Holstad
EVP Product Management



The Wi-Fi Alliance says there are 18 billion [Wi-Fi](#) devices in use. A glance around the home or workplace shows Wi-Fi is integral to the way we work, rest and play.

With the introduction of [Wi-Fi 6](#), the technology is set to become even more widespread. The latest specification brings features that make Wi-Fi even better suited to the IoT. Examples include an advanced power saving mode and the capability to support many more devices on a single channel without coexistence challenges.

Together with [Bluetooth LE](#) and [cellular IoT](#), Wi-Fi is a foundation technology of the IoT. Nordic is the leader in Bluetooth LE and is disrupting the cellular IoT sector with its low power cellular IoT. However, until now, the company didn't offer a Wi-Fi solution. That's changed with the availability of the [nRF7002](#), a Wi-Fi 6 companion IC. The introduction is accompanied by the nRF Connect SDK, helping developers get started on nRF7002 Wi-Fi IoT projects immediately.

The nRF7002 operates alongside Nordic's nRF52 and nRF53 Series SoCs to bring Internet Protocol (IP) connectivity to Bluetooth LE networks where it will enhance existing applications and enable new ones. The nRF7002 will form a key part of Nordic's [Matter](#) standard solutions which bring interoperability to smart home ecosystems. The IC also works well with the [nRF9160 SIP](#) where it supplements cell-based and GPS-based location services with the SSID-based Wi-Fi location service offered in [nRF Cloud](#).

This is an exciting time for Nordic. The company is now one of very few suppliers with wireless IoT solutions for all three key technologies. And this is just the start; our R&D roadmap details major advances in our Bluetooth LE, Wi-Fi and cellular IoT products which I'm looking forward to telling you about soon.

“With the introduction of Wi-Fi 6, the tech is set to become even more widespread. The latest specification brings features that make Wi-Fi even better suited to IoT applications”

Wireless Quarter is contract published on behalf of Nordic Semiconductor by Ecritech Media

Editor
Steven Keeping sk@ecritech.media
Assistant Editor
Chris Williams cw@ecritech.media
Contributing Editor
Kalon Huett kalon@ecritech.media
Production Editor
Andrew Woolls-King awk@ecritech.media
Creative Director
Sam Grimmer sam@ecritech.media
Prepress
Nathan Sargent
Print & Distribution
Printech Europe



The Bluetooth® word mark and logos are registered trademarks owned by the Bluetooth SIG, Inc. and any use of such marks by Nordic Semiconductor is under license.

© Nordic Semiconductor 2023



To subscribe to WQ visit www.nordicsemi.com/wqmag

Contents

News	4
News Extra	10
Nordic tech delivers foundation for Amazon Sidewalk projects	
Analysis	12
Connectivity a driving force for EV infrastructure	
Comment	13
IoT engineers are in demand	
WQ Special Report	
How the IoT Can Help Save the World	14
The IoT is providing the platform for the shift to a sustainable planet	
Warehouse Rave	22
The IoT is helping solve online shopping logistical challenges	
The Digital Aged	26
Remote monitoring solutions are helping care for our older population	
Nordic Inside	30
BluArmor C30 Helmet Comms	
Case Study	32
Wireless flow monitor provides real time water leak detection	
Industry Viewpoint	33
Tony Chung, Dayton Industrial	
Tech Zone	34
Nordic introduces nPM1300 PMIC to simplify power design	
Tech Briefing	36
An introduction to Nordic's low power Wi-Fi companion IC	
Nordic Product Summary	38



New Product - Wi-Fi

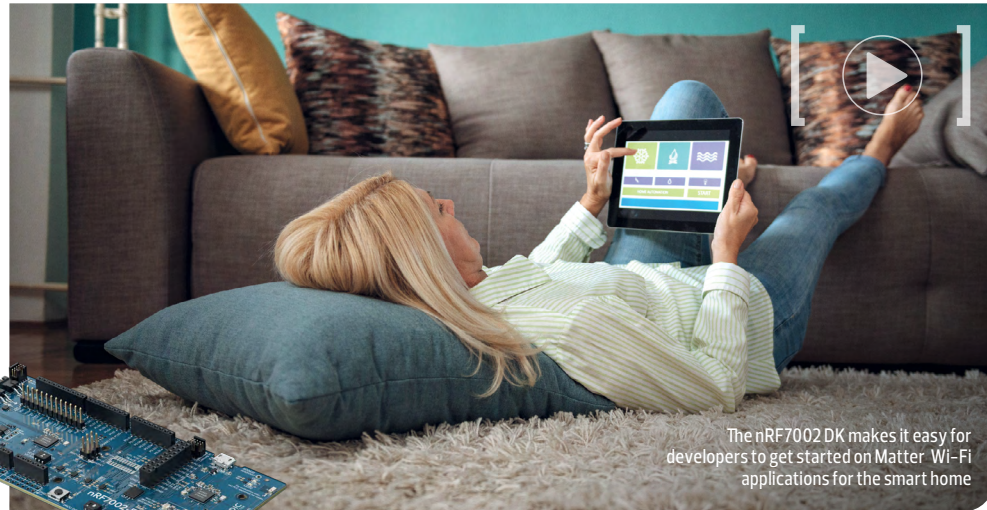
Nordic introduces nRF7002 companion IC for Wi-Fi 6 IoT applications

Nordic Semiconductor has announced the availability of its [nRF7002](#) Wi-Fi 6 companion IC and the associated nRF7002 DK. The IC is the first in Nordic's Wi-Fi product family and is a low power device providing dual band (2.4 and 5 GHz) connectivity. By using the IC, developers can take advantage of Wi-Fi 6's higher throughput compared with, for example, Bluetooth LE, and ubiquitous infrastructure.

The nRF7002 IC can be used together with Nordic's award-winning nRF52 and nRF53 Series multiprotocol SoCs and the nRF9160 cellular IoT SiP, but can equally be used in conjunction with non-Nordic host devices. The DK makes it easy for developers to get started on nRF7002-based IoT projects.

Wi-Fi 6 brings significant benefits to IoT applications—such as smart home products, industrial sensors, asset trackers, and wearables—including power efficiency gains for battery powered Wi-Fi operation, and management of large IoT networks comprising hundreds of devices.

"The nRF7002 Wi-Fi 6 companion IC is a testament to Nordic's leadership in low-power wireless technology," says Svein-Egil Nielsen, CTO/EVP of R&D and Strategy at



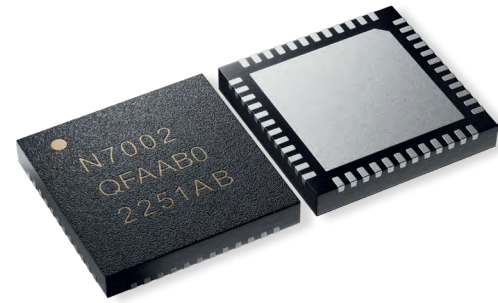
The nRF7002 DK makes it easy for developers to get started on Matter Wi-Fi applications for the smart home

the company. "Supported with the nRF7002 DK and the award-winning nRF Connect SDK, combined with Nordic's best-in-class technical support, I believe it has never been easier to develop great Wi-Fi products."

"The nRF7002 is a perfect fit for [Matter](#), a smart home standard backed by Amazon, Apple, Google, Nordic, Samsung, and others," says Finn Boetius, Product Marketing Engineer with Nordic. "The nRF7002 makes it

easy for developers to get started on Matter over Wi-Fi applications." Matter uses [Thread](#), Wi-Fi and Ethernet for data transport, and Bluetooth LE for commissioning.

The nRF7002 is the ideal choice for implementing low power SSID-based Wi-Fi locationing when used together with Nordic's nRF9160 SiP and the company's [nRF Cloud](#) Location Services. The nRF7002 companion IC and nRF7002 DK are available now from Nordic's distribution partners.



Connected Health

Wearables provide seniors healthcare metrics

Yarward Electronics has launched two [wearables](#) for patient use in hospitals and aged care facilities. The wearables offer a wide range of features including patient location monitoring, health data acquisition as well as automated alerts and emergency calling. For example, staff in an aged care facility could use the products to not only remotely monitor an individual's key health metrics but also their location in the building.

The YH-WR6 smart watch and YH-WR7 smart bracelet both employ Nordic's [nRF52832](#) SoC to provide Bluetooth LE wireless connectivity to send data to a gateway. From the gateway the data is relayed to the Cloud where hospital or facility staff can review it via a web-based platform.

The IP68 waterproof-rated devices integrate sensors including an accelerometer for activity monitoring; an optical sensor for

heart rate and blood oxygen measurement; an air pressure sensor; a temperature sensor; gyroscope; and an ambient light sensor to adjust the screen brightness and save power. The SoC's Arm Cortex-M4 processor acts as the main microcontroller and helps oversee the inbuilt sensors. The nRF52832 also enables the devices' location monitoring functionality.



Asset Tracking

Samsung keeps track of consumer valuables with Nordic technology

Nordic's [nRF52833](#) SoC is being used to power the Galaxy SmartTag from global IT and mobile company Samsung Electronics. The Galaxy SmartTag provides a simple and effective way to keep track of commonly misplaced items, such as keys or bags. Nordic's SoC provides Bluetooth LE wireless connectivity, which Galaxy SmartTags use to pair with the SmartThings app on Galaxy smartphones.

"The demand for consumer asset tracking solutions has witnessed significant growth in our increasingly mobile world, and Samsung is a technology leader in this area," says Nordic's Bjørn Åge "Bob" Brandal, VP of Sales and Marketing, Asia Pacific. "Nordic is delighted to be working closely with Samsung Electronics on the new Galaxy SmartTag."

For tagged items lost but still within Bluetooth LE range, the SmartThings' 'search nearby' feature lets users see the approximate location of the tag, while the 'ring' feature allows the tag to emit a beeping sound. If the tag is out of range, the user will receive a smartphone or smartwatch notification letting



them know the item has been left behind. Any nearby Galaxy smartphone or tablet that has opted in can alert the Samsung server, which in turn alerts the owner. The user data is encrypted and securely protected, ensuring the location is only revealed to the owner.

With Nordic's Bluetooth LE wireless connectivity, Galaxy SmartTags can do more than locating valuables. They can also be programmed to perform automated tasks such as activating a home security system, dimming the lights, or controlling a smart TV.

Internet of Things

Nordic becomes full member of DECT Forum and joins board



Nordic Semiconductor has announced its full membership of the DECT Forum, the organization responsible for fostering the development of the DECT (Digital Enhanced Cordless Telecommunications) industry standard, and the adoption of the DECT New Radio (NR)+ standard.

The European Telecommunications Standards Institute's (ETSI) [DECT NR+](#) is the first non-cellular 5G wireless standard and is designed to support massive IoT at densities of a million devices per square kilometer.

Nordic has been a key contributor to the development of the DECT NR+ standard since the initial specification was published in July 2020. The standard promises 99.99 percent reliability due to features built into the lower layers of its RF stack. Nordic became the main

contributor for the stack's physical (PHY) layer and a key contributor for the Media Access (MAC) layer at the launch of the specification. The company continues to serve as the editor for the PHY layer.

As part of its membership, Kristian Sæther, Nordic's Product Director of Cellular IoT and NR+, will join the DECT Forum Board. Nordic has also joined several key working groups.

"Nordic is a believer in bringing the IoT to the widest audience," says Sæther. "Our strategy is to support the IoT technologies that cater for the widest range of applications while being based on open standards and built to exacting technical specifications. DECT NR+ fits the bill perfectly," he adds. "We joined the DECT Forum due to its proven track record for establishing DECT in the market."

In Brief

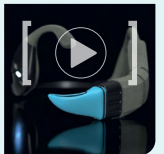
IMPROVING AIR QUALITY



Nordic has added its technical expertise to an international air quality monitoring initiative. The South African Consortium of Air Quality Monitoring

(SACAQM) is a consortium with the goal of bringing together the private sector, and other institutions to promote and develop IoT-powered air quality monitoring and prediction technology. Due to the cost and complexity associated with deploying traditional air quality monitoring systems, countries are forced to allocate their limited resources to monitor priority sites which necessitates the omission of others. As such, SACAQM is developing an AI-powered IoT system envisioned to address shortcomings in currently available commercial systems.

A SCENT FOR VIRTUAL REALITY EXPERIENCE



Scent might soon become part of the multisensory extended reality experience. At CES 2023, U.S. startup OVR Technology presented

ION, a wearable featuring a cartridge filled with unique digital aromas. The company says the sense of smell influences emotions and behavior. The device, which connects wirelessly over Bluetooth LE to a smartphone, PC or VR headset could open up a new realm of possibilities for gamers, retailers and healthcare providers, the company claims. Adding scent to a virtual reality retail exhibit or therapeutic VR environment, for example, could influence the way people respond to it.

NORDIC THINGY:53 WINS AWARDS



The Nordic Thingy:53 has been named the winner of two important industry awards. The IoT prototyping platform won the 'Best IoT Innovation

of the Year' category of the Electronics Maker (EM) Best Awards 2022, India's most prestigious electronics industry awards. The Thingy:53 was recognized as the ideal platform for building advanced wireless proofs-of-concept with ML capabilities on short schedules. It then won the 'RF/Wireless/Microwave' category of the 2022 World Electronics Achievement Awards (WEAA), which honors products, companies and individuals that have made outstanding contributions to innovation and development.

Smart Agriculture

Livestock tracking solution offers remote health and location alerts

U.S.-based HerdDogg has released a suite of livestock tracking solutions to provide ranch operators with remote health and location data for their herd of cattle. The range includes three DoggTag smart tags—TraceTag, YardTag and WelfareTag—as well as the DoggBone gateway which relays the smart tag data to a Cloud platform for review by ranch management.

The smart tags are applied to the ear of an animal using a standard tag applicator and the tag then records its proximity to the gateway at specific times. Ranchers can then use the data to determine, for example, if or when an animal visits a feed trough or a watering location, as well as maintain a location-based inventory of their herd. If an animal fails to visit a feed trough it could be a sign that the animal is unwell or of potential theft.

The WelfareTag also includes temperature and light sensors as well as a MEMS accelerometer to record data about animal behavior. This data is gathered several times an hour and is stored in the smart tag's memory until it can be relayed to the Cloud when the animal is next within range of the DoggBone



HerdDogg's smart tags provide ranch operators with remote health and location data for their herd of cattle

gateway. The data can also be used for estrus detection—identifying when a female animal is ready for breeding—as well as for health alerts for apparent lameness, fever or Bovine Respiratory Disease.

The TraceTag and YardTag smart tags are powered by Nordic's [nRF52833](#) SoC, while the WelfareTag device employs the advanced [nRF52840](#) SoC. The Nordic SoCs provide

Bluetooth LE wireless connectivity between the tags and the gateway at a distance of up to 90 meters in standard operation.

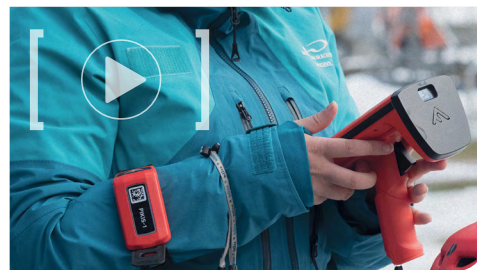
The DoggBone gateway employs two U-Blox [BMD345](#) modules—which integrate the [nRF52840](#) SoC—to provide long range wireless connectivity between the gateway and the smart tags. From the gateway, the data is relayed to the Cloud using cellular or Wi-Fi.

Location & Tracking

Resort management solution tracks skier location on mountains

Flaik, a ski school management firm, has upgraded its workforce management solution to include IoT network capabilities. The network indicates the location of thousands of guests and instructors anywhere on the mountain in near real time. The Flaik SnowSports Workforce Management solution with GPS Tracking platform comprises the flaik tag wearable device using Nordic's [nRF9160 SiP](#) and the associated Mountain View web-based dashboard.

The SiP provides the GNSS positioning and cellular IoT connectivity that allows the skier's location data to be relayed from the flaik tag to a smartphone or tablet via the Cloud. The [nRF9160](#) combines cellular location data with



GNSS trilateration for precise location.

The location of individuals is continually relayed to the flaik servers for a comprehensive understanding of what's happening on the ski fields.

The system allows, for example, ski management to direct late students to classes in minutes or track any classes late to return at the end of the day. At the same time, data-driven feedback helps instructors set level-appropriate lessons. At the biggest resort at which it is deployed in Whistler, Canada, flaik can scan and associate up to 3,500 devices to guests and instructors.

Sports & Fitness

Connected rowing machines provide performance insights

Rowing machine maker, WaterRower, is using Nordic Bluetooth LE connectivity in its rowing machine performance monitors to provide users with real time access to programs to help them train smarter.

The WaterRower rowing machines provide smooth and even resistance and a realistic rowing experience. The company's S4 Performance Monitor can be mounted to the machine and displays a range of time, distance and intensity metrics. It integrates Insight SiP's [ISP1907-LL](#) module based on Nordic's [nRF52811](#) SoC. The module provides Bluetooth LE connectivity to the WaterRower Connect iOS and Android app. From the app the user can review their workout history.

Location & Tracking

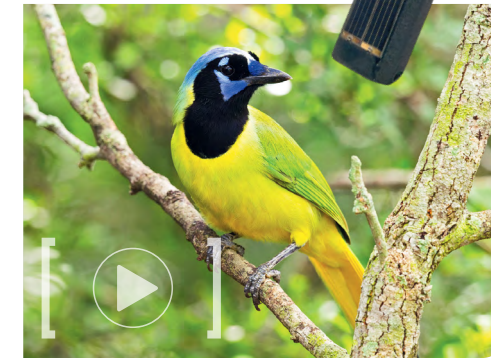
Cellular IoT animal tracker monitors small species

Wildlife telemetry solutions provider, Cellular Tracking Technologies, has developed a lightweight tracker designed for monitoring the migration patterns of species weighing as little as 75 grams. The company has already deployed the trackers on species that were previously too small to carry trackers – such as the American Robin and Green Jay.

Both versions of the animal tracker, FlickerGPS and FlickerCL (CellLocate), come in a compact form factor—the smallest version weighs approximately 2.5 grams—with the transmitter generally weighing below 3 percent of a tracked bird's weight so as to not impact its natural behavior.

