WQ Special Report

Living the Dream

With broad industry support, Matter stands to unify connectivity and revolutionize the smart home.
Welcome

Finn Boetius
Product Marketing Engineer

Nordic is hardly a newcomer to the smart home and yet the company’s decade of development of products for the sector is only a small slice of a much longer story.

Historians might place the genesis of the smart home with the ECHO IV, a home computer designed in 1966 by Jim Sutherland, a Westinghouse engineer. But I'd put the starting point to 1975 when Busch-Jaeger introduced their X10 network technology. This later evolved into EIB/KNX bus. Today, most electricians recommend a wired KNX-system to make a home smart.

But why use a decade-old, wired technology when you can have wireless appliances? Wireless would allow you to achieve a higher level of integration without the cost of cable but, unlike the KNX system, most wireless smart home product aren't interoperable.

Today smart speakers exist in no less than 33 percent of German and U.S. houses and more than a quarter of Australian ones. But the fully integrated wireless smart home is rare beyond the early adopter.

Progress has been hampered by “walled gardens of technology” as Christopher LaPré, Head of Technology at the Connectivity Standards Alliance (CSA) explains it.

These walled gardens feature impressive smart home tech but lock consumers into a single vendor, limiting their options. The CSA is doing a lot to break down the walls by promoting Matter. The new standard is a wireless (and wired) specification that sees smart home products from any vendor happily playing together. Matter is backed by over 200 companies, including Nordic and major players in the consumer smart home market. It’s a major collaboration between companies that otherwise spend their workdays fiercely competing.

Progress is good and Matter products, many powered by Nordic chips, are entering the market. A future where a robot butler prepares dinner while vacuuming the carpet is still some way off. But Matter will bring that time much closer. Read more about this smart home initiative in this edition’s Special Report on page 14.

The nRF5340 SoC

Perfect for Smart Home with concurrent Matter and Bluetooth LE support

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

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Wireless Logic acquires Nordic’s cellular IoT SIM partner Arkessa

Wireless Logic, which claims to be Europe’s largest independent IoT connectivity firm, has acquired Arkessa, a Nordic Semiconductor cellular IoT SIM partner company. Wireless Logic’s CEO, Kristian Fisker, says that the acquisition will give Nordic customers a “super-charged” expansion in global network access and an even wider choice of cellular IoT data and connectivity options. "I would like to reassure Nordic customers,” he says, “that Wireless Logic is an extremely well-established, 20-year-old firm that will continue to collaborate with them in the future."

Wireless Logic has an experienced team of over 80 people from numerous countries who are experts in IoT SIM connectivity. The company has an extensive global network of partners and has direct access to 50 IoT networks, including all of their legacy and LTE-M/LPWAN/LTE-M networks in Europe.

Although the Arkessa brand and its LPWAN expertise are retained, Wireless Logic Group says the acquisition will give Nordic customers a “super-charged” expansion in global network access and an even wider choice of cellular IoT data and connectivity options. “I would like to reassure Nordic customers that Wireless Logic Group is an extremely well-established, 20-year-old firm that will continue to collaborate with them in the future,” says Kristian Fisker, CEO of Wireless Logic Group.

The acquisition will support future growth of cellular IoT and ensure consumers benefit from a greater range of connected products and services.

Cellular IoT

Internet of Things

Nordic and Nokia collaborate to simplify SEP licensing

Nordic Semiconductor and Nokia, together, announce a new approach to licensing the use of cellular IoT (IoT) Standard Essential Patents (SEP). The deal will provide companies purchasing IoT hardware from Nordic with the opportunity to acquire licences to Nokia’s industry-leading portfolio of cellular patents.

Nokia has defined many of the fundamental inventions used in virtually all cellular devices and, as well as LTE and NB-IoT technologies. In practice, this means any device connected to any cellular network automatically uses Nokia’s intellectual property (IP).

The agreement, a first of its kind, will simplify and speed up the SEP licensing process and provide greater transparency and predictability to companies delivering IoT solutions. Licences will be available at the end device level and companies will continue to have the option to license direct with Nokia.

“Nokia is all about making IoT easy for its customers,” says Kjell Holstad, EVP Product Management at Nordic. “Throughout this collaboration, we have added transparency and predictability early in the design process, giving the increased clarity and certainty that companies will continue to enjoy when working with Nordic. “Nokia has a history of working closely with industry to find effective licensing solutions and this innovative new approach is another example,” says Jonni Lakander, President of Nokia Technologies. “It’s a win/win for Nordic’s customers and Nokia, simplifying SEP licensing and making it easier for licensing agreements to be concluded amicably and efficiently. The move will support future growth of cellular IoT and ensure consumers benefit from a greater range of connected products and services.”

A geolocation asset tracker built for rugged environments and offering over a decade of battery life has been launched by IoT firm, Digital Matter. The Oyster3 product employs Nordic’s nRF9160 SiP with integrated LTE-M/NB-IoT modem and enables telematics businesses to easily track and manage a range of powered and non-powered equipment, tools, bins and containers.

Rugged, cellular IoT geolocation device tracks and traces high value assets

Oyster3 supports automatic roaming between LTE-M and NB-IoT networks with minimal delay and marginal performance impact. The SiP also enables new early registration abort and seamless scanning techniques to save power and optimize the device for different use cases across varied network coverage.

The Oyster3 intelligently transmits the whereabouts of the asset via a cellular LTE-M or NB-IoT network. Digital Matter’s DEM Device Server Cloud platform can be used to manage and update devices over-the-air.

Location and other asset/device data can also be sent to any IoT or telematics platform with comprehensive documentation and a flexible and open payload format.

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Nordic welcomes Norway’s Minister of Trade and Industry in green initiative

Norway’s Minister of Trade and Industry, Jan Christian Vestre, has paid a visit to Nordic Semiconductor’s head office in Trondheim as part of the Norwegian government’s efforts to accelerate green industrial projects, while creating jobs, strengthening investment and boosting the country’s exports.

“We think it’s great that the Minister takes the time to sit down with those who create jobs and is willing to hear what needs we have to grow a sustainable company,” says Svenn-Tore Larsen, Nordic’s CEO. “The important thing is to understand what’s needed to grow a sustainable company,” says Svenn-Tore Larsen, Nordic’s CEO. “The important thing is to understand what’s needed to grow a sustainable company,” says Svenn-Tore Larsen, Nordic’s CEO. “The important thing is to understand what’s needed to grow a sustainable company.”

Nordic holds a long-standing commitment to sustainability, and was recently recognized as one of the top 100 companies by STOXX Global ESG Leaders Index, the benchmark for sustainability champions. Nordic is also committed to the United Nations’ Sustainable Development Goals. (See QW Issue 1, 2022 p2)

“Sustainability depends on technology and innovation projects within the IoT that can contribute to the realization of the United Nations’ sustainability goals,” adds Larsen. “This will be decisive for the transition to products and services that have significantly fewer negative consequences for the climate and environment than today.”

Larsen welcomed the dialogue with the Minister as a positive step towards helping deliver a green shift.

“Farmers say they pay around AUS$50 (336) per month in network charges per device, whereas our Initial Trials suggest we can reduce this to around AUS$5 (0.34),” says Christopher Hunt, CTO of Titan Class. “Our approach is also more robust and reliable because we’re getting a much higher range and penetration.”

One of the challenges is that a sensor in a field could be up to 20 km from the nearest base station. As it’s almost impossible to maintain full connectivity, companies like Farmify, some of the most remote farms in Australia.

Nordic’s asset protection platform integrates Nordic’s new leak sensors with LTE-M and NB-IoT into its existing product portfolio, providing a cost-effective solution for businesses to improve their leak detection capabilities.