The products use Nordic's [nRF9160](#) low power SiP for the GNSS positioning and cellular IoT connectivity that allows the animal data to be relayed to the Cloud.

The battery- and solar-powered devices feature a three-axis accelerometer for detecting mortality, providing a general level of activity (not moving or moving significantly), and providing the user with raw X,Y,Z measurements. Algorithms can also be deployed to identify specific animal behaviors



like roosting, flight and foraging, for example.

"The FlickerGPS and FlickerCL leverage a whole new suite of tools enabling the study of animal movement and behavior at a spatial and temporal scale previously unattainable for a wide range of smaller species," says Sheldon Blackshire, the firm's CTO.

FlickerGPS and FlickerCL use Nordic's [nRF Cloud Location Services](#) for power-efficient and accurate positioning. From the web platform the user can see where the animal is on a map, view sensor data and update device configurations over-the-air.

Toys & Gaming

Haptic skin VR system provides vivid touch experience

A hand-worn wireless haptic interface system that collects personalized tactile sensation data to provide a vivid touch experience in the virtual world has been developed by researchers in Hong Kong. The ultra thin, ultra flexible, wireless skin-integrated electrohaptic tech is designed to enhance the immersive experience of [VR and AR](#) users. Users can feel virtual objects at varying degrees of force proportional to actions in the metaverse – such as a mouse running along the hand, or grasping a tennis ball.

Based on personalized threshold data, electrohaptic feedback can be delivered to any part of the hand on demand and within an intensity range that is strong enough to be noticed but will not cause any pain.

Unlike typically cumbersome haptic gloves

which tend to rely on bulky pumps and air ducts powered through cables, the WeTac system, developed at the City University of Hong Kong (CityU), employs Bluetooth LE connectivity provided by a soft driver unit worn on the wrist. This enables configuration from a smartphone to adjust the strength of the electrohaptic stimulation. WeTac has application potential across gaming, sports and skills training, and remote robotic controls.

"Touch feedback has great potential, along with visual and aural information, in VR, so we kept trying to make the haptic interface thinner, softer, more compact and wireless, so that it could be freely used on the hand, like a second skin," said Dr Yu Xinge, Associate Professor in the Department of Biomedical Engineering at CityU, who led the research.



In Brief

WASTE ENERGY POWERS WEARABLES



Researchers at the University of Massachusetts Amherst have invented an innovative method of harvesting waste energy

to power wearable devices using the human body as an antenna. After experimenting with an antenna made out of coiled copper wire to collect leaked RF energy, the team found that placing the coil in contact with a human body could maximize the collection of waste energy – up to ten times more than the bare coil alone. The result of this discovery is an upper forearm-worn device called Bracelet+ that can reach up to microwatts to support, for example, body worn health monitoring sensors that require little power.

SURGE FOR SMART METERING TECH



The smart electricity meter penetration rate in North America reached 77 percent at the end of 2022, and a new report from market

research firm Berg Insight says smart meter penetration in the U.S. will increase to reach 93 percent by 2027. Overall, the analyst projects the installed base of smart electricity meters will grow at a compound annual growth rate (CAGR) of 4.8 percent to reach a total of 173.4 million units at the end of the 2021 to 2027 forecast period. Yearly shipments of smart electricity meters in North America will continue to grow from 10.7 million units in 2021 to 17.3 million units in 2027, according to the study.

MIC BLOCKS AMBIENT SOUND



A wireless soundproof microphone that straps over the user's mouth to create a seal can prevent ambient noise from leaking in while

simultaneously suppressing the user's voice to make it less audible to the outside world. Developed by Japanese company Shiftall, the Mutalk device is designed for various applications in environments where external noise might hinder communication, such as VR, online gaming and conference call scenarios. The technology is based on the Helmholtz resonator principle to achieve a significant sound deadening effect. It operates as a wireless headset when linked to a smartphone via Bluetooth LE connectivity.

Photo courtesy: City University of Hong Kong

Smart City

Speeding up a rapid transit system

The rapid transit system of one of China's most populous cities is employing Nordic Bluetooth LE wireless technology to help the 10 million people who use the network each day get to their trains and destinations faster. The point of sale (POS) ticketing system at the Shanghai Metro's entry and exit gates uses Shanghai Dito Information Technology's (Dito) QR Code Bluetooth Security Signature Verification Module. The module employs Nordic's [nRF52832](#) multiprotocol SoC. The SoC enables secure, offline signature verification to authorize customer payments in the event of network loss.

To access Shanghai Metro, commuters can download the Shanghai Daduhui app to their smartphone. From the app, users can generate a QR code that is scanned on approach to the entry or exit gates. In addition to Shanghai Metro, the POS ticketing system has also been rolled out across a number of other smart transportation facilities across China. The



system is used up to 150 million times each day, accounting for more than 35 percent of transportation payment

transactions in China, according to the firm. "With Nordic's in-depth cooperation and support, Dito's offline ... verification module is not only improving travel convenience of citizens' travel, but also greatly reducing the use of physical cards and tickets, and the resources required to make them," says Bruce Xie, CEO of Dito.

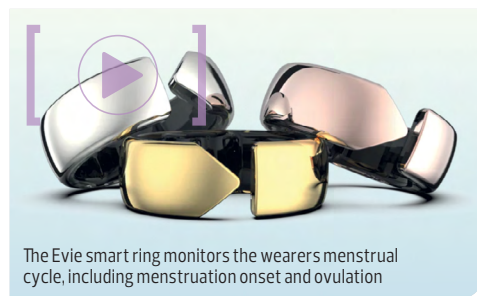
The solution comprises a QR code module—which is linked to the main board of Shanghai Metro's POS machine to provide QR code camera control—as well as the Nordic-powered Bluetooth verification module. Bluetooth LE provides an alternative method of verifying the QR code and authorizing customer payments should the entry or exit gates suffer a loss of network signal. The nRF52832 SoC ensures secure Bluetooth LE connectivity between the entry and exit gates and the user's smartphone.

Smart Health

Developers delivering health solutions for women

Wireless devices that target women's health are beginning to emerge on the consumer market. At CES 2023 in Las Vegas, Movano Health introduced a future iteration of its medical-grade Evie smart ring for women, which will monitor health metrics to help users better understand the timing of their menstrual cycle, including menstruation onset and ovulation windows. The device also offers support for menopausal symptoms through insights delivered to an app on a paired smartphone.

"By monitoring their [women's] temperature, through the course of the month, as well as their heart rate, we can track and predict when, say, the period is



The Evie smart ring monitors the wearers menstrual cycle, including menstruation onset and ovulation

about to start," John Mastrototaro, Movano Health's CEO and Director, recently explained to *TechCrunch* magazine.

Elsewhere at CES 2023, Withings demonstrated a version of its hands-free home urine lab, which sits under the front rim of a toilet bowl. It monitors menstrual cycles by tracking hormone levels. The device can even help screen for bladder and ovarian cancer, says the company.

Information collected by the device is relayed to a smartphone app via low power wireless connectivity.

Cellular IoT

Cellular IoT gateway enables sensor data collection



An IoT gateway solution developed by German company TYMIQ sits at the heart of its asset monitoring and data acquisition platform. The Prylada IoT Gateway (ADH-02) provides a set of connection interfaces for gathering telemetry data from a variety of sensors including temperature, humidity, light, liquid leak, air quality and movement detection.

The device employs the computational power of Nordic's [nRF9160 SiP](#)'s Arm Cortex-M33 application processor to oversee the sensors and collate data. The nRF9160 SiP enables the collected sensor data to be securely transmitted to the proprietary Cloud portal, Prylada Cloud, via a cellular IoT network.

Smart Agriculture

Wireless sensor networks predict environmental changes

Three wireless sensor networks that supervise square kilometers of land and water to predict environmental changes are being developed by a team of researchers in the U.S. Led by Supratik Guha, Professor at the University of Chicago's Pritzker School of Molecular Engineering, the team is creating a sensory network capable of tracking pollution, moisture levels and chemical composition to generate data about the rapidly shifting composition of the planet.

"We want to see how rivers are being polluted, how much fertilizer is washing out of the soil," said Prof. Guha. "With better data, terrestrial ecologists can develop better nitrogen and carbon dioxide cycling models. [And] farmers can use exactly the right amount of water at exactly the right time."

Under the project name Thoreau (after the famous naturalist Henry David Thoreau), Guha's team have created one network that monitors the water quality in several Indian rivers, another that records ground moisture around the University of Chicago campus, and a third that collects soil information at a pilot farm near Fermi National Laboratory in Batavia, Illinois.



The Fermi farm network (Thoreau 2.0), for example, uses a [soil sensor](#) connected to a plastic-encased circuit board. The farm has 23 battery-powered nodes buried beneath the surface where they detect and monitor volumetric water content, temperature and soil electrical conductivity.

The sensors have an operational life span of roughly four-and-a-half years, thanks largely to their use of low power wireless tech.

The nodes collect data every 30 minutes, relaying it via a cellular IoT network to a solar-powered base station in the middle of the field, which in turn transmits the information to a remote laboratory.

Sports & Fitness

GPS bike computer provides riding data and supports sensors

Magene has launched a multifunctional GPS bike computer that can record over 100 different items of riding data across 13 categories as well as support up to eight peripherals. The C406 Pro uses satellite positioning to accurately record and display a range of data such as speed, mileage, time, temperature and altitude on its 2.4-in LCD screen. The integration of Nordic's multiprotocol [nRF52840 SoC](#) allows the bike computer to support wireless sensor devices such as heart rate monitors, power meters, speed and cadence sensors, as well as electronic shifting systems and the company's L508 Radar Tail Light.



The nRF52840 SoC's powerful Arm Cortex-M4 processor provides ample computational resources to supervise the data acquisition, data processing, data saving and GUI display.

The SoC's Bluetooth LE connectivity enables data to be synced between the C406 Pro and Magene's OnlapFit app on a smartphone. From the app the user can review and manage their ride data and statistics, engage with social media platforms, as well as select training modes. The SoC also supports the ultra low power ANT+ wireless protocol which allows the bike computer to be simultaneously linked with complementary ANT+ Magene and third party devices.

By the Numbers

\$777 million in revenue

Nordic Semiconductor has reported [2022 annual revenue](#) of \$777 million, representing growth of 27 percent over the 2021 full year. The result comes on the back of all time record Q4 revenue of \$191 million, an increase of nearly 12 percent in the quarter over 2021. The strong year-on-year demand reflects significant growth across all Nordic's main verticals with Bluetooth LE once again dominating, contributing \$669 million to annual revenue.

\$556 billion by 2030

The global consumer IoT market size is forecast to reach \$556 billion by 2030, registering a CAGR of 12.7 percent from 2023 to 2030, according to Grand View Research. The analyst ascribed this growth to the increasing adoption of IoT devices—including smart wearables, fitness trackers, smart home devices and more—that gather and share data over the network. The wireless segment held a considerable revenue share in 2022 and is projected to expand further at a significant CAGR.

\$1.67 million smart rings market

The global smart rings market was worth \$1.67 million in 2022, according to a study by market research firm Contrive Data Insights. The analyst anticipates the smart rings market will reach \$11.44 million by the end of 2030 with a CAGR of 24 percent over the 2023 to 2030 forecast period. The Asia-Pacific region has the largest market share. Cloud services enable these small devices provide various functions, the firm says.

Smart Home

Nordic Bluetooth LE approved for Amazon Sidewalk IoT network applications

Amazon Sidewalk combines Bluetooth LE and sub-GHz radio technologies to help wireless devices work better indoors and extend their reach beyond the home

Bluetooth LE is on the path to ubiquity. Wearables, smart lighting, home security, and energy management are just some of the applications enabled by the smartphone interoperable technology. Dogs too are getting in on the act with their own Bluetooth trackers that let owners know where they have wandered (see [WQ Issue 3, 2021 pg14](#)). But what if the pet decides the yard is boring and scales the fence to explore the neighborhood? Once out of Bluetooth LE range, the animal is lost.

[Amazon Sidewalk](#) offers a solution. The technology uses widespread Amazon Echo and Ring smart home devices as gateways (known as Sidewalk Bridges) to provide both Bluetooth LE and longer range 'neighborhood-wide,' sub-GHz wireless connectivity. In this way, Amazon Sidewalk forms a free-to-connect 'community' wireless IoT network.

The network is based on two variants. The first suits applications in the home and uses Bluetooth LE (2.4 GHz). For applications outside the home, a second license-free band in the sub-GHz spectrum allocation enables longer range applications. Like tracking escaped pets.

[Amazon Sidewalk over Bluetooth LE](#) will streamline connecting Bluetooth LE devices to the Cloud with a particular focus on data privacy and security. This variant is most applicable to equipment located inside buildings. The longer range version operates at a lower throughput and forms a network sitting between the home Wi-Fi and cellular IoT LPWANs. It provides greater neighborhood coverage than home Wi-Fi, but without incurring the data costs associated with a cellular network connection.

Built with Nordic

Nordic Semiconductor's technology can now be used by developers as a basis for both variants of Amazon Sidewalk. The company's [nRF52840 SoC](#) is the ideal basis for the home-based Bluetooth LE networks. The longer range sub-GHz Amazon Sidewalk variant will make use of the Nordic SoC's Arm Cortex-M4 application processor while the radio will provide smartphone-interoperable Bluetooth LE connectivity to authenticate new devices into the network and provide over-the-air firmware updates (OTA-DFUs).

Developers can design and test Amazon Sidewalk products using the nRF52840 and Nordic's nRF Connect SDK (see sidebar next page [Building Amazon Sidewalk products](#)).

In the U.S., the longer range Amazon Sidewalk variant will use the license-free 900 MHz band. The Nordic



Keeping track of adventurous pets will be among the applications made more effective with Amazon Sidewalk



Amazon Sidewalk over Bluetooth LE will streamline connecting Bluetooth LE devices to the Cloud with a particular focus on data privacy and security

solution for this variant will use a Semtech SX1262 transceiver which opens up two further two options: Amazon Sidewalk over LoRa and Amazon Sidewalk over FSK (using frequency shift keying modulation and offering higher throughput than LoRa but with shorter range).

In addition to keeping track of errant pets, application examples for Amazon Sidewalk include smart outdoor lighting, environmental sensors, utility meters, asset trackers, and domestic appliances such as washing machines—that are often kept in basements or garages—as well as healthcare and commercial devices.

Sidewalk Bridges allow all Amazon Sidewalk devices to communicate with the Internet. The gateways share a small portion of their Internet bandwidth to provide services to any Amazon Sidewalk product. This will also enable use cases such as asset tracking and lost or misplaced item finding.

With Amazon Sidewalk now open to developers, device makers can focus on designing products without worrying about how to connect them to the Internet.

"Amazon Sidewalk is a really promising development," says Finn Boetius, Product Marketing Engineer at Nordic. "By upgrading its near ubiquitous infrastructure in the U.S., Amazon has taken a unique opportunity to expand the application range and market potential of wireless IoT. This includes using Bluetooth LE to make it simple for consumers to add Amazon Sidewalk devices to their network using their smartphones."

Amazon Sidewalk is currently only available in the U.S.

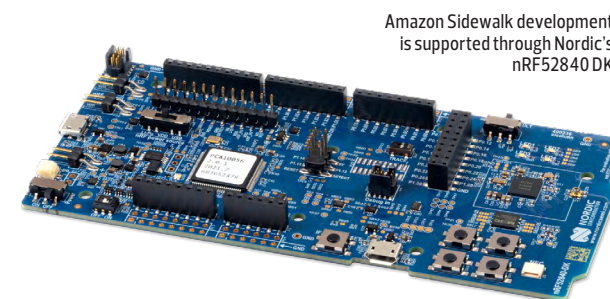
Building Amazon Sidewalk products

A combination of a Nordic [nRF52840](#) Bluetooth LE SoC and a Semtech SX1262 sub-GHz radio transceiver provides the foundation to build an Amazon Sidewalk device. The nRF52840 is the most advanced SoC in the nRF52 Series. It supports Bluetooth 5.3, and Bluetooth 5's Long Range and high throughput (2 Mbps) modes.

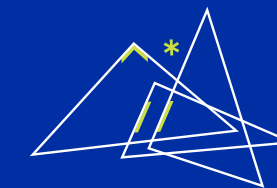
The nRF52840 uses a powerful 64 MHz 32-bit Arm Cortex-M4 processor and includes 1 MB Flash plus 256 KB RAM. The multiprotocol radio offers up to +8 dBm power output and -95 dBm sensitivity at 1 Mbps Bluetooth LE for a link budget of 103 dBm. The nRF52840 includes a full-speed (12 Mbps) USB 2.0 controller on-chip. An extensive range of peripherals are available with a number of high performance digital interfaces such as high speed SPI (32 MHz) and quad SPI (32 MHz) to allow direct interfacing to displays and external memory.

The nRF52840 uses the [nRF Connect SDK](#) for Amazon Sidewalk software development. The scalable, unified software development kit enables developers to build software optimized for size and performance on devices with limited memory, as well as more sophisticated and feature-rich software for more advanced devices and applications. The SDK can be used by developers to immediately get started on Amazon Sidewalk projects because it integrates the latest version of the Amazon Sidewalk software repository. In addition, the SDK brings developers a wealth of varied examples, including Bluetooth LE profiles and driver support for all peripherals. It supports applications using Bluetooth LE and Bluetooth mesh as well as other popular protocols.

Amazon Sidewalk applications can be evaluated using the [nRF52840 DK](#). This is a versatile single board development kit for Bluetooth LE, Bluetooth mesh, and other low power 2.4 GHz protocol development on the nRF52840 SoC. It facilitates development by exploiting all features of the nRF52840 SoC. All GPIOs are available via edge connectors and headers, and 4 buttons and 4 LEDs simplify input and output to and from the SoC. An on-board external memory is connected to the QSPI peripheral in the nRF52840 SoC.