Bmmpr, a U.S. startup, has unveiled its Bmmpr x Assets platform, which has been regularly attended by cleaning personnel. The marker, says Larsen, 1.0’s small form factor makes it easy to install in any remote location. The system works by either detecting water leaks, or other LPWAN technologies such as NB- IoT, LTE-M and LoRaWAN, but was reported as having been financially troubled for some time.

The news was first reported in French publication La Tribune, which quoted a company, Titan Class, to develop Farmify, a Rust programming language application—combined with a Rust programming language application—combined with Nordic’s new leak sensors with LTE-M and NB-IoT, the Marker-I and Stratosfy Marker-IO devices. The Marker-I and Stratosfy Marker-IO devices.

The beacons can concurrently support Apple’s iBeacon and proprietary Stratosfy-IO beacon technology, and once installed at a facility, can be used for distance calculations between a service point and an employee’s smartphone. The technology can allow for proximity-based services such as parking lots and garbage bin areas.

Insurers are increasingly making use of wireless IoT technology to help monitor potential water damage threats, environmental changes, and sound monitoring equipment. The platform allows farmers to get a complete picture from all the sensors spread across their property, without needing to install costly infrastructure.

Nordic’s CEO, Tore Larsen, says, “The important thing is to understand what’s needed to strengthen our international position as a driving force for a green industrial boost.”

"This will be decisive for the transition to products and services that have significantly fewer negative consequences for the climate and environment than today.""
Smart shelf labeling system remotely updates product pricing

Shenzhen Minew Technologies, a China-based technology company, has released a smart shelf labeling system that enables an operator such as a retailer to automatically update individual shelf price labels across multiple stores, or in certain geographic locations, from a central point. The Minew ESL (Electronic Shelf Label) solution comprises the proprietary ESL Cloud Platform, the ETL gateway integrating Nordic’s nRF52810 SoC, and the electronic shelf labels of various dimensions each integrating the nRF52810 SoC. The dynamic displays can remotely updates product pricing of various dimensions each integrating the Nordic’s nRF52810 SoC. The dynamic displays can be used as beacons for marketing to consumers in close proximity via compatible apps on the consumer’s smartphone. The labels also report back to the gateway and the Cloud platform, allowing retailers to remotely manage their stock and the positioning of products on shelves. Aside from the retail sector, the solution can also be used for applications across warehouses and logistics, healthcare and smart offices.

Smart Health

Reusable, wearable sensor records mask performance

Researchers have developed a lightweight, reusable sensor that clips onto a face mask to monitor how well it’s working. The device, called FaceBit, senses leaks and records wear time while continuously measuring a wearer’s heart and breathing rate. Its developers hope it will aid research and help health care workers and others who wear face coverings throughout the day to battle the transmission of diseases such as COVID-19. Rather than developing an entire smart mask, which might be impractical to reuse, the team created a small electronic device that attaches to a face covering with a magnetic clip and contains several sensors. A pressure sensor detects leaks, indicating how well a mask is fitting, and also enables the FaceBit to determine when the mask is over someone’s face. so it can record wear time and can enter sleep mode when idle. The FaceBit additionally monitors heart rate with a sensitive accelerometer that records minuscule facial skin movement caused by each pulse beat. It also measures breathing rate with a temperature sensor. A Bluetooth LE wireless connection transmits the data to a companion smartphone app, which displays the data in real-time and displays notations when leaks are detected or if breathing rate and heart rate slow down. The device activates the injector that delivers naloxone which rapidly restores breathing. If cessation of breathing is detected, the device activates the injector that delivers naloxone which rapidly restores breathing. If cessation of breathing is detected, the device activated the injector that delivers naloxone which rapidly restores breathing. If cessation of breathing is detected, the device activates the injector that delivers naloxone which rapidly restores breathing. If cessation of breathing is detected, the device activates the injector that delivers naloxone which rapidly restores breathing. If cessation of breathing is detected, the device activates the injector that delivers naloxone which rapidly restores breathing. If cessation of breathing is detected, the device activates the injector that delivers naloxone which rapidly restores breathing. If cessation of breathing is detected, the device.