Amazon Sidewalk development is supported through Nordic's nRF52840 DK



NORDICTECH WEBINARS

Catch all the latest Nordic webinars on-demand

HIGHLIGHTS

- Introduction to low-power Wi-Fi
- How to go to market with Matter
- Exciting new features in the nRF Connect SDK v2.3.0

WATCH NOW

webinars.nordicsemi.com/videos



Logistics & Transport

Connectivity a driving force to standardize EV infrastructure

Bluetooth LE, Wi-Fi and cellular IoT connectivity can help electric vehicle charging companies manage the complex EV ecosystem and grow clean transport

As the world transitions away from internal combustion engine (ICE) vehicles to help meet climate targets, the rollout of electric vehicles (EVs) as a viable, more sustainable transport alternative is increasing.

Government mandates and regulatory incentives have been a key driver of the growth in EV adoption. The U.S. Government is aiming to make EVs half of all new vehicles sold by 2030. And the E.U.'s Green Trucking Directive calls for 50 percent toll discounts for EVs from 2023 and air pollution charges for gas vehicles from 2026.

But deployment schedules around the world are still checkered. According to the Global EV Outlook from the International Energy Agency, Europe's Nordic nations—with Norway (86 percent) and Iceland (72 percent) at the top—led the world in global EV market penetration in 2021, while the U.S. barely made the top 20 with 5 percent EV sales as a percentage of overall car sales.

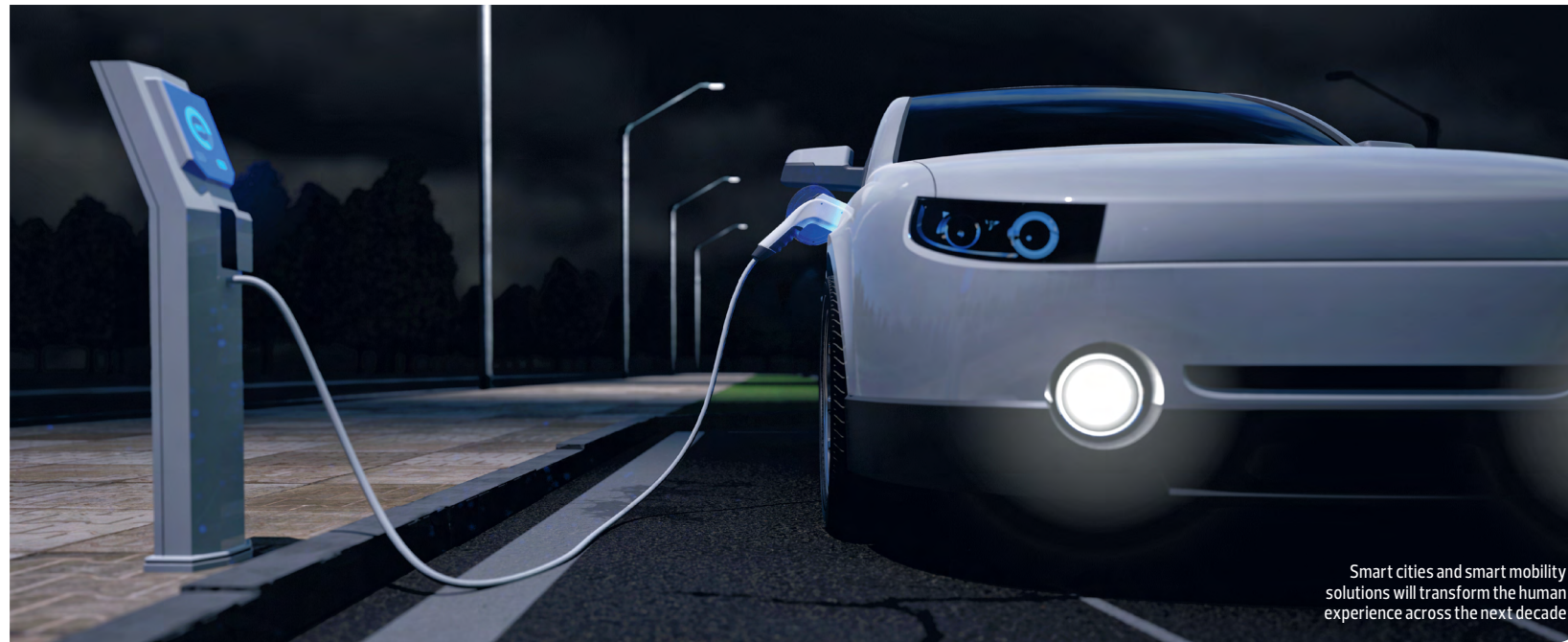
One roadblock to faster EV adoption is that infrastructure and customer experience challenges remain. The drivers of EVs rely on the availability of dedicated EV charging stations to efficiently plan their journeys. While traditional fueling stations for ICE vehicles are readily available, a much smaller network of operational EV charging stations has prevented many people from making the switch to electric. And the charging stations that do exist must be kept reliably up and running. Companies also need to continue to invest in smart charging technologies to generate faster charging options, while also reducing potential grid overload during peak charging times, says analyst ABI Research.

According to a new report, [Connected EV Charging](#), from global telco infrastructure leader Ericsson, "EV charging stations are critical to ensure a steady adoption, and there are significant business opportunities for EV charging companies and the related ecosystem."

Despite these challenges, there are signs of movement with a recent study by Berg Insight forecasting 9.7 million charging points in Europe by 2024.

The need for connectivity

As in so many other industry sectors, reliable, secure wireless connectivity to EV charging stations enhances their value proposition. Connectivity enables data to be gathered on how customers use the station, as well as the availability and condition of charging sockets. Data can be relayed to a central platform for staff to respond to disruptions or problems remotely. Avoiding potential



Smart cities and smart mobility solutions will transform the human experience across the next decade

technical issues can improve maintenance and uptime at the electrical outlet. It can also help charging companies plan when and where to scale their charging network based on demand. Data gathered can even be used to provide real-time visibility of all stations to drivers directly, helping them map out their journey.

Cellular IoT will be a driving force for the fledgling EV charging market, according to the Ericsson report. The report suggests [LTE-M/NB-IoT](#) connectivity can help EV charging companies manage the complex ecosystem of stakeholders including drivers, hardware and connectivity providers, utility companies, automotive OEMs, and asset owners like parking operators, cities and homeowners.

"By connecting charging stations with cellular IoT, EV charging companies are better positioned to effectively manage their orchestration, administration and maintenance, offering a smoother driving and customer experience," the Ericsson report stated.

A flexible approach

Cellular IoT is not the only wireless tech with a role to play in the future of EV charging. "Bluetooth LE, Wi-Fi and cellular connectivity are all needed to enable a flexible approach for EV charging stations," says Martin



Bluetooth LE, Wi-Fi and cellular connectivity are all needed to enable a flexible approach for EV charging stations

Need to Know

Initially developed for consumer electronics, the Li-ion battery type has become increasingly important for use in EVs. As more countries advance in the shift towards cleaner fuel alternatives, analyst Statista projects the global market demand for Li-ion batteries used in EVs will grow from 500 gigawatt hours in 2023 to approximately 1,525 gigawatt hours in 2030

Jannicke Ianssen
VP Organizational Development & Talent,
Nordic Semiconductor



Calling all engineers – you are in high demand

Nordic's establishment of a base in Denmark builds on the company's strategy of opening local offices to attract skilled staff

As the pandemic-induced chip shortage eases, new IoT product development is accelerating. That's increasing the demand for skilled electronics software and hardware engineers, and created human resource shortages. In response, many countries have implemented educational programs so areas that might have previously not been considered engineering hotspots are now producing thousands of highly skilled practitioners.

highly experienced cellular IoT and Wi-Fi groups. These key expansions have enabled the company to significantly strengthen its wireless technology hardware and software expertise and become one of the few companies able to offer Bluetooth LE, LTE-M/NB-IoT and Wi-Fi solutions. These engineers enhance the company's credibility and expertise in the foundation technologies of the IoT and increases customer confidence.

And now we have continued this approach by [opening-up an office](#) in Copenhagen, Denmark. The office houses a team of analog designers, while also serving as a location for attracting other talent in Denmark.

The new office is a further example of Nordic's dynamic and flexible approach to recruiting. This is helped by a distributed management structure and flat hierarchy dynamics, enabling fast decisions to secure talent.

Engineers are the lifeblood of a tech company, especially one like Nordic which places a heavy emphasis on R&D. Today, the engineering team make up over 70 percent of the company's staff. But we're always looking to strengthen. If you're interested in seeing what we need go to [nordicsemi.com/About-us/Careers](#).

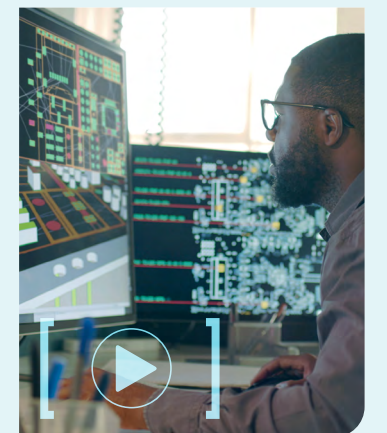
Nordic has taken a global perspective to recruitment, underpinned by the establishment of hubs where talent is concentrated

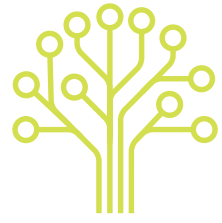
Examples are India, Turkey, Poland and Nigeria. And today's highly interconnected world means talent doesn't have to be uprooted to work overseas.

We are working hard to secure global talent because engineers are fundamental to ensuring Nordic designs and builds the products our customers need today and in the future. That's why we've taken a long-term, global perspective to recruitment, underpinned by a local presence in the regions where talent is concentrated.

In recent years, Nordic has expanded into Finland, Poland, the U.K., the U.S, Sweden and India.

By moving to where the engineers live, Nordic has not only bolstered its Bluetooth LE team but also built up





How the IoT Can Help Save the World

As we face up to the challenge of transitioning to a sustainable global economy, the IoT is providing the platform to help countries, communities and companies meet their green responsibilities

In Short

There are serious challenges to building a sustainable world, from raw material constraints to stressed supply chains and climate change impacts

As the importance of environmental sustainability grows, organizations are increasingly being mandated to be part of achieving net-zero emissions

The IoT and other smart technology form the basis of sustainable economies

Sustainability—the ability to live, thrive and advance without depleting the planet’s natural resources—has become something of a catchcry for the 21st century. But now it’s imperative the word becomes much more than a slogan or convenient rhetoric.

According to *Scientific American*, over 200 countries have shaped their environmental policies around limiting the planet’s maximum temperature rise to 1.5 degrees centigrade compared to pre-industrial levels. And yet Earth has already warmed by 1.3 degrees and, while they are only whispering it in private, climate experts collectively believe the target will be overshoot in as little as ten years, the publication reports.

A world that warms by two degrees looks a lot different to one that increases by 1.5. There would be more heatwaves, greater rainfall (although less freshwater), lower crop yields and higher sea levels. Such somber predictions make it incumbent on humanity to take meaningful action now, even if some of the suggestions seem a little extreme (see sidebar pg19 *Weird Science*). The stark reality is the planet needs us to do much more than just talk.

The good news is the hard work needed to overcome sustainability challenges is already underway. Initiatives include greener extraction of raw materials, energy-efficient supply chains, robust financial operations and labor forces that are paid fairly and kept safe. These efforts are positively impacting the ability of countries, communities and companies to adapt their economies.

Since the 1980s the pace of development in the electronics sector has outstripped that of practically any other industry. It has become a leading contributor to the economy of some countries and a major input to total industrial production in many others. And the rate of growth is showing no signs of slowing down; according to analyst Fortune Business Insights, the chip sector alone will expand from \$527 billion in 2021 to \$1,380 billion in 2029 at a compound annual growth rate (CAGR) of 12.2 percent. In part, this growth is

down to an increasing appetite for consumer electronics, but the emergence of the IoT and machine learning (ML) is leading to many new applications that are also boosting semiconductor demand.

Increased accessibility to electronics technology has improved the lives of many, and as it becomes even more environmentally-friendly, modern technology will also improve the health of the planet. New practices are being adopted for material sourcing through processing, manufacture, distribution, retail, repair and recycling. (See analysis pg21 *Making greener semiconductors*.)

Growth of electronics technology is making the management of e-waste one of the most important issues. Recycling is key. According to the UN, 20 percent of e-waste is successfully recycled today, and the organisation has announced a plan “By 2030 [to] substantially reduce waste generation through prevention, reduction, repair, recycling and reuse.”

“There’s a growing focus on supply chain sustainability in electronics and manufacturing, with an emphasis on responsible sourcing of materials and reducing the environmental impact of production,” says Linda Pettersson, Senior Vice President Legal & Compliance, Nordic Semiconductor. “Additionally, there’s a growing trend toward recycling semiconductor materials to reduce waste and conserve resources.”

DOING THE RIGHT THING

As befits a global body, the UN is helping drive the international sustainability agenda through its [Sustainable Development Goals](#) (SDGs). Created in 2015, SDGs have encouraged organizations to strive to enhance the sustainability of their practices and investments. The 17 SDGs include targets to ensure availability and sustainable management of water and sanitation (SDG 6); ensure access to affordable, reliable, sustainable and modern energy (SDG

By the Numbers

1.5°C

Target limit for global average temperature (above pre-industrial levels)

Source: United Nations Framework Convention on Climate Change

2.7x

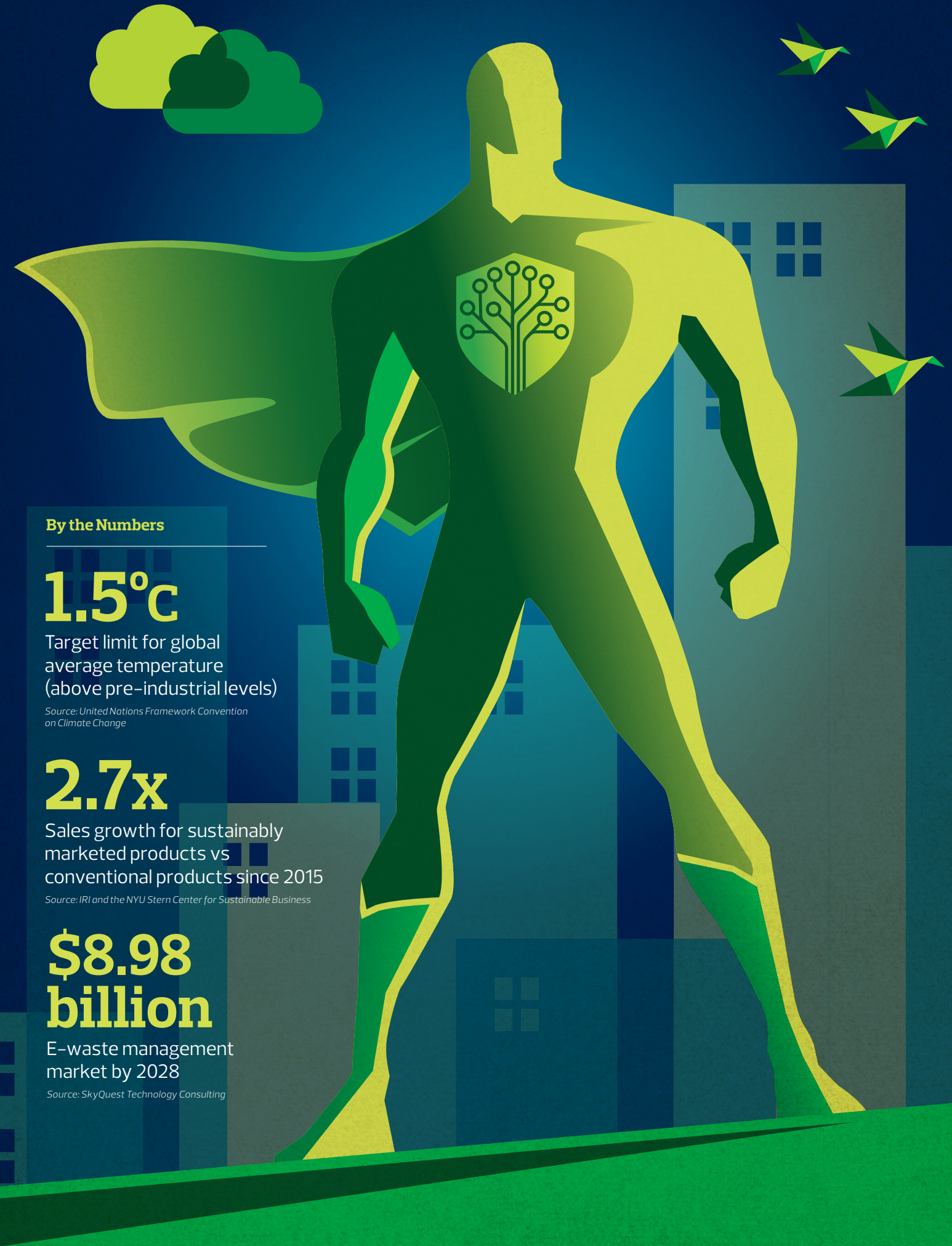
Sales growth for sustainably marketed products vs conventional products since 2015

Source: IRI and the NYU Stern Center for Sustainable Business

\$8.98 billion

E-waste management market by 2028

Source: SkyQuest Technology Consulting





7); and make cities and human settlements inclusive, safe, resilient and sustainable (SDG 11). There are also goals to promote sustainable consumption and production patterns (SDG 12) and take urgent action to combat climate change and its impacts (SDG 13), among others.

The goals themselves do not yet form the basis of enforceable legislation or provide economic imperatives for compliance; they do, however, impose specific, measurable and observable targets. And it's those targets that are motivating industry to get its act together. Companies are spending time and financial resources to enhance sustainability with the SDGs acting as the baseline for their efforts.

While the SDGs are the posterchild for sustainable action there are also regulatory frameworks and commercial dynamics encouraging firms to become greener. A greater emphasis on social responsibilities based on policies that actively promote companies' social accountability alongside profits, and which make them directly answerable to stakeholders and the public, has created sustainability ratings, new legislation and government incentives for adopting environmentally-friendly practices – or penalty fees for non-sustainable ones.