Pricing commands are sent wirelessly from the web-based dashboard on an NFC to gateways located at a store. From there the commands are then relayed to the smart labels using the Bluetooth 5 connectivity provided by the Nordic SoC. Designed to replace traditional paper tags that need to be manually updated, Minew ESL labels allow users to achieve benefits such as improved price visibility, reduction in pricing errors, promotional capabilities, labor cost reduction and an enhanced customer experience. In addition, the smart labels can be used as beacons for marketing to consumers in close proximity via compatible apps on the consumer’s smartphone. The labels also report back to the gateway and the Cloud platform, allowing retailers to remotely manage their stock and the positioning of products on shelves. Aside from the retail sector, the solution can also be used for applications across warehouses and logistics, healthcare and smart offices.

Smart Health

Wireless wearable targets overdose deaths

University of Washington researchers have developed a closed-loop wearable naloxone injector system they claim could help in reducing opioid overdose deaths. Opioid toxicity is readily reversed with naloxone which rapidly restores respiration and decreases sedation. The Proof-of-Concept solution comprises a pair of on-body accelerometers that measure respiration, and a Nordic Semiconductor SoC tracking the subject’s body motion and respiration. If cessation of breathing is detected, the device activates the injector that delivers the antidote to the individual. Bluetooth LE wireless connectivity enables information to be relayed to a smartphone to notify first responders as well as family and friends.

Smart Home

Nordic-powered smart lock reimagines the home entry experience

An Apple HomeKit- and Amazon Sidewalk-compatible smart lock that can be retrofitted onto almost any existing door has been launched by California-based company Level Home. The Bluetooth LE-based Lock uses a combination of Nordic’s nRF52840 advanced multi-protocol SoC and enables instant and secure keyless entry to its authorized users. The smart lock is paired to a user’s smartphone where from the Level Home app users can automatically lock and unlock their door without the need for a physical key, and send digital keys to authorized guests; for example a tradesperson, friend or babysitter. From the app, users can also set specified entry periods for guests with a ‘Party Pass’ feature, create a single pass for multiple people to use, as well as view a record of the smart lock’s activity.

The Nordic nRF52840 SoC incorporates features that support a range of cryptographic services for secure applications, and support Level Lock’s security requirements for the unlocking process. Nordic-powered Apple HomeKit and Amazon Sidewalk compatibility provides the user remote connectivity to Level Lock via HomeKit hub or Sidewalk-enabled devices. The ability to connect to either Apple, Amazon, as well as third party smart home devices allows consumers to perform automations or create linked events, for example turning on lights or activating security cameras once the door has been locked.

Smart Home

Wonderlabs ecosystem wirelessly controls appliances

Tech company, Wonderlabs, has launched a smart home ecosystem for automated control of a range of Nordic-powered, sensor-based smart home devices and peripherals. The SwitchBot ecosystem includes the SwitchBot Curtain and SwitchBot Bot that can be used independently or in conjunction with each other using a proprietary Bluetooth-based mesh networking solution. The user can wirelessly configure and control the devices from a smartphone app. SwitchBot Curtain is a motorized device that can transform an existing curtain rod and rail curtain into an automated smart curtain system controlled by the companion app, a remote controller device or a compatible smart home ecosystem such as Amazon Alexa, Apple Siri and HomePod or Google Home. Using the functionality of its built-in sensors, the device can be scheduled to close curtains at night and open curtains when it senses daylight. SwitchBot Bot mechanically turns on or off appliances in a home or office that employ a button or rocker switch, for example a coffee machine. The device can be controlled using the companion app or via voice control.
Cellular IoT

Nordic and Acklio optimize live NB-IoT network

Static Context Header Compression will significantly simplify the deployment of NB-IoT LPWANs, optimize throughput and bring IPv6 to Non-IP Data Delivery

LPWANs are a fundamental element of the IoT. They form a critical link between short range wireless networks or a supported end device and the Cloud, bypassing a gateway. The cellular IoT technology, NB-IoT, is a leading LPWAN solution and offers up to 15 kilometer range together with low power consumption. Further optimization of NB-IoT can be achieved by reducing data overheads, improving network capacity and lowering latency. To make it easier to implement this optimization the [SCHC](https://github.com/IETF/schc) introduces lower IP overheads for a cellular IoT device to eliminate all IP headers from the radio packet, and to send just the packet payload through the carrier network. This so-called [Non-IP Data Delivery](https://www.3gpp.org) (NIDD) is an optional communication method available on a growing number of NB-IoT networks.

"LPWANs enable many processes and things to be measured in a smarter and battery-efficient way," says Afzal Mangal, Founder of IoT Creators, an IoT connectivity firm. "The various solutions that can be built on them are innumerable. But sometimes the LPWAN by itself is not enough. In cases like that, NIDD can provide the solution by reducing both data [traffic] and battery consumption." However, NIDD does bring some disadvantages that have staked its deployment. (See sidebar p7) Addressing the challenges of NB-IoT with NIDD. But now Nordic Semiconductor and Acklio, an IoT software company have collaborated to demonstrate a solution that overcomes these drawbacks. The solution combines Nordic’s nRF9160 low power SiP and Acklio’s Static Context Header Compression (SCHC) technology. The SiP combines an Arm Cortex-M33 dedicated application processor with integrated LTE-M/NB-IoT modem and GNSS and is a popular solution for cellular IoT products. The demonstration was made possible in an alive NB-IoT network thanks to Deutsche Telekom IoT access provider, IoT Creators, with its IoT access management platform and integrated SIM.

Network optimization and security gains

For the live NB-IoT network demonstration, the Nordic SiP used NB-IoT with NIDD and then employed Acklio’s SCHC to both compress and fragment messages exchanged over the network. This compression and fragmentation technique is tailored to the needs of LPWANs and is the key to the network optimization gains for network-equipment using both SCHC and SCHC with NIDD compared to networks using NB-IoT alone. Crucially, SCHC also brings IPv6 inter-operability between NB-IoT with NIDD and other LPWANs, as well as the rest of the Internet. “Once deployed at large scale, SCHC will unlock a technical barrier that has threatened to stall IoT traffic by directly addressing the inherent limited throughput and capacity of NB-IoT and the lack of IP interoperability of some LPWANs,” says Lorenzo Amicucci, Business Development Manager with Nordic. “LPWANs are critical to the success of the IoT and SCHC will significantly simplify their deployment.”

Additional gains resulting from the use of SCHC include enhanced network security, lower power consumption, less complexity and increased end-device density. “While SCHC has been successfully deployed on other LPWAN networks, this is a world-first demonstration of this leading edge technology on a non-IP cellular IoT network,” says Amicucci. He noted that the demonstration’s success relied on the combination of Acklio’s expertise in SCHC, which is now an [Internet Engineering Task Force (IETF)](https://www.ietf.org) working group, and Acklio’s founders played a vital role in the development of SCHC and formed a key part of the IETF IPv6 over-LPWAN working group that defined the specification.

SCHC tackles the challenges introduced when using NIDD by compressing and fragmenting messages exchanged by wireless networks. By adding SCHC, NB-IoT devices become IPv6 compatible, and can support UDP and DTLS communication. The result is a significantly network with lower power consumption, but with dramatically reduced traffic compared to a conventional NB-IoT implementation. Further benefits include higher network security and simplicity. Moreover, by enabling DTLS communication and optimization, engineers can solve some of the typical challenges caused by dynamic IP and frequent DTLS resumptions in cellular IoT networks, yielding even lower power consumption.