Challenges remain: "Changing consumer behavior to prioritize sustainability is a significant challenge, as old habits are difficult to break, and there are often financial barriers to



The IoT will soon generate enough savings to pay back the energy cost of its manufacture and deployment and, from then on, will save around eight times the energy it consumes

adopting sustainable practices," says Nordic's Pettersson.

But thanks to the efforts of farsighted people, there's a master plan. And it's a plan that sees electronic tech not as part of the problem, rather as a major part of the solution.

THE GREEN ADVANTAGE

In addition to enhancing a company's image, green policies can boost its competitive advantage and strengthen its bottom line. A 2019 survey by U.S. insurance company Aflac found 77 percent of consumers are more willing to purchase from companies with an environmental pledge. According to new NielsenIQ survey data, 46 percent of consumers are looking to brands to take the lead on creating sustainable change, while 93 percent of business leaders believe consumers are likely to hold businesses accountable for their environmental impact, the Environmental Defense Fund claims.

But while an individual company's action can help towards a sustainable economy, a group of organizations working together can do much more. Industry group the [Responsible Business Alliance](#) (RBA) is committed to sustainable global supply chains. The alliance has developed a sustainability code of conduct inspired by international standards, including the Universal Declaration of Human Rights, International Labor Standards and International Social Accountability Standards. The RBA drives suppliers, partners and customers to meet similar environmental responsibility goals, influencing every part of the process through sustainable practices.

The more than 170 members of the RBA have now also committed to driving sustainable value for workers, the environment and business throughout the global supply chain. Members, including Nordic, are accountable to a Code of Conduct. "For corporations, change begins with enhanced visibility and control of the supply chain itself," says Pettersson. "RBA members are more likely to require their suppliers, partners and customers to meet similar green goals by following the RBA Code of Conduct, which sets a baseline for all relevant areas including business ethics, diversity, non-discrimination, workers' rights and privacy." (See [WQ Issue 3, 2021 pg12](#).)

As the importance of environmental sustainability grows, organizations are increasingly being mandated to be part of the transformation toward achieving 'net-zero'—or even carbon negative—objectives. It is working, says analyst ABI Research. The company notes that regulations addressing climate change and environmental impact are influencing greener corporate and product business strategies. For example, the German Supply Chain Act, which came into force in January 2023, and the E.U.'s proposal for Corporate



Sustainability Due Diligence Directive are proposing or requiring companies to conduct due diligence on their value chains, while assessing environmental risks such as pollution, carbon emissions and biodiversity loss. Furthermore, mandatory climate risk reporting has been introduced in the U.K, the U.S., the E.U., Japan, Brazil, Hong Kong, New Zealand, Singapore and Switzerland.

THE CIRCLE OF (PRODUCT) LIFE

Changing how we do business at the corporate level is going to help, and new business models are helping too. The old trend to introduce new products every few years has gone and in the process it has dramatically decreased the volume of e-waste. Sleek new products are designed to last instead of being thrown away after just a few years. One example, reported in *The New York Times*, is the Fairphone 4 made by an Amsterdam company of the same name. The smartphone has a plastic cover that can be easily removed to expose its internal components. And those components can be replaced in minutes by removing a few ordinary screws.

Other manufacturers are making it easier to fix broken products—meaning trivial faults no longer put expensive devices permanently out of commission—and simplifying disassembly at the end-of-life to aid recycling. It all helps to build a sustainable economy and the smartphone makers

Industry Viewpoint:

Theodor Rohde
CEO,
Lobaro



Linda Pettersson
Senior Vice President
Legal & Compliance,
Nordic
Semiconductor



The IoT has a major sustainability problem when it comes to batteries. We talk about the promise of a massive IoT, but we have to consider how we are going to power it. Replacing or recharging batteries in billions of devices is so impractical it isn't even an option. Instead, as soon as the battery is empty the device is written off and scrapped, creating further waste. As an industry we have to increase our investment in harvested solar energy.

My company was the first manufacturer to launch a completely solar-powered NB-IoT and LoRaWAN gateway that enables the remote wireless reading of consumption meters. The combination of a supercapacitor, sophisticated firmware and a custom solar cell make it possible for the device to be completely battery free. We have shown that a single 13 by 13 cm solar cell provides more than enough energy to power a gateway or sensor reporting data every hour year round, 24/7, even in winter. Even indoors with only a little daylight, it is already feasible to power IoT devices without disposable batteries.

A battery-free future for the IoT is possible, but the responsibility for it doesn't lie with the end customer, it lies with the hardware developer to design battery-free solutions.

Nordic Semiconductor has a history of investing in sustainable practices. While these practices have positive side-effects such as lowering operating costs, ensuring we comply with regulatory requirements, and mitigating business risks, more importantly they reduce the company's carbon footprint and help to conserve the planet's precious resources.

Nordic is part of a highly-interconnected supply chain where much of the sustainability responsibility lies directly with its suppliers and customers. But we do work very hard to implement sustainable practices where we have direct control, and we do work hard to engage with partners on their efforts to do things in a greener manner.

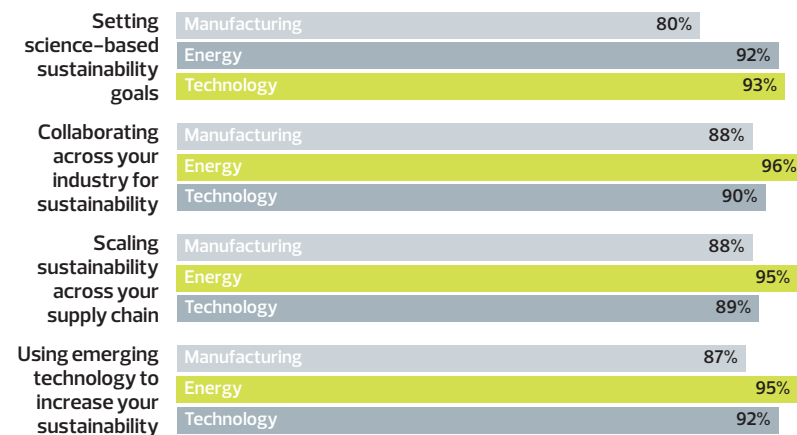
Our [sustainability focus](#) is on continuing to develop energy-efficient chips that together with optimized manufacturing can reduce waste and emissions, and increase the use of renewable energy. And we are committed to helping our customers find ways to use our energy-efficient chip technology in innovative solutions that support and promote sustainability.

There are still challenges for Nordic, our customers and the industry, to overcome. But overcome them we must to create a sustainable future.

State of Play

Executives embrace sustainability leadership

Business leaders across industries are under pressure to meet green targets. Among CEOs and VPs surveyed in 2019, seven in ten said they felt the push from customers and investors to make sustainability a strategic priority for their organization, and eight in ten noted coercion from regulators. According to the research by the Environmental Defense Fund, this is how manufacturing, energy and technology executives are embracing the pillars of sustainability leadership:



Source: *Business and the Fourth Wave of Environmentalism* report – Environmental Defense Fund.



are not alone in their good endeavors. New PCs, TVs, tablets and wearables are among the consumer products that now offer longer life and easier recycling.

Manufacturers are embracing a circular economy concept. The concept aids sustainability through strategies based on the five 'Rs'—reduce, reuse, repair, recycle and restore—and has the potential to contribute to multiple UN SDGs.

According to [The Connected Consumer Report 2030](#), produced by business think tank The Future Laboratory for Vodafone Smart Tech, so-called smart circularity—the circular economy as it relates to connected technology and the IoT—can help the world shift away from linear consumption to an economy where resources are fed back into a closed loop of recycling, reusing and sharing.

By 2025, improved resource productivity could deliver an annual net material cost saving of \$600 billion in Europe alone, according to the Ellen MacArthur Foundation, and cut greenhouse gas emissions by 39 percent.

To reach these ambitious targets, chip makers and electronic device manufacturers are playing a critical role. Tech products now emphasize reusability, and developers consider recyclability and multi-purpose use in their designs from the beginning.

Consumers can expect new devices to be compatible with several generations of previous technology. This forward and backward integration is cutting down on e-waste and discouraging over-consumption. Meanwhile, tech advances such as over-the-air firmware updates increase end-product longevity, ensuring users don't have to buy new

Need to Know

Nordic Semiconductor takes its green responsibilities seriously and has aligned its policies with the RBA Code of Conduct sustainability goals since 2007. As a result, Nordic has been recognized as one of the top 100 companies by STOXX Global ESG Leaders Index, a benchmark for sustainability champions



hardware to access the latest software product features. *The Connected Consumer Report 2030* also notes beyond the electronics design and manufacturing community, IoT technology can also help the whole of society embrace smart circularity with the potential to transform how we view and manage consumption. (See [WQ Issue 4, 2022 pg12](#).)

Planned obsolescence in all its guises—from contrived durability and repair prevention to software lockouts and batteries that can't be replaced—is now consigned to history.

TECHNOLOGY TO THE RESCUE

While consumers and corporations are changing their habits, protecting the planet and its resources for tomorrow will also need widespread deployment of new technology. The UN already recognizes the transformative power of tech; its 2030 Agenda for Sustainable Development states: "The spread of information and communications technology, and

global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies, as does scientific and technological innovation across areas as diverse as medicine and energy." But how exactly to turn that progress, knowledge and innovation towards the sustainability challenge?

The IoT will form a foundation platform for sustainable tech. But first it needs to be fully rolled out and that will incur an energy cost. Will that cost be worth it? A Transforma Insights and 6GWorld report, *Sustainability in New and Emerging Technologies In 2030*, highlights how building the IoT from now until 2030 will significantly increase global electricity use, and 112 million cubic meters of water will be consumed during the manufacture of IoT-enabled solutions until that time. Hydrocarbons used for the distribution and deployment of IoT solutions will add to the cost.

Yet the Transforma report concludes that the positive environmental impact of IoT applications will make the cost well worth the initial sacrifice. In fact, IoT technology will soon generate enough savings to pay back the energy cost of its manufacture and deployment and, from then on, will save around eight times the energy it consumes (see [WQ Issue 1, 2022 pg12](#)). IoT devices will also conserve nearly 230 billion cubic meters of water in 2030, the report says, with 35 percent of this impact coming from improved water grid operations and the balance boosted by IoT-enabled agricultural applications such as smart irrigation (see [WQ Issue 3, 2022 pg14](#)).

The benefits of big data are also expected to be crucial in justifying the IoT's environmental footprint. When combined effectively with, for example, ML applications, the IoT will generate swathes of information to help people and organizations better understand their energy costs and make informed environmental decisions (see case study pg18 *Better waste management using the IoT*). Moreover, the key green benefits of the IoT will largely come from enterprise solutions, which are generally associated with efficiency savings – often in the form of reduced electricity consumption leading to lower carbon emissions (see case

“ There is a growing focus on supply chain sustainability in electronics and manufacturing, with an emphasis on responsible sourcing of materials and reducing the environmental impact of production

Case Study: Better waste management using the IoT

Even in a completely sustainable world there will be some waste which must be carefully treated and disposed of. Some of the companies that do this important work are customers of German firm [adhoc networks](#). The firm is helping the business of trash itself become more sustainable by releasing a Nordic [nRF9160 SiP](#)-based smart waste management solution.

The system is capable of remotely measuring fill levels in waste containers which enables waste management businesses to better allocate collection resources and avoid overflow. The smart device uses optical sensors to monitor the fill levels of a variety of different containers, including

underground waste systems which present additional monitoring challenges through reduced visibility and increased storage volume.

The monitoring process is overseen by Nordic's nRF9160, which then collates the data and sends it to the Cloud, using its cellular IoT connectivity. Users can then view this information through the centralized web platform, manage waste container assets, as well as review current and historical data. The platform can also perform self-learning fill level prediction modeling and offers dynamic route simulation to optimize collection crew productivity.

"Our platform has been tailored so customers can easily manage their container fleet and conduct dynamic routing based on fill levels," says Christian Wedekind, Senior Product Manager at adhoc networks. "This helps save resources and reduces CO₂ emissions by only scheduling waste collection when containers are actually filled. With our solution, emissions in waste disposal businesses can be reduced by up to 40 percent."



The company is supporting a sustainable economy by choosing low power technology to maximize battery usage. "Battery life was a very important factor as the product is designed to be used on a large number of containers, meaning the less we have to change the battery, the better," explains Michael Ebert, Senior Embedded Developer at the company. "As such the extended lifetime enabled by the nRF9160 SiP was a major drawcard for us."



Weird Science

Alex Osborn, the father of the creativity technique we know today as brainstorming, was a firm believer that there was no such thing as a bad idea. For successful brainstorming, he said, participants had to suspend judgement. But even Osborn's faith may have been put to the test by some of the less well considered ideas proposed in the last 15 years when it comes to slowing climate change, promoting sustainability and fighting pollution.

For example, back in 2011, U.S. Republican politician Dana Rohrabacher suggested clear cutting the world's forests as a means to eliminate greenhouse gas emissions. Cutting down the forests, he said, would get rid of 90 percent of emissions generated by nature itself. Then there are the proponents of pouring iron into the oceans to stimulate the production of CO₂-eating phytoplankton. The only downside is it creates algal blooms loaded with a brain-damaging neurotoxin.

But not all off the wall environment-saving ideas are a crazy as they sound. For example, one Belgian NGO is using human hair to absorb environmental pollutants. The company collects clippings from hairdressers and feeds them into a machine that turns our hair into matted squares. These squares can be used to absorb oil and other hydrocarbons polluting the environment. A single kilogram of hair can absorb seven to eight liters of oil and hydrocarbons, according to the developers.

Meanwhile, earlier this year, astrophysicists from the University of Utah proposed a plot fit for Hollywood to create a solar shield in space in order to deflect the sun's rays away from Earth. How does it work you ask? Simple really. Go to the moon, start mining for millions of tons of dust, and then ballistically eject it about one and a half million kilometers into space from a massive electromagnetic railgun. Sitting between Earth and the sun, the dust particles would partially block incoming sunlight.

Improbable though the solution might be, the science is sound. Natural lunar dust grains are exactly the right size and composition for scattering sunlight, and it would take significantly less energy to launch from the moon's surface rather than from Earth. Maybe there really is no such thing as a bad idea.



study below, *Smart lights cut carbon emissions*) or reduced fuel or water consumption, for example through smart electricity grid operations. (See [WQ Issue 2, 2021 pg22.](#))

On more modest scales, innovative developers are doing their bit to use the IoT to create solutions that cut down the total amount of resources the world consumes. For example, the Smarter Sustainable World Challenge with Nordic Semiconductor competition—launched in conjunction with hardware education community [hackster.io](#) (an Avnet company)—called upon participants to plan, design and prototype cutting-edge solutions that reduce humanity's ecological footprint using the power of sensors and wireless connectivity. Participants were provided with the Nordic [Thingy:53](#) multiprotocol prototyping platform to help them realize their innovative ideas.

The overall winner, Elijah Maluleke from South Africa, created a smart water tap leakage controller that automatically closes a valve whenever there is an abnormal flow of water through the water tap. The volume of water saved by using the IoT device, when scaled to millions of water sources, would have a huge impact on conservation efforts. Another entrant, Mateusz Pająk from Poland, used the IoT technology to create a vertical self-regulating soilless farm built to fight the food storage crisis and at the same time achieve maximum yield.

Nordic corporate customers are also sustainably developing innovative solutions to help other businesses and communities work towards a greener future. One example is China-based [MOKO Smart's](#) MK117NB Smart

Nordic has continually lowered the power budget of its wireless solutions without compromising performance

Plug, a Nordic-powered Bluetooth LE/cellular IoT electricity plug that can be used to monitor energy usage and save power consumption by remotely controlling load switches. Another is Canadian technology firm [AquaSensing's](#) Leak Sensor 1.0, a battery free, self powered leak detection device using a sensor as both its power source and for detecting water leaks. The solution harvests energy from any fluid ingress to power the Nordic [nRF52832](#) SoC that wirelessly connects to a smartphone, from where the user can receive alerts of active leaks via an accompanying app.

The flexibility built into Nordic IoT solutions—which are used in millions of IoT applications optimizing resource usage in areas of energy, travel, transport, agriculture, manufacturing, waste handling, smart cities and more—makes it easy to customize the trade-off between duty cycle, throughput and battery life to suit the needs of the application. Nordic also builds its hardware to last for years, backwards compatible with previous generations of

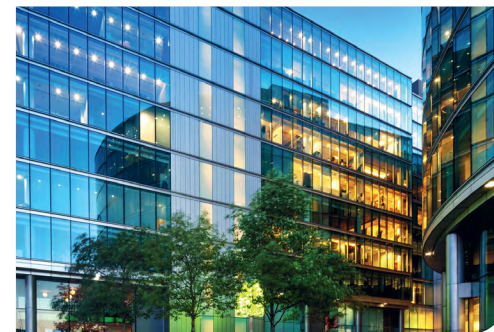
Case Study: Smart lights cut carbon emissions

The glowing filament of traditional incandescent bulbs turned only around 5 percent of the electrical energy powering them into light. Fortunately, the devices have now largely been consigned to museums. Today lighting companies have turned to the LED. These devices generate photons through electroluminescence and use about 15 percent of the energy of an incandescent bulb to generate the same amount of light and last up to 30 times longer.

According to the U.S. Department of Energy, lighting accounts for 5 percent of worldwide greenhouse gas emissions. The organization says a wholesale [shift to LEDs could reduce CO₂ emissions](#) by 800 million tonnes per year, the equivalent to shutting down 684 coal-fired power stations.

That's a big step towards sustainability. But even better results can be gained from teaming LEDs with wireless connectivity to allow smart control such as automatically turning down the lights when external conditions are brighter, or cutting illumination when people leave the room. The energy saving results are even better when the wireless controllers are themselves optimized for the lowest power consumption.

This is why U.S. smart lighting and building solutions company, Acuity Brands, chose Nordic's Bluetooth LE SoCs for its smart lighting controllers. The company estimates by pairing Nordic's ultra low power technology with solid-state lighting it has [saved over 2.3 million tonnes of CO₂ emissions](#) from six million of its smart lighting deployments since 2016. The CO₂ emission reduction is based on a calculation of lower fossil fuel-generated energy consumption of the new Acuity lights compared with the energy consumption of the previous lighting solutions.



Acuity says the Nordic Bluetooth SoCs played a critical role in reducing the power consumption of its smart luminaire lighting fixtures by 40 watts while they're in use. "Sustainability requires every single joule of energy to be conserved... and Nordic wrote the book on energy-efficient short-range wireless chips. The [company's] SoCs allowed us to maximize [carbon] savings," explains Adam Handler, Director of Corporate Sustainability at Acuity Brands.



Analysis:

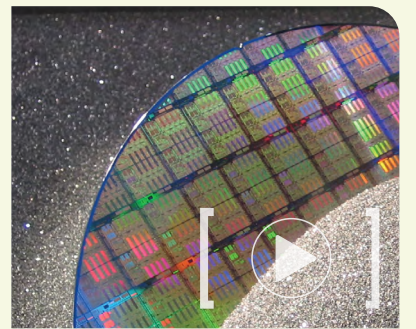
Making greener chips

Rolling out a dense global IoT network comes with an ecological cost. What's being done to lower it?

The distributed intelligence of the IoT is founded on the chemical element silicon which is used in the manufacture of semiconductors. The elemental form of silicon is rare – but locked-up in rocks as silicon dioxide (silica) it is the second most abundant element in the Earth's crust (after oxygen). The raw material is typically extracted from sand, which is mined from lakes, riverbeds and coastlines, or from quartzite, a silica-rich rock. The mining process is not without an environmental footprint, but it is nowhere near the scale of that for materials such as iron ore.

There are some options for making silica extraction a little greener. For example, sugarcane contains significant amounts of silica taken up from the soil as the plant grows. Work is under way to find ways to economically extract the silica from the waste products of sugar refining. Other plant waste, for example that from wheat, corn and sunflowers, also contains significant amounts of silica.

A bigger environmental challenge arises when converting the silica into



renewable energy since 2018 and the company reused half its water in 2021.

Foundry silicon is about 99 percent pure – good enough for most uses outside of electronics (for example, for alloying with aluminum and iron) but not for chips. To raise it to the 'seven nines' (99.99999) purity needed for semiconductors requires a process that includes mixing the elemental silicon with hot, gaseous hydrochloric acid to turn it into a gas called trichlorosilane. This gas and hydrogen are then pumped into a reaction chamber using electrodes heated to 1150 degrees centigrade. The gas then decomposes onto the electrodes as seven-nines silicon. The main environmental cost is that the process consumes a lot of energy to keep the electrodes hot.

However, a lower energy option is being developed for mass production. Based on a fluidized bed reactor it does away with the energy-intensive electrodes – instead using heated and fluidized silicon powder onto which the trichlorosilane gas can decompose into the highly purified silicon.

While the chip industry works diligently to clean up its act, it is already way down the list of major carbon emitters. Tech publication *Arstechnica* reported that the total ICT sector was responsible for between 1.8 to 3.9 percent of global greenhouse gas emissions in 2021. Beef production, by comparison, was responsible for 9 percent.

its products. Software is continuously upgraded to include new features and easily downloaded through over-the-air software updates. These upgrades make it simple for customers to enhance the performance and lower the energy consumption of products in the field.

STRIVING FOR A BATTERY-FREE WORLD

Network equipment provider Cisco suggests that in as little as a decade, there could be more than 50 billion wireless and cellular IoT sensors. Many of those will be powered by batteries. Apart from the maintenance issues—even if each cell lasts for a decade, technicians across the globe would still be faced with changing millions of batteries every day—those cells threaten to undermine the IoT's sustainability credentials. Exotic materials such as lithium must be mined, the cells must be fabricated, then distributed around the world, and then there's the major problem of safely disposing of them once exhausted.

Nordic has continually lowered the power budget of its wireless solutions without compromising performance. Such is the modest power consumption of its latest generation of products that, in certain applications, energy from harvested sources alone is sufficient to power the end-product.

Tomorrow's wireless solutions will be even more efficient, dramatically extending the range of applications that will be able to harvest all their energy from the environment. And a new generation of power management ICs (PMICs), customized for energy harvesting devices, will stabilize the variability of harvested-energy sources and play a significant part in freeing IoT products from batteries.

While the potential for a thriving connected world is huge, we must ensure sustainability is built into everything we do. It's clear the challenges are immense, but the stakes are even higher. But by no longer simply taking, making, using and disposing, we are adopting a better way.

Together with clever engineers, progressive politicians and savvy consumers, the IoT can ensure sustainability becomes a part of everything we design, manufacture, use and discard. We have the technology, we have the tools, we have the motivation and we still have a beautiful planet. All we need to do now is work together to keep it that way.

Warehouse Rave

Warehouses are rapidly adopting IoT solutions to meet the challenges of the huge global shift towards online shopping

In Short

Demand for online shopping has seen the addition of millions of square meters of new warehouse space and more varied and dynamic product holdings

To meet the challenges of the new digital landscape, operators are turning to technology to build warehouses that are smarter and more optimized

IoT sensors are helping find products faster using technologies such as Wi-Fi locationing and can also help detect changes in product quality, identify damage and prevent workplace incidents

A few years ago, dozens of malls and retail outlets in the U.S. began shutting, one closure after the other. Not long after, warehouses and fulfillment centers sprouted up in those very same locations.

Demand for online shopping had begun to take hold, and with it, intense demand for warehouse space from a growing number of online retailers and logistics providers. Between 2016 and 2019, 734,000 square meters of retail space—including Walmart and Target stores and cinemas—was converted into one million square meters of industrial warehouse space, according to U.S. broadcaster *CNBC*.

When COVID hit, this nascent trend became a tidal wave. Lockdowns forced even larger swathes of retailers globally to lock up their shopfronts and shift aggressively to digital channels. In the first year of the pandemic alone, the share of e-commerce grew at two-to-five times the rate it had grown prior to 2020, according to McKinsey. Online retail figures everywhere — be it the U.S., U.K., Asia, or Latin America all told a similar story.

To support the shift online, major changes also needed to take place on the ground. Millions of square meters of new warehouse space were acquired and created to support the increased retail demand. Warehouse occupancy by retailers in the U.K. alone increased more than 600 percent, according to the U.K. Warehousing Association (UKWA).

For warehouse operators there'll be no turning back — three-quarters of people who used digital channels for

the first time during the pandemic will continue in this vein, says McKinsey. It's estimated that 140 million square meters in new warehouse space will be needed globally to meet the rise in e-commerce sales.

As well as the addition of new facilities, the typical individual warehouse is expanding, by more than 140 percent in some parts of the globe. Amazon's largest ever warehouse, measuring 381,000 square meters, is now being built in California.

Warehouse operations will need to modernize fast in response to the growing size and number of warehouses. Storing goods in their designated places in the warehouse and locating those goods to retrieve them for packaging and shipment are already intensive and exhaustive processes. Employees spend about a third of their shifts just moving around inside the building. With larger tracts of floor space for workers to cover, a shrinking labor pool, and inventories expanding in line with the growth in online shopping, these numbers risk blowing out unsustainably.

Supporting the dynamics of online shopping, warehouses today must also support smaller and more frequent orders and work with more varied products lines and unpredictable buying patterns.

A PERFECT STORM FOR IoT

To meet all these demands, leading operators are now turning to technology to build warehouses that are smarter, safer and more optimized. A prime example of this is Amazon's Industrial Innovation fund, a \$1 billion corporate venture capital investment for projects to improve outcomes in warehousing, supply chain and logistics. Analyst Frost & Sullivan also predicts the warehouse automation market will double to \$27.2 billion by 2025.

U.K. newspaper *The Economist* says the imperative to introduce automation and robotics in the warehouse sector as labor pools shrink is a "watershed moment". Other analysts have described the situation as a "perfect storm" for IoT, a rapidly maturing technology with a track record for precisely solving the kinds of problems affecting the warehouse sector. These include improving visibility of physical assets, enhancing efficiency and condition monitoring, and delivering rich data-driven insights using



Warehouses today must support smaller and more frequent orders and work with more varied products lines and unpredictable buying patterns

sensors, connected networks, location services and machine learning (ML) capabilities.

Let's start with the [challenges of locating goods in ever larger warehouses](#). Connected sensors placed on warehouse assets can provide workers information about the precise locations of products, allowing them to locate and retrieve those products more efficiently. Sensors installed throughout a warehouse can also support the building of 'digital twin' applications that provide workers with information about how best to access key locations.

Several IoT technologies support these location needs. Wi-Fi locationing is one geolocation solution that is suited for asset tracking in indoor environments. "In addition to the high propagation of Wi-Fi signal strength, one of the benefits of Wi-Fi locationing is the ability to build off the warehouse's existing Wi-Fi connectivity infrastructure," says Clay Hine, Business Development Manager — Asset Tracking at Nordic Semiconductor. Devices such as Nordic's [nRF7002](#) Wi-Fi 6 companion IC, when built into an asset tracker, use the known location of the warehouse's

Wi-Fi access points to provide an accurate location of a given asset, Hine says. Nordic's chip provides fast and reliable connectivity, and low power consumption.

Bluetooth LE beacons, when taking advantage of features such as the [Nordic Distance Toolbox](#)—which uses phase based measurements to get more accurate distance values compared with conventional received signal strength indication (RSSI)—offer another option for low power, cost effective indoor location finding. The ubiquity of Bluetooth in smartphones gives warehouse workers easy access to tech that helps them locate assets. Hine adds that Bluetooth Direction Finding, supported by several Nordic SoCs, delivers centimeter-level indoor positioning and location (see [WQ Summer 2019 pg26](#).)

As well as improving the ability to locate goods, Bluetooth LE beacons can help warehouses preserve product quality. By combining accelerometers with sensors in the beacons placed on goods, warehouse operators can detect incidents of drops, impact or other disruption to products. Other sensors, used in combination with Bluetooth LE, can



Tech Check

U.K. firm [System Loco](#)'s asset tracker, LocoTrack HGC4, is embedded in transport pallets. The device includes a temperature sensor and an accelerometer. The product uses Nordic's [nRF52840](#) SoC as part of GNSS, Wi-Fi, Cellular IoT and Bluetooth LE location techniques to indicate the position of the pallets



[Semiconsol](#)'s LINT device uses Nordic [nRF52833](#) SoC for Bluetooth LE connectivity and location finding. LINT is suitable for a wide range of indoor industrial or enterprise asset monitoring. The device supports applications including indoor tracking, navigation, asset management, and condition monitoring



[Estimote](#)'s Anchor Beacons can be placed in fixed corner locations in a facility and use ultra wideband (UWB) technology to compute their relative position and map the dimensions of the warehouse. Assets with UWB tags automatically appear on the digital map





also detect temperature or humidity changes, ideal for warehouses that store perishable goods.

Once warehouses get started with IoT automation, the benefits quickly flow. Sensors can turn warehouse shelves into smart shelves that can detect and broadcast information about stock levels, product displacement or theft, improving inventory management. Beacons can communicate with driverless robots and forklifts, helping them move more efficiently and safely around the aisles.

Further, the IoT can monitor the performance of critical equipment, by collating sensor data about the operation of key parts and using ML to detect and predict failure.

TUNING UP FOR THE FUTURE

A compelling extra benefit that comes with introducing IoT to solve problems such as locating assets, are the rich and broader insights that can be gleaned from the data generated by sensors. In the 'smart warehouse' context, sensor data about the location and movement of products, and even movement of workers and machinery, can help operators optimize operations.

By using ML and AI, operators can identify potential bottlenecks in the movement of goods and calculate more efficient routes for workers and machinery – supporting both productivity gains and reducing risk of collisions and accidents. AI technologies can also use data on product retrieval frequency to optimize where products should be located for most efficient storage and retrieval.

Establishing an IoT platform also positions warehouses to capitalize on further innovative integrations as complementary technologies advance. For instance, as enterprise wearable technology becomes more prevalent, connected products or warehouse shelves could communicate with a worker's wearable smart glasses to guide them to the exact location of a product.

And many of the benefits of warehouse IoT will extend beyond the warehouse and into the supply chain. Data about inventory levels could be fed to manufacturing facilities to ensure further production or ordering of raw materials occurs on a just-in-time basis, supporting lean manufacturing and sustainable economies (see *this issue pg14*).

By the Numbers

140 million m²

The warehouse space that will be needed globally to meet the rise in e-commerce

Source: CBRE

30%

Average time employees spend traveling inside a warehouse during a shift

Source: ReadWrite

\$27.2 billion

Size of the global warehouse automation market in 2025

Source: Frost & Sullivan

Tech Check: Boxing Clever

When COVID-19 struck, e-commerce in Europe jumped 71 percent. In Asia it rose 82 percent. Warehouses were suddenly brimming with online orders needing fulfillment. To have a hope of meeting demand, companies have had to embrace wireless tech in an effort to keep pace

At the heart of the wireless warehouse are beacons employing [Bluetooth Direction Finding](#), [Ultra Wideband \(UWB\)](#) or a combination of both to support accurate and reliable location systems. Bluetooth Direction Finding beacons use Angle-of-Arrival technology to identify the location of tags on pallets and parcels with precision. UWB systems use Time-of-Flight of the RF signal to establish the exact distance between the beacon and the target tag

Amazon's warehouse near Ontario, California will have a floor space about a fifth the size of Disneyland. Little wonder then that sometimes things can go missing. In the predigital age, tracking assets indoors was a laborious, error-strewn manual process, often resulting in forlorn packages. Now, asset trackers including a [Wi-Fi](#) radio and [nRF Cloud Location Services](#) can reveal the position of boxes relative to Wi-Fi access points. Moreover, the Bluetooth Direction Finding angle of arrival feature estimates the distance and angle of a tracking device from a known fixed point such as a beacon

Illustration: Greg Bakes
http://www.illustratorstudio.com/portfolio/greg-bakes/

Every year, around a billion dollars worth of consumer goods are subject to shipping damage, and who picks up the bill can be a contentious and litigious blame game. Cellular IoT devices paired with GNSS and nRF Cloud Location Services, and using a host of sensors, can track and monitor assets in real time. The tech enables end-to-end supply chain monitoring and ensures freight companies and consumers can identify the party responsible for any damage

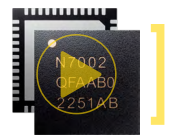
[Tracking moving assets](#) using GNSS is precise but energy intensive – which drains batteries. Wi-Fi locating using the known position of access points is less accurate but saves power and works where GNSS doesn't, for example, indoors. Single-cell locating uses a nearby base station for a coarse location, while saving battery power. Using more towers aids precision. Nordic's nRF Cloud Location Services optimally manages the trade-off between accuracy and power

Warehouses aren't just full of things, they're full of people too, and wireless access management systems can keep both boxes and personnel safe and sound. Bluetooth LE and cellular IoT-based [wearables](#) can ensure only authorized staff gain facility access, as well as report staff location to the Cloud in real time or trigger location-based alarms. Paired with multiple sensor inputs they can also discriminate between a legitimate access attempt or a break-in

The average warehouse can ship up to 200,000 boxes a day during a peak holiday season, which makes a warehouse manager's job of coordinating incoming and outgoing stock, reconciling orders in databases, and managing teams of warehouse staff a busy one. Employing wireless tech in the form of [Bluetooth LE](#) or Wi-Fi enables management staff to constantly track movements in real time via web-based warehouse management software running on tablet computers

Some robots may soon be smart enough to take over the world, but others are simply happy to follow instructions. Warehouse robots are designed to augment human labor by performing various tasks from picking and palletizing to transportation. With next-gen 3D LiDAR, robots will be able to identify obstacles – such as humans – and pick the best path around them. They will also be able to detect vertical drops – thus avoiding a damaging plunge off the edge of a loading dock

The nRF7002 Wi-Fi 6 companion IC is the ideal choice for implementing low power Service Set Identifier (SSID) Wi-Fi locating. SSID Wi-Fi locating supplements GNSS- or cell-based locating by providing accurate positioning in warehouses with a high density of Wi-Fi access points



The Digital Aged

As the world's population ages, pressure is mounting on health and assisted living facilities to provide adequate care to seniors. Cellular IoT-based remote monitoring solutions are plugging the gap

In Short

Remote monitoring tech is increasingly offering solutions to keep older people out of hospital and aged care and in their home for longer

The pandemic has accelerated adoption of wireless healthcare solutions, however people over the age of 60 are under represented amongst the user base

Cellular IoT is gaining traction for remote monitoring devices as it is reliable and secure, and eliminates the need for a smartphone, gateway or user intervention

Stereotyping older people is a risky business. Against every cliché of infirmity, it takes less than a minute to find a video on the Internet of someone's 85-year-old grandmother skydiving, or a bare-chested retiree flexing his abdominal muscles. So while stereotypes are best avoided, certain maxims about the older population generally hold true, not least a dislike of hospitals. While not many of us of any age like a trip to hospital, statistically at least, people over the age of 65 are much more likely to end up there.

And it doesn't have to be a hospital. Moving from your own home into a residential aged care facility is a step many are understandably reluctant to make. Moving out of your long time family home, loss of independence, boredom, being alone or forgotten, are all frequently cited reasons for resisting the move. On the other side of the ledger are the realities of aging and the associated risks – falls and accidents, forgetting important things like taking medication, and not eating properly, for example, all of which can result in that unwelcome trip to hospital.

Nothing can reverse the march of time and the aging process, but technology is increasingly offering a means to keep people out of hospital and out of aged care in certain circumstances. Even before the COVID-19 pandemic

that put unprecedented pressure on hospital beds and healthcare systems worldwide, the delivery of healthcare services was already transforming into one increasingly relying on technology- and data-led 'virtual' care, remote from hospitals or doctor's surgeries. While technology adoption may have been accelerated by the pandemic, a significant barrier to adoption has been that many older adults distrust or simply don't understand technology, making it difficult to practically implement.

While technology use has grown markedly among the over 65s in the last decade, today still only 61 percent of U.S. people in that age bracket own a smartphone, while only 75 percent are Internet users, according to a recent study by Pew Research. This compares poorly to 18 to 29 year-olds where both smartphone ownership (96 percent) and Internet usage (99 percent) are for practical purposes, universal. In the case of wearables, older Americans are even less well represented, with only 19 percent of over 55s owning such a device in 2021, according to Statista.

TECHNOLOGY AT ANY AGE

Increasing the adoption of technology solutions that can assist older people to stay in their own home—or help residential aged care facilities provide more effective care despite staff shortages—should neither rely on smartphone ownership nor a graduate qualification in wireless communication.

"Digitalization is one of the most powerful drivers and potential enablers of positive change across generations toward healthier aging populations," says Jane Barratt, Secretary-General of the International Federation on Ageing. "The pandemic has served as a propellant accelerating the adoption of devices, models and digitalization faster than might have otherwise occurred, [and] digital access at home and in facilities is now equally critical to our capacity and quality of life."

Unfortunately, the benefits of technology have been divided highly unevenly between different generations (see State of Play pg28 *A healthcare tech age divide*). Digital healthcare tech has to be widely available and useable by the demographic most in need of its benefits.



Yet of the people who use healthcare wearables, for example, only 15 percent are over the age of 65, according to the *Journal of Medical Internet Research*.

The solution, according to the American Association of Retired Persons (AARP), is to design the technology to suit the needs of this population group, and to democratize technology by simplifying its use for everyone. Developers are listening.

ELIMINATING THE MIDDLEMAN

While [Bluetooth LE](#) remains the most popular wireless technology for connected [wearables](#), [cellular IoT](#) is gaining traction in health-related wearable devices as it removes the middleman, doing away with the need for a smartphone or a gateway and enabling continuous monitoring without the need for intervention on the part of the wearer. For older people this is of enormous significance – no pairing, no smartphone, no remembering passwords for Wi-Fi networks, just data sent reliably and securely to the Cloud.

Reassuringly for what can amount to life and death applications, LTE-M and NB-IoT low power cellular IoT provides the gold standard in reliable and secure connectivity. In terms of coverage, operators have rolled out networks across the globe with the same country-

wide coverage as their mobile phone networks. This means most of the industrialized world—and an ever-increasing proportion of developing countries—offers ubiquitous NB-IoT and/or LTE-M coverage.

Cellular IoT is also about the most secure communications technology around, with baked-in security features as part of the 3GPP standards. Additional security can also be applied at the chip level with devices that offer a secure-by-design product development process. For example, Nordic Semiconductor's nRF9160 low power SIP with integrated LTE-M/NB-IoT modem makes use of Arm TrustZone's and Arm CryptoCell's additional layers of security for Internet-level encryption and application protection. This level of security is reassuring to both developers and consumers, particularly when it comes to healthcare wearables handling and transmitting potentially sensitive personal information.

LOOKING AFTER OTHERS

One company driving the development of cellular IoT-based health monitoring wearables for older people is Californian tech firm, [SalusWear Corp](#). Last year the [company launched](#) a cellular IoT-powered wearable designed to track and monitor individuals suffering from



Tech Check

Nordic's [nRF9160](#) is a low power cellular IoT SiP. The integrated modem supports both LTE-M and NB-IoT wireless connectivity. Arm TrustZone technology helps build solid and secure IoT applications that feature secure boot, trusted firmware updates and root of trust implementations without performance compromise

Alzheimer's, dementia or autism. The solution has application in aged care facilities or by individuals living independently.

The SalusWear device integrates Nordic-powered LTE-M connectivity and GNSS to report the location of the wearer to family, friends, or caregivers in the event they go missing, as well as an accelerometer to detect if they have potentially been subject to a fall. The wrist-worn solution requires no interaction on behalf of the wearer and responds directly to specific SMS commands from preapproved phone numbers, without the need for a smartphone app. For example, a caregiver can text "LOCATE" to the device's dedicated phone number to receive a map link to the wearer's location, or "TRACK" to receive a map link with a location update every minute.

"We know that a significant portion of our user base will be older, and can sometimes find new technology challenging, so we have designed this device with ease-of-use in mind," says Chris Rotberg, President of Saluswear Corp. "In an emergency they can just send a quick text and not worry about finding the app on their phone or trying to remember a username and password. This is especially important because in the case of a missing person - time is of the essence."

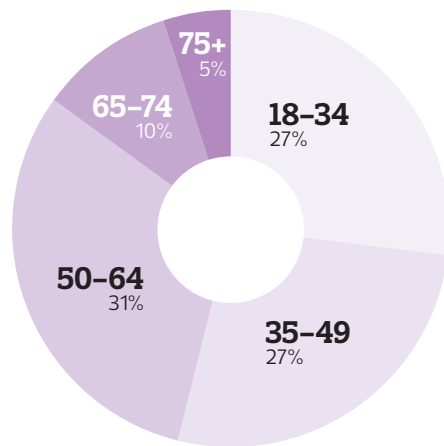
KEEPING ON TOP OF HEALTH METRICS

Another company championing the use of device-to-Cloud cellular IoT connectivity in health wearables is [August International](#), that last year launched a pair of smartwatches that provide continuous monitoring and recording of a range of key health metrics.

State of Play

A healthcare tech age divide

Wearable healthcare technology has the potential to improve access to healthcare information especially for older people. It can also empower them to play an active role in the self-management of their health. Despite the potential benefits, the acceptance and use of wearable healthcare technology declines as people get older. The most likely users of the technology are white women, aged between 18 and 50, with some level of college education and a household income in excess of \$75,000. The least likely are non-white single men over the age of 65 who failed to complete high school.



Use of wearable healthcare devices by age group:

Source: Journal of Medical Internet Research



Digital access at home and in facilities is critical to our capacity and quality of life



The August International smartwatches allow carers to continuously monitor and record a range of key health metrics remotely

The E2 and N2 devices both integrate pulse oximeter, temperature, and inertial measurement unit (IMU) sensors to determine heart rate, blood oxygen, blood pressure, and body temperature vital signs, while the N2 also includes an ECG sensor to record heartbeat and rhythm, as well as providing GPS positioning and fall detection functionality. As they are primarily designed as healthcare devices for family members, clinics and care homes to remotely monitor the health of the wearers, the company chose to employ Nordic nRF9160 SiP cellular IoT connectivity to relay key health data direct to the Cloud, rather than using a smartphone as a Bluetooth LE gateway.

"Due to COVID-19, there has been a need to reduce the frequency of face-to-face medical appointments [and] the use of remote healthcare devices has subsequently become a key part of patient care," says Dr Keming Zhou, Managing Director of August International. "When doctors have access to data collected by the E2 or N2, they can obtain a more detailed and accurate insight into the wearer's condition, and adjust treatment as necessary."

For those requiring urgent care, the smartwatches include an SOS button which calls for assistance and transmits the user's location to emergency services, as well as sending a prerecorded message alert and position notification to third parties. The nRF9160 SiP combines cellular network location data with GPS trilateration for precise position monitoring in case of any SOS alerts.

Hong Kong-based microelectronics company, Dayton Industrial, has gone a step further, integrating both cellular IoT and Bluetooth LE connectivity into its new healthcare wearable, that can serve the dual purposes of a remote healthcare/telecare solution as well as a multifunctional device the wearer can connect to their smartphone and use as a conventional smartwatch.

The Link2Care Smartwatch DA13700 features a 3D motion sensor for activity records, inactivity alerts, sleep



monitoring and fall detection. By pressing the SOS key, the user can activate an SOS alert message with their health information—including name, gender, age, blood type and any drug allergies—and location that is sent to predefined mobile phone numbers and uploaded to a Cloud server and service center for emergency response. Further information, including sleep/activity stats and wellness data such as daily step count /distance and calories burned, can be uploaded to the Cloud and a customer service center using Nordic LTE-M/NB-IoT cellular connectivity.

Nordic's [nRF52832](#) provides Bluetooth LE connectivity enabling, for example, calls and notification relaying from smartphone to wearable. The smartwatch also supports the Bluetooth LE Beacon profile - allowing connection to beacon accessories for indoor location tracking.

IT'S A GRAY WORLD AFTER ALL

By 2030, one in six people in the world will be over the age of 60 years, according to the World Health Organization. By that time, the number will equate to 1.4 billion people. Fast forward to 2050, and the world's population of people aged 60 years and older will double from what it is now, to 2.1 billion. The demand on assisted living and healthcare facilities will be at unprecedented levels, and tech will be essential in helping manage the challenge. Not only to keep people in their own homes longer, but also to support staff in facilities supervise the health of people in their care.

Sophisticated wearables will do the heavy lifting on behalf of the medical profession by wading through huge volumes of data to rapidly establish anomalies that could indicate underlying health issues. Cellular IoT wireless connectivity will seamlessly and autonomously relay this data to the Cloud for just-in-time medical intervention, allowing carers to make rapid, accurate clinical decisions. This is the future of aged care, and its a future that's closer than we think.



Dayton Industrial's Link2Care Smartwatch DA13700 features a 3D motion sensor to record activity and inactivity, sleep and falls

What's age got to do with it?

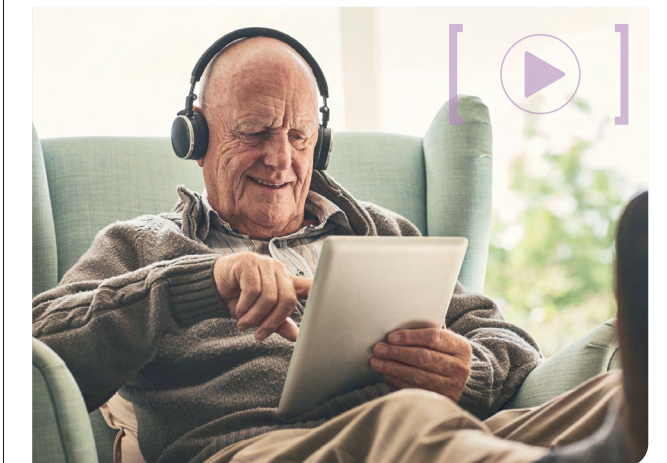
Older people have a reputation for struggling with new technology, a reputation anyone who had to teach their grandmother how to use Zoom during the height of the pandemic lock-downs can probably attest. The more serious side of this disconnect was the difficulty older adults had registering online for vaccines during the same period.

However, we all need to be careful when it comes to age-based stereotypes because in some aspects of technology and life, the older brain has been demonstrated to outperform a younger one. For example, in a study of air-traffic controllers and airline pilots, those between ages 50 and 69 took longer than those under 50 to master new equipment. Once they had however, they made fewer mistakes using it. Reassuring for next time you take your seat on an aircraft and the captain looks past retirement age.

According to numerous studies, people in their fifties and sixties also consistently outperform younger people when it comes to visual spatial processing and reasoning tasks. Visual spatial processing tells you how far objects are from you and each other, and means older people are better at some aspects of driving—reverse parking and merging lanes for example—than teenagers or people in their twenties.

Another survey by file hosting platform Dropbox found IT workers over the age of 55 are less stressed using technology in the workplace than their younger peers, and they are better at using multiple devices at work.

In fact, when it comes to some technology, young adults are not only getting left behind by older generations, but by younger ones too. A study by U.K. communications watchdog Ofcom, said digital understanding peaks between the ages of 14 and 15, before gradually dropping throughout adulthood. The report also said that while the average six-year-old child may not know how to tie their own shoelaces, they understand more about digital technology than most millennials.



Audio & Music

BluArmor C30 Helmet Comms

This Bluetooth LE motorcycle helmet communication unit offers hands-free long range connectivity between riders

The wireless audio device market is already booming, but is projected to reach \$143 billion by 2029 based on current growth trends, according to analyst Fortune Business Insights. The company said Bluetooth-based solutions would likely dominate the industry and propel its growth owing to the technology's rich connectivity and interoperability features

While the C30 can connect an impressive 20 riders in an audio mesh network, some motorcycle gatherings get a little larger than that. [The Sturgis Motorcycle Rally](#) held annually in South Dakota brings together around 500,000 riders for 10 days in August, with the crowd peaking at a whopping 739,000 in 2015. Originally held for stunts and races, since then the rally has become an event for both riders and sightseers involving parties, bike shows, live concerts and of course, a lot of motorcycles

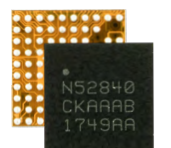
The [BluArmor C30 Helmet Comms Unit](#) allows groups of up to 20 riders to maintain a continuous audio connection while on the road. This enables motorcyclists to speak to any other member of their group over a range in excess of 1 km. The C30 is not only capable of connecting to the user's smartphone, but also to their pillion rider, their riding group and their bike. Using RIDEGRID proprietary mesh intercom technology, riders can listen to music while having a conversation with other riders

Last year Japanese bike manufacturer Yamaha announced plans to make the world's cheapest motorcycle priced at just \$500 for the 100 cc model. For those with a bigger budget at the other end of the scale there is the [Neiman Marcus Fighter](#). The limited edition Neiman Marcus bike is powered by a 2000 cc 45° air-cooled V-Twin engine and can allegedly reach a top speed of 305 kph. At auction the bike sold for a cool \$11 million

When it comes to famous motorbike riders, it is hard to beat Evel Knievel, a stunt performer and entertainer in the 1960s and 1970s. Knievel found widespread fame [jumping over cars, buses, canyons and sharks](#), as well as for breaking 433 bones in the process, a Guinness World Record that stands to this day. His dangerous line of work and accident prone nature made Knievel virtually uninsurable. He was rejected 37 times by Lloyd's of London, a firm with the reputation for insuring unusual risks



The C30 is powered by a 1000 mAh LiPo cell that can achieve a battery life of up to 16 hours between recharge in 'mesh and music' mode, thanks in part to the ultra low power operating characteristics of the Nordic SoC. The SoC has been engineered to minimize power consumption with a fully automatic power management system. The BluArmor Comms app offers over-the-air firmware updates, dynamic volume control and ride management features



Tech Check

The C30 is supervised by the [nRF52840 SoC](#)'s 64 MHz, 32-bit Arm Cortex M4 processor with floating point unit (FPU) and the nRF21540 RF FEM power amplifier/low noise amplifier (PA/LNA). The addition of the FEM offers a highly adjustable TX power boost up to +21 dBm, with the LNA providing +13 dB RX gain, enabling the device to relay audio data from headset to headset over a range of 1.2 km, allowing riders to stay in contact on the road

Smart Metering

Wireless flow monitor provides real time usage data and leak detection

The Nordic nRF9160 SiP-powered Water Monkey smart water flow device helps ensure accurate water billing and alerts users when water usage exceeds expected volumes

Despite the fact that water makes up over 70 percent of the Earth's surface, less than half a percent of it is fresh, making it an incredibly precious commodity. And yet, waste is happening right under our noses. According to the U.S. Environmental Protection Agency, nearly 4.5 trillion liters of water are lost annually across the country through household leaks. Not only is this hugely detrimental to the environment, it's costing homeowners and landlords a fortune.

Because leaks can often occur in hard-to-see spots—where damage to the building may not be immediately noticeable—anomalous water use is key to leak detection. And that is not always easy to spot using conventional water meters. It might be that the leak is small; but any leak is continuous, so if left unattended losses mount.

"In North America, multifamily residential buildings consume a significant amount of water," explains Johann van Niekerk, CTO at Connected Sensors, a Canadian green technology company that's leading the way in the water monitoring and conservation space. "The volume of water is typically measured using a compound meter—however, these meters are not always accurate, and the volumes of water used are sometimes estimated by local utilities, resulting in customers being billed incorrectly.

"In addition, when water meters do function properly, they only provide a summary of the water used in each period. Due to this limitation, building owners and utilities have no way of knowing about potential leaks. [And yet] we have seen that [leaks] alone can account for 30 to 60 percent of a landlord's total water bill."

Accurate flow measurements

To help combat these issues, Connected Sensors has released the Water Monkey, a smart water flow device powered by Nordic's nRF9160 cellular IoT SiP. This product provides residents and property managers with precise water usage data for billing and leak detection.

The Water Monkey uses an impeller—which rotates as water passes through it—to calculate the volume of liquid being used. The device also houses accelerometers to detect the pipe vibrations that might indicate problems are afoot. Using the edge processing capabilities of the nRF9160 SiP's powerful 64 MHz Arm Cortex-M33 dedicated application processor, the Water Monkey can provide near real time water volume detection.



Need to Know

It took Connected Sensors only six months to design, manufacture and certify Water Monkey. Such a short timeline was made possible thanks to the features of the nRF9160 low power SiP, as well as the global community of followers and support available for this solution, according to the company

This data is then sent to the Cloud using the nRF9160's LTE-M/NB-IoT connectivity. From a web interface, users can view their water use metrics and set up SMS and email alerts. This notifies landlords and homeowners if the water usage exceeds expected amounts, which can assist in both leak detection and early flood warning.

"After conducting thorough research and considering our customers' requirements, we decided to use cellular IoT instead of [other] LPWAN technologies for several reasons," says van Niekerk. "Firstly, we concluded that having a decent amount of edge computing capability would be beneficial, and the [robust] connection offered by cellular options would allow us to [update] our software [over the air] on Water Monkey. Using cellular IoT does not require any additional infrastructure, and we are able to deploy the smart water flow device almost anywhere with the assurance of having coverage."

Wireless monitoring

A further advantage of the device is that it can be easily retrofitted to most water meters without the need for an electrician or plumber, as it doesn't require an external power source. And it includes an expansion port, allowing it to be used on both single and compound water meters.

"Conventional 'water to Cloud' interface devices often



The Water Monkey can function for up to five years between battery replacements with the nRF9160 SiP's low power consumption



Water Monkey can be easily retrofitted to most water meters without the need for an electrician or plumber, as it doesn't require an external power source

require hardwiring," says van Niekerk. "However, building owners and managers are often not allowed to alter the wiring of their water meter without facing penalties. The Water Monkey, on the other hand, can be non-invasively attached to the side of the water meter, allowing it to detect the rotation of the impeller without requiring any changes to the meter itself.

"Water Monkey is the first device of its kind offering the ability to monitor compound meters from a single device over a readily available wireless network while running on battery power for an extended period of time."

The Water Monkey can function for up to five years between battery replacements with the help of the nRF9160 SiP's low power consumption. The Nordic product supports both PSM and eDRX power saving modes, allowing the device to sleep for long periods.

"The reference designs, technical information and development applications provided by Nordic were already enough to convince me that they are a reliable partner," adds van Niekerk. "[But] when it came time to choose a chipset for the Water Monkey, the additional support and reference material available specifically for the nRF9160 further strengthened my belief in Nordic and made me confident in our decision to use the company's products."

It's a decision that will help to keep the water flowing when we need it but safely stored when we don't.

Industry Viewpoint

Tony Chung

Sales & Marketing Manager, Dayton Industrial

Health over fitness drives wearables to careables shift

Sensor tech and the pandemic have changed the paradigm for wearables

Step counting and fitness may have been the drivers behind the first wave of wearables, but the development of better sensor tech and the demand for real time data exchange between healthcare providers and their patients is definitely behind the latest boom.

COVID-19 created the demand for wirelessly capturing our health metrics and sharing them with our GPs, but this wouldn't have been possible or meaningful without the sensors we can now package in a wristwatch-sized wearable. Equally, it wouldn't have been possible without the connectivity, processing and power consumption capabilities of the highly integrated SoC or

care facility there isn't always the staff available to check on their health round-the-clock. This is what the next generation of wearables has the potential to do, and they will increasingly use machine learning to determine what information is critical to report and what is not.

Powering remote healthcare

This thinking was behind our company's recent [Link2Care Smartwatch DA13700](#) launch,



a Nordic Bluetooth LE- and cellular IoT-powered wearable that enables remote healthcare and telecare applications. A 3D motion sensor records activity, inactivity, sleep and falls.

Further, the user can activate an SOS alert with their health information—including name, gender, age, blood type, and any drug allergies—as well as location. This is sent to predefined mobile phone numbers and uploaded to a Cloud server for emergency response.

Ultra low power is key, which is not easy when you consider the increased sophistication of these devices and the sensors we expect the batteries to power. Under normal conditions, for Bluetooth LE wearables, up to five days between recharge is possible, but for Cloud connectivity using LTE-M, there's room for further optimization.

Data security will also become important because personal health data from wearables is being shared via the Cloud. Our wearable incorporates Arm TrustZone and Arm CryptoCell security for encryption and application protection via Nordic's nRF9160 SiP, but developers as a whole have to build customer confidence that their data is well protected.

The senior care market is going to be a huge driver of wearable tech in the next decade

SiP supervising them. Let's face it, measuring ECG, blood glucose, SPO₂, blood pressure, potential falls and sleep patterns from your wrist and sending them to the Cloud for your healthcare provider or loved ones to review and respond to in real time is pretty remarkable. It's also probably essential for the future of our aging population.

To that end I think the senior care market is going to be a huge driver of wearable tech in the next decade. People are getting older, they want to remain at home and even if they do move into an aged

[Tech Zone]

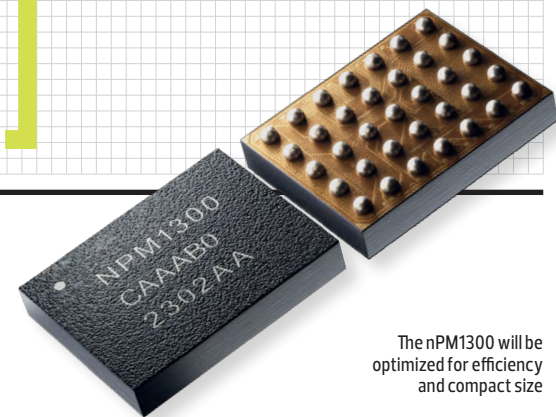
An in-depth look at Nordic's wireless solutions

Power Management

Nordic announces nPM1300 PMIC to simplify power system design

Nordic Semiconductor has announced its plan to release a third power management IC (PMIC) in mid-2023. The [nPM1300](#) will expand the company's PMIC offering by adding support for both charging of larger batteries and four regulated power rails. The nPM1300 will be optimized for efficiency and compact size (3.1 by 2.4 mm WL-CSP or 5 by 5 mm QFN) and is digitally configurable through an I2C-compatible Two Wire Interface (TWI). The digital interface provides access to system management functions that are usually discretely implemented in Bluetooth LE devices – such as hard reset, battery fuel

gauge, system-level watchdog, power loss warning and recovery from failed boot. "Nordic's customers [now] have access to on-chip functions that enhance product safety and provide additional ways of conserving battery energy," says Geir Kjosavik, Product Director – PMIC at Nordic. The nPM1300 provides highly efficient power regulation for Nordic's nRF52 and nRF53 Series multiprotocol SoCs. The PMIC's four regulated power rails and battery charger make it ideal for compact and advanced IoT products based on, for example, an nRF5340 SoC host and multiple peripheral functions such as sensors.



The nPM1300 will be optimized for efficiency and compact size

Examples include advanced wearables and portable medical applications.

The nPM1300 charges single-cell Li-ion, Li-Pol and LiFePO4 batteries with a linear charging module that supports up to 800 mA charge current. The termination voltage is programmable from 3.5 to 4.45 V. The battery charger features automatic thermal regulation with programmable maximum chip temperature during charging to enable simple thermal management that can be adapted to any system requirement.

The nPM1300 is available for limited sampling now, and will be available to order from Nordic's distributors mid-2023.

Enterprise IoT

Bluetooth LE device and gateway enable indoor tracking

A platform which enables a wide range of indoor industrial and enterprise tracking and monitoring solutions has been launched by India based Semiconsoul Technologies. The Nordic [nRF52833 SoC](#)-powered LiNT (Location of Interest) device supports indoor tracking, navigation, asset management and condition monitoring.

LiNT features several sensors including infrared (IR) proximity, IR array, ambient light and addressable LED indicators, as well as footprints on the board for additional sensors including an accelerometer, gyroscope and magnetometer.

LiNT operates in both Bluetooth LE host and peripheral mode under Semiconsoul's Secure Platform for IoT Data Exchange (SPIDEX). Using the nRF52833 SoC-enabled Bluetooth LE connectivity, the product is able to continuously scan nearby Bluetooth LE devices, and can also act as a peripheral to

connect to any IoT gateway or the proprietary, Nordic SoC-powered parent gateway, Special Purpose Industrial-IoT Gateway (SPIGWAY).

SPIGWAY runs on a Linux open-source system and provides the IoT connectivity framework called C3F (Common Communication and Control Framework) to control data acquisition, data cleansing, filters, device management, over-the-air device firmware updates and edge processing. Multiple LiNT devices can connect to a single gateway, with collected sensor data then sent to the Cloud for further analysis. Optionally, the LiNT also supports mesh networking.

"The continuous Bluetooth LE connectivity and ability to acquire sensor data enabled by the Nordic SoCs [enables firms] to improve operational efficiency," says GovindaRao Gotta, Chief Functionary – IoT Device Platform Engineering & Technology, Semiconsoul.



Internet of Things

Module enables Cloud connectivity for Modbus RTU devices

An IoT module [launched](#) by Germany-based grandcentrix (part of Vodafone) enables Cloud connectivity via NB-IoT and LTE-M for any Modbus Remote Terminal Unit (RTU) devices.

The grandcentrix Modbus Cloud Connect allows any devices running the Modbus RTU protocol to report their data to the Cloud rather than via a wired connection. By using converters, it can also be used for a range of other device protocols.

Typical use cases of Modbus Cloud Connect include the remote connection of industrial machinery. Modbus Cloud Connect connects the Modbus RTU over a local RS-485 interface to a Cloud-based platform or central IT system. The product provides standardized, well-documented interfaces (MQTT and HTTP) to connect to the customer's Cloud or central IT system.



Awards

Nordic's enhanced PPK2 wins awards double

Nordic Semiconductor's enhanced [Power Profiler Kit II \(PPK2\)](#) has been named winner of two highly regarded awards in Greater China. The PPK2 for power profiling and power optimization of embedded solutions won the 'Best Development Tool' categories of the 2022 EE Awards Asia and the 21ic Electronics Network Top10 Power Awards.

"The PPK2 is an affordable yet powerful tool used by embedded Bluetooth, Wi-Fi, LTE-M and NB-IoT developers, says Bjørn Åge "Bob" Brandal, Nordic Semiconductor, VP of Sales and Marketing, Asia Pacific. "We're delighted to receive these awards and recognition for the enhanced Power Profiler Kit.

The EE Awards Asia celebrates the best products, companies and individuals across the continent's highly regarded electronics industry. Winning products were required to demonstrate the ability to add value and improve modern life through the application of technology. The 21ic Electronics Network Top10 Power Awards were launched in 2003, and recognize technological innovation in power products.

LED Lighting

Lighting products allow OEMs to make luminaires Matter-compatible

Austrian lighting technology company, Tridonic, has launched a suite of Nordic [nRF52840 SoC](#)-powered solutions to help make professional and hospitality lighting installations compatible with [Matter](#) – the smart home standard maintained by the Connectivity Standards Alliance. Matter brings interoperability between smart home devices and ecosystems to reduce complexity. Tridonic's Matter-enabling lighting products ensure customers can take advantage of popular ecosystems and controls from Amazon, Apple, Google and Samsung, allowing users to build a smart, voice-controlled environment where the lighting systems – plus all other Matter-compatible devices operate over a common application layer.

The Wireless Matter Driver is a 24 V constant voltage LED driver that dims and switches LED strips, while the Push Button Coupler, installed in a flush-mounted box, converts existing conventional switches into Matter-compatible smart light switches. The Wireless Matter to DALI Active module (complete with its own

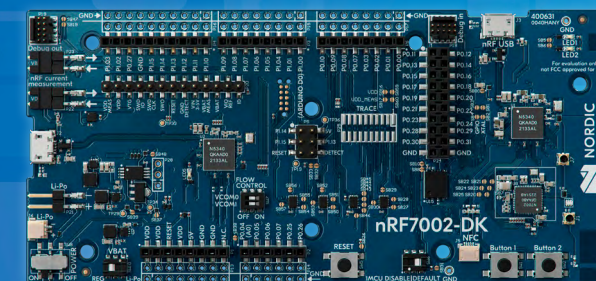
power supply) and the Wireless Matter to DALI Passive module (used with an external supply) can be used to upgrade any DALI (Digital Addressable Lighting Interface – a professional lighting standard) luminaire or existing installation into Matter-ready. This allows commercial units to become Matter-enabled and virtual assistant controllable.

Each product works with the Thread protocol so it can be integrated into an existing Thread network without using a gateway. Thread, a smart-home protocol, together with Wi-Fi and Ethernet, forms the transport for Matter (with Bluetooth LE used for commissioning).

"Thread devices compatible with Matter support battery-powered sensors and have the ability to support Thread mesh lighting networks in addition to alternative wireless protocols," says Philipp Heindl, VP Business Development, Tridonic GmbH & Co KG.



Low Power Wi-Fi for the IoT



The nRF7002 DK is a easy-to-use Wi-Fi 6 development kit, enabling low-power dual-band Wi-Fi and coexistence with Bluetooth LE, Thread and Zigbee

START YOUR DEVELOPMENT TODAY

nordicsemi.com/nRF7002dk



NORDIC SEMICONDUCTOR

An Introduction to Nordic's Low Power Wi-Fi

The launch of the nRF7002 companion IC adds Wi-Fi 6 to Nordic's product portfolio and will enhance current IoT applications while enabling many new ones

According to the Wi-Fi Alliance, the organization that promotes the use of [Wi-Fi](#), the economic value derived from the tech is a staggering \$3.5 trillion. (*Global Economic Value of Wi-Fi 2021 - 2025*.) The alliance says there are 18 billion Wi-Fi devices in use and 4.4 billion annual shipments of which 2.3 billion meet the latest Wi-Fi 6 standard. Wi-Fi is seriously big business.

This popularity is down to Wi-Fi's Internet Protocol (IP) interoperability. A Wi-Fi device can connect directly to the Cloud without the need of a gateway beyond existing Access Points (AP). And the adoption of Wi-Fi 6 made the tech better suited to the IoT where it complements existing IoT technologies used for low power networks, for example, Bluetooth LE and Thread. Wi-Fi 6 offers higher throughput and longer range than these other protocols allowing it to enhance existing IoT applications while enabling new ones. This synergy is evident in Matter, a standard that brings together separate [smart home](#) ecosystems (see [WQ Issue 4, 2022, pg10](#)).

How Wi-Fi 6 has been built for the IoT

Wi-Fi 6 introduced many enhancements to the specification but those most useful for Nordic's IoT solutions are Orthogonal Frequency Division Multiple Access (OFDMA), beamforming (on the receiver side rather than the transmitter), longer symbol duration, Target Wake Time (TWT – a new power saving mode (PSM)) and Basic Service Set (BSS) Coloring (a method of differentiating between access points (APs) broadcasting on the same channel). Among these, it is TWT and OFDMA which make the greatest contribution to power saving and allow energy-constrained devices to take advantage of Wi-Fi where it might previously have been impossible.

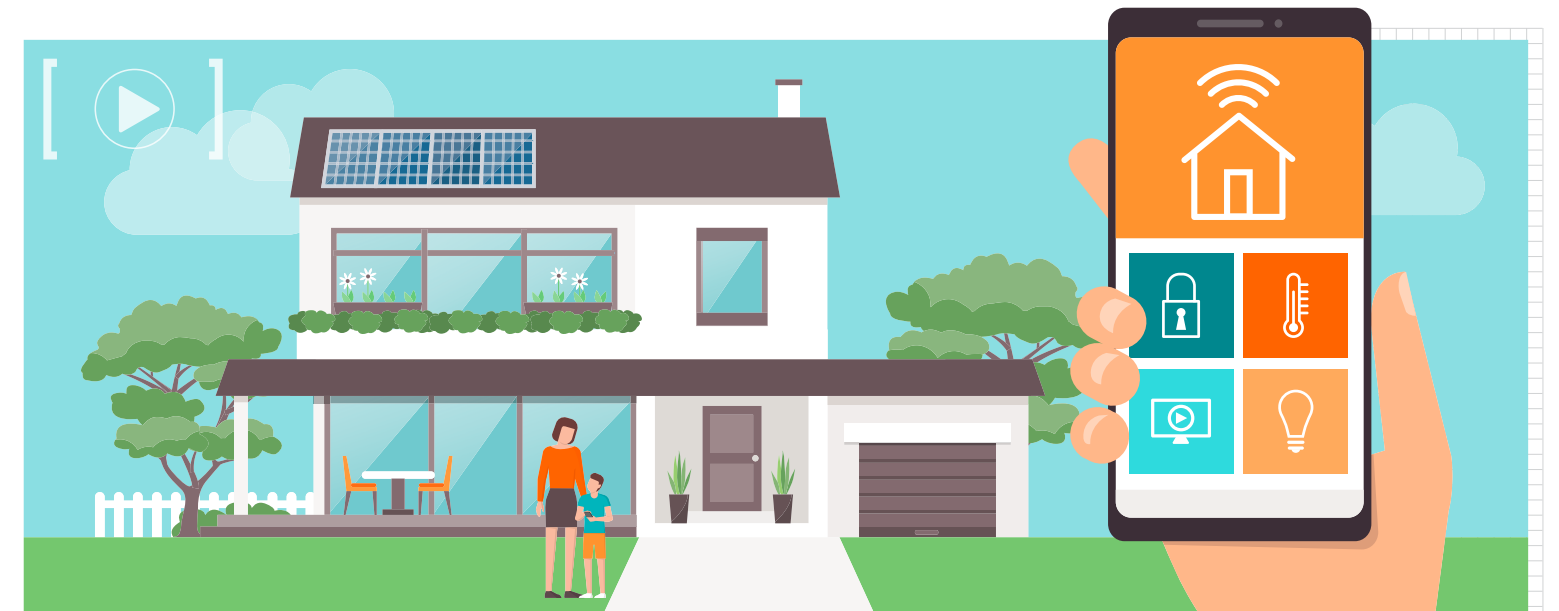
Earlier versions of the Wi-Fi standard do include PSM,

Nordic's Wi-Fi companion ICs make it simple for engineers to extend their legacy and future Bluetooth LE and Thread networks directly to the Cloud within Nordic's familiar development environment

but the power saving mechanisms are controlled by the AP and offer limited flexibility to the end device. The end device was forced to remain awake to receive the AP's beacon ahead of a data exchange. The TWT PSM included in Wi-Fi 6 allows the end device to individually negotiate a wake-up schedule with the AP. This enables it to sleep for defined periods which helps to significantly lower power consumption. Data exchange then occurs at the agreed wake-up time. Another advantage of TWT is that it enables interference mitigation by letting the AP allocate dedicated time slots for end device data transfer.

The OFDMA employed in Wi-Fi 6 allows for a higher number of subcarriers within a single Wi-Fi channel. For example, a 20 MHz channel can be further divided into 117 subcarriers each side of the channel's central frequency. Groups of subcarriers can then be allocated to a certain end device while other groups can be allocated to different end devices depending on the data traffic requirement. This technique (called Multi User uplink/downlink) does add complexity to AP transmission and receiving but this is not the case for the end device which only works with its dedicated subcarrier frequencies. OFDMA is particularly useful for large IoT sensor networks with many end devices, but with each needing to send only a small amount of data, because it enables dynamic, flexible and highly efficient division of the available spectrum bandwidth. Without OFDMA, a large sensor network would typically generate a lot of channel contention, as Wi-Fi client devices attempt to access the medium without much coordination, causing higher interference levels and resulting in reduced throughput.

Nordic recently launched the [nRF7002](#) Wi-Fi companion IC (see [this issue pg4](#)). The product is part of a planned series of companion ICs—each of which require the resources of a separate microprocessor—that will add



low power Wi-Fi capabilities to embedded IoT systems. When combined with Nordic's nRF52 and nRF53 Series multiprotocol SoCs, the companion IC enables many new applications. For example, the higher throughput supports applications such as video cameras. Wi-Fi also boosts range compared with Bluetooth LE or Thread alone and introduces high-grade security. Wi-Fi is also a good option for 'always connected' devices such as home appliances.

The companion IC can significantly enhance existing applications. For example, the high throughput is useful for scenarios when occasional high volumes of data are transferred – such as performing over-the-air (OTA) updates for complex firmware. Wi-Fi also brings higher security for sensitive data transfers than Bluetooth LE.

A third area where the nRF7002 will play a key role is in making it easy to build a gateway between low power Bluetooth LE or IEEE 802.15.4-based networks and the Cloud. The [nRF5340 SoC](#) operates as the host processor for the gateway with the nRF7002 handling Wi-Fi traffic. The nRF7002's built-in coexistence control features a Generic Packet Traffic Arbiter (PTA) design which ensures the Wi-Fi IC doesn't transmit at the same time as the nRF5340 host processor on the 2.4 GHz band.

operates with a peak transmit current (2.4/5 GHz) of 191/260 mA and a peak receive current of 60/56 mA. Sleep current (with real time clock (RTC)) is 15 µA and shutdown current is 1.7 µA. With TWT (2.4 GHz, 60 s interval), the average current is 29.5 µA, reducing to 18.2 µA for one day intervals. Sensitivity (1DSSS, 2.4 GHz) is -98.6 dBm and TX(max) (2.4/5 GHz) is 21/15 dBm.

The nRF7002 supports the Wi-Fi Protected Access (WPA)3 high grade security protocol which features increased cryptographic strength and more robust authentication. The nRF7002's support for WPA3 removes some of the security burden from the host side.

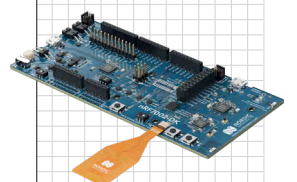
The companion IC implements the IEEE802.11 Physical layer (PHY) and Medium Access Control (MAC) firmware only. The Wi-Fi Driver and Wi-Fi and Transmission Control Protocol (TCP)/IP stack are held on the host processor. Communication between the MAC and the other parts of the stack is via the nRF7002's Serial Peripheral Interface (SPI) or Quad SPI (QSPI).

Nordic offers an open source Wi-Fi 6 Certified stack to support the nRF7002 through the nRF Connect SDK, the company's unified and scalable software development kit. A qualified solution makes it easier for users to get end product certification. The Wi-Fi stack in the nRF Connect SDK is designed for use with the Zephyr Project's Zephyr real time operating system (RTOS) but could also be used with other RTOSs.

The nRF7002 DK has just been launched (see [pg4](#)). The DK has a nRF5340 host processor (connected to nRF7002 by the QSPI) but Nordic plans further kits with nRF52840 SoC and nRF9160 cellular IoT SiP host processors.

Nordic's Wi-Fi companion ICs make it simple for engineers to extend legacy and future Bluetooth LE and Thread networks directly to the Cloud within Nordic's familiar development environment. The ICs also make it straightforward to add Wi-Fi SSID location services by complementing the nRF9160 SiP and nRF Cloud in applications such as asset tracking.

A Nordic Webinar entitled [Introduction to low-power Wi-Fi is available from \[bit.ly/3IHw5bl\]\(https://bit.ly/3IHw5bl\)](#).

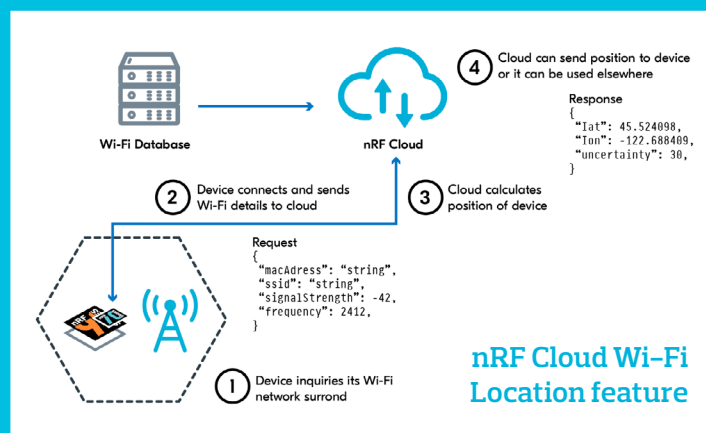


Need to Know

The nRF7002 DK is the development kit for the nRF7002 companion IC. The DK comprises everything needed to get started developing Wi-Fi solutions on a single board. The DK features an nRF5340 multiprotocol SoC as a host processor for the nRF7002

Where am I?

The nRF7002 Wi-Fi companion IC can be used with the [nRF9160](#) cellular IoT SiP to enhance location accuracy. Together with [nRF Cloud Location Services](#), (see [WQ Issue 3, 2021 pg10](#)) the SiP can use cell-based (single- or multi-cell) and/or GPS-based (Assisted- or Predictive-GPS) location features. The nRF7002, together with nRF Cloud Location Services, enables a third location service that complements the others. Wi-Fi SSID location is more accurate than cell-based location features and less power hungry than GPS. Moreover, Wi-Fi excels where GPS struggles. For example, among a city's high buildings the GPS signal can be patchy yet there's typically a high density of Wi-Fi APs. Wi-Fi is also good indoors where GPS fails. The nRF7002 looks for a nearby AP and obtains its SSID; the nRF9160 then sends the SSID to nRF Cloud which in turn checks a Wi-Fi AP database. nRF Cloud then returns the location, with the degree of uncertainty, to the SiP, or elsewhere.



Nordic Product Guide

This handy summary describes all of Nordic's IoT solutions



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

RF SoCs and SiP

		nRF 41 SERIES	nRF 53 SERIES	nRF 52 SERIES						
		nRF9160	nRF5340	nRF52840	nRF52833	nRF52832	nRF52820	nRF52811	nRF52810	nRF52805
WIRELESS PROTOCOL	LTE-M	●								
	NB-IoT	●								
	GNSS	●								
	BLUETOOTH LOW ENERGY		●	●	●	●	●	●	●	●
	BLUETOOTH 5.3		●	●	●	●	●	●	●	●
	LE AUDIO		●							
	DIRECTION FINDING		●		●		●	●		
	2 Mbps		●	●	●	●	●	●	●	●
	LONG RANGE		●	●	●	●	●	●	●	●
	BLUETOOTH MESH		●	●	●	●	●	●	●	●
	THREAD		●	●	●	●	●	●	●	●
	MATTER		●	●	●	●	●	●	●	●
	ZIGBEE		●	●	●	●	●	●	●	●
	ANT		●	●	●	●	●	●	●	●
TYPE	2.4 GHz PROPRIETARY		●	●	●	●	●	●	●	●
	NFC		●	●	●	●	●	●	●	●
CORE SYSTEM	SYSTEM-ON-CHIP (SoC)		●	●	●	●	●	●	●	●
	SYSTEM-IN-PACKAGE (SiP)	●								
SECURITY	CPU	64 MHz Arm Cortex-M33	128 MHz Arm Cortex-M33+64 MHz Arm Cortex-M33	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4	64 MHz Arm Cortex-M4
	FPU	●	●	●	●	●	●	●	●	●
	DSP INSTRUCTION SET	●	●	●	●	●	●	●	●	●
	CACHE	●	●	●	●	●	●	●	●	●
	MEMORY	1MB Flash, 256 KB RAM	1MB Flash, 512 KB RAM +256 KB Flash, 64 KB RAM	1MB Flash, 256 KB RAM	512 KB Flash, 128 KB RAM	512 KB or 256 KB Flash, 64 KB or 32 KB RAM	256 KB Flash, 32 KB RAM	192 KB Flash, 24 KB RAM	192 KB Flash, 24 KB RAM	192 KB Flash, 24 KB RAM
	CLOCKS	64 MHz / 32 kHz	128 MHz / 64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz	64 MHz / 32 kHz
	ARM TRUSTZONE	●	●	●	●	●	●	●	●	●
RADIO	ARM CRYPTOCELL	310	312	310						
	ROOT-OF-TRUST	●	●	●						
	SECURE KEY STORAGE	●	●	●						
	AES ENCRYPTION	●	●	●	●	●	●	●	●	●
PERIPHERALS	LTE-M/NB-IoT/GPS MODEM	●								
	CERTIFIED LTE BANDS	1-5, 8, 12-14, 17-20, 25-26, 28, 66								
	FREQUENCY	700-2200 MHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz
	MAXIMUM TX POWER	23 dBm	3 dBm	8 dBm	8 dBm	4 dBm	8 dBm	4 dBm	4 dBm	4 dBm
CERTIFICATIONS	RX SENSITIVITY	-108 dBm (LTE-M), -114 dBm (NB-IoT), -155 dBm (GPS)	-98 dBm (1Mbps)	-95 dBm (1Mbps)	-96 dBm (1Mbps)	-96 dBm (1Mbps)	-95 dBm (1Mbps)	-97 dBm (1Mbps)	-96 dBm (1Mbps)	-97 dBm (1Mbps)
	ANTENNA INTERFACE	50 Ω single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended	Single-ended
	HIGH SPEED SPI	●	●	●	●	●	●	●	●	●
	TWI, SPI, UART	4xTWI/SPI/UART	4xTWI/SPI/UART +TWI/SPI/UART	2xTWI/SPI, SPI, 2xUART	2xTWI/SPI, SPI, 2xUART	2xTWI/SPI, SPI, UART	2xTWI/SPI, UART	TWI/SPI, SPI, UART	TWI, SPI, UART	TWI, SPI, UART
	QSPI		●	●	●	●	●	●	●	●
	USB		●	●	●	●	●	●	●	●
	PWM	4	4	4	4	3		1	1	
	PDM	●	●	●	●	●	●	●	●	●
	I2S	●	●	●	●	●	●	●	●	●
	ADC, COMPARATOR	ADC	●	●	●	●	COMP	ADC, COMP	ADC, COMP	ADC
TIMER, RTC	3, 2	3, 2 + 3, 2	5, 3	5, 3	5, 3	4, 2	3, 2	3, 2	3, 2	
TEMPERATURE SENSOR	●	●	●	●	●	●	●	●	●	
OPERATING TEMPERATURE	-40 to 85°C	-40 to 105°C	-40 to 85°C	-40 to 105°C	-40 to 85°C	-40 to 105°C	-40 to 85°C	-40 to 85°C	-40 to 85°C	
SUPPLY VOLTAGE RANGE	3.0 to 5.5 V	1.7 to 5.5 V	1.7 to 5.5 V	1.7 to 5.5 V	1.7 to 3.6 V	1.7 to 5.5 V	1.7 to 3.6 V	1.7 to 3.6 V	1.7 to 3.6 V	
DEVELOPMENT KITS	nRF9160 DK, Nordic Thingy:91	nRF5340 DK, nRF5340 Audio DK, Nordic Thingy:53	nRF52840 DK, nRF52840 Dongle	nRF52833 DK	nRF52 DK, Nordic Thingy:52	nRF52833 DK	nRF52840 DK	nRF52 DK	nRF52 DK	
PACKAGES	10x16x1.04 mm LGA	7x7 mm aQFN94 (48 GPIOs), 4.4x4.0 mm WLCSP95 (48 GPIOs)	7x7 mm aQFN73 (48 GPIOs), 6x6 mm QFN48 (30 GPIOs), 3.5x3.6 mm WLCSP94 (48 GPIOs)	7x7 mm aQFN73 (42 GPIOs), 5x5 mm QFN40 (18 GPIOs), 3.2x3.2 mm WLCSP (42 GPIOs)	6x6 mm QFN48 (32 GPIOs), 3.0x3.2 mm WLCSP50 (32 GPIOs)	5x5 mm QFN40 (18 GPIOs), 2.53x2.53 mm WLCSP44 (18 GPIOs)	6x6 mm QFN48 (32 GPIOs), 5x5 mm QFN32 (17 GPIOs), 2.48x2.46 mm WLCSP33 (15 GPIOs)	6x6 mm QFN48 (32 GPIOs), 5x5 mm QFN32 (17 GPIOs), 2.48x2.46 mm WLCSP33 (15 GPIOs)	2.48x2.46 mm WLCSP28 (10 GPIOs)	

Power Management ICs

		nPM FAMILY		
		nPM1300	nPM1100	nPM6001
FEATURES	PMIC	●	●	●
	BUCK REGULATOR	2	1	4
	BATTERY CHARGER	●	●	
	LDO	2		2
CHARGER	LOAD SWITCH	2		
	TERMINATION VOLTAGE	3.5 to 4.45 V	4.1 to 4.2 V or 4.25 to 4.65 V	
	MAX CHARGING CURRENT	800 mA	400 mA	
	POWER PATH MANAGEMENT	●	●	
POWERRAILS	THERMAL PROTECTION	●	●	
	BATTERY COMPATIBILITY	LiFePO4, Li-ion, LiPo	Li-ion, LiPo	
	INPUT VOLTAGE	4 to 5.5 V	4.1 to 6.7 V	3 to 5.5 V
	USB COMPLIANCE	Type-C	●	
SYSTEM MANAGEMENT	REGULATED OUTPUT VOLTAGE	1 to 3.3 V	1.8 to 3 V	0.5 to 3.3 V
	MAX CURRENT PER BUCK	200 mA, 200 mA	150 mA	550 mA, 200 mA, 150 mA, 150 mA
	ADC	10-bit		
	FUEL GAUGE	●		
SYSTEM MANAGEMENT	HARD SYSTEM RESET	●		
	TIMED WAKE-UP	●		●
	WATCHDOG TIMER	●		●
	SHIP MODE / HYBERNATE	●	●	●
	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 105°C	-40 to 85°C
	EVALUATION KITS	nPM1300 EK	nPM1100 EK	nPM6001 EK
PACKAGE OPTIONS	5x5 mm QFN32, 3.1x2.4 mm WLCSP	4x4 mm QFN24, 2.1x2.1 mm WLCSP	2.2x3.6 mm WLCSP	

Cloud Services

nRF Cloud Services

Description: nRF Cloud Services are optimized for Nordic's low power IoT Devices. nRF Cloud Services support Device-to-Cloud or Cloud-to-Cloud use. In the former, the device connects directly to nRF Cloud. In the latter, connection is to a customer's Cloud that then connects to nRF Cloud's REST API.

Services: nRF Cloud Services are offered in nRF Cloud and include GPS, cell-based and Wi-Fi assisted locationing. The product supplies accurate, rapid location data for IoT devices. The A-GPS service reduces time-to-first-fix. The result is lower latency and lower power consumption. P-GPS downloads predictive data, extending the validity of assistance data. For Wi-Fi location, the device scans two or more Wi-Fi APs and sends network information to nRF Cloud, where the location is calculated. Cell based services use base stations to predict location. Each location feature has its advantages, so switching between different location services during operation can be useful.



Tech Spec

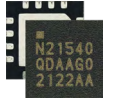
Location services
Assisted GPS (A-GPS), Predictive GPS (P-GPS), Single-Cell (SCELL), Multi-Cell (MCELL), Wi-Fi
Additional features
Supports Cloud-to-Cloud use cases for devices provisioned to a different Cloud provider
Supported products
nRF9160 SiP, nRF9160 DK, Nordic Thingy:91, nRF7002 companion IC
Applications
Industrial, smart appliances, asset tracking, RTLS

Wi-Fi 6 Companion IC

nRF7002

Description: The nRF7002 is a Wi-Fi 6 Companion IC for use in the 2.4 and 5 GHz bands. The product offers good coexistence with Bluetooth LE devices and features one Spatial Stream (SS), 20 MHz channel bandwidth, 64 QAM (MCS7), 86 Mbps PHY throughput and OFDMA (downlink and uplink).

Operation: The nRF7002 Wi-Fi 6 Companion IC is a low power and secure Wi-Fi device for IoT applications. It provides Wi-Fi connectivity and Wi-Fi-based locationing (using SSID sniffing of local Wi-Fi hubs). The nRF7002 incorporates Wi-Fi 6's Target Wake Time (TWT), a power-saving feature allowing the IC to negotiate a wake-up schedule with the access point (AP) to which it is connected. The nRF7002 accompanies Nordic's nRF52 and nRF53 Series Bluetooth LE SoCs, and the nRF91 Series cellular IoT SiPs. The nRF7002 can also be used as a companion IC in applications hosted by non-Nordic products. Development is supported through Nordic's nRF Connect SDK.



Range Extender nRF21540

Description: The nRF21540 is an RF front-end module (FEM) that improves range and connection robustness for Nordic nRF52 and nRF53 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, Thread, Zigbee and 2.4 GHz protocol applications. 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



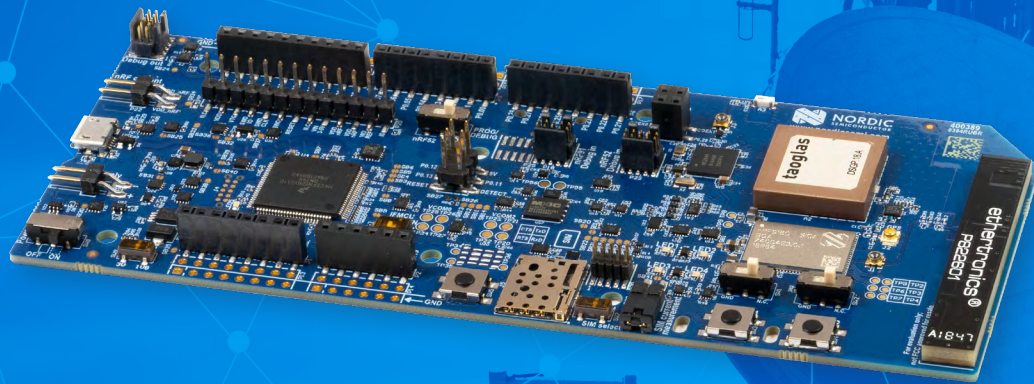
Tech Spec

Compliance
IEEE 802.11b (Wi-Fi 1)/a (Wi-Fi 2)/g (Wi-Fi 3)/n (Wi-Fi 4)/ac (Wi-Fi 5)/ax (Wi-Fi 6)
Package
6 by 6 mm QFN
Features
Low power, good coexistence with Bluetooth LE, TWT
Development tools
nRF7002 DK, nRF Connect SDK
Applications
Asset tracking, smart home, industrial



NORDIC[®]
SEMICONDUCTOR

Cellular IoT made easy



nRF9160 DK

Easy-to-use cellular IoT development kit with
software development environment



BUY ONLINE
nordicsemi.com/nRF9160dk