A demonstration of Acklio’s SCHC running on Nordic’s nRF9160 SiP with NIDD in a live European NB-IoT network achieved a 74 percent reduction in traffic when using SCHC with NIDD compared to conventional NB-IoT communications. The demonstration also showed a minimum 64 percent reduction in traffic compared to a conventional NB-IoT network without SCHC (or NIDD). (See Figure below.)

Addressing the challenges of NB-IoT with NIDD

While improving NB-IoT efficiency, Non-IP Data Delivery (NIDD) has some drawbacks that have slowed its deployment. These disadvantages include lack of interoperability with other LPWAN technologies, added complexity and lack of support for IPv6, User Datagram Protocol (UDP) and Datagram Transport Layer Security (DTLS). IPv6 is the latest version of the Internet Protocol and provides the identification and location system for computers connected to the network plus traffic routing. UDP is part of the IP suite and minimizes latency for loss-tolerant connections across the network. DTLS provides security for communications using UDP.

Static Context Header Compression (SCHC) is a compression and fragmentation framework tailored to the needs of LPWANs and was adopted as an open standard in 2020 by the Internet Engineering Task Force (IETF). French firm Acklio’s founders played a vital role in the development of SCHC and formed a key part of the IETF IPv6 over-LPWAN working group that defined the specification. SCHC tackles the challenges introduced when using NIDD by compressing and fragmenting messages exchanged by wireless networks. By adding SCHC, NB-IoT devices become IPv6 compatible, and can support UDP and DTLS communication. The result is a significantly network with lower power consumption, but with dramatically reduced traffic compared to a conventional NB-IoT implementation. Further benefits include higher network security and simplicity. Moreover, by enabling DTLS communication and optimization, engineers can solve some of the typical challenges caused by dynamic IP and frequent DTLS resumptions in cellular IoT networks, yielding even lower power consumption.

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See Figure below.

**Tech Check**

The compact nRF9160 low-power SiP features a dedicated application processor and an LTE-M/NB-IoT modem in a compact 6x6x1.8 mm package. The SiP supports both SIM and eSIM, PSM and eDRX power saving modes, NB-IoT and other NB-IoT/SPP profiles/4 features.

**Figure below.**

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<th><strong>Traffic handshake (in bytes)</strong></th>
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Bills of battery-powered wireless IoT sensors are expected to connect and enhance tomorrow’s world. But reaping such ubiquitous connectivity will come at an energy cost. According to a new Transforma Insights and 6G World report, *Sustainability in New and Emerging Technologies to 2030*, building the IoT from now until 2030 will increase global electricity use by 34 terawatt-hours (TWh), with another 3 TWh equivalent in hydrocarbon fuel used to power assembly equipment to make the IoT’s components. Further, water consumed during the manufacture of IoT-enabled solutions will reach 112 million cubic meters. The report also goes on to state that deploying the IoT will result in the equivalent of an additional 5.1 TWh equivalent of hydrocarbons used for distribution and deployment of solutions. In addition to the up-front energy cost of building the IoT, the infrastructure will bring further environmental impact through the manufacture (and disposal) of batteries for IoT products that may need replacing several times during the life of the device. Finally, the energy consumed by the Internet and the Cloud infrastructure needed to support IoT applications must be taken into account. Overall it’s a massive energy impact. But, the report concludes, the positive environmental impact of IoT applications will make the cost well worth the initial sacrifice.

### Saving more than it consumes

The Transforma report states that the IoT’s impact ultimately prove its worth and then some. For example, IoT applications will save over 1.8 petawatt-hours (PWh) of electricity in 2030, up from 0.6 PWh in 2020, plus the equivalent of an additional 3.4 PWh of hydrocarbon fuel. This will result in total savings of around 5.2 PWh of energy. On the debit side, 653 TWh of electricity will be used to power IoT applications. The result is that IoT technology will soon generate enough savings to pay back the energy cost of its manufacture and deployment and then some will save around eight times the energy it consumes.

IoT devices will also conserve nearly 2.3 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. How will the IoT re-consumingly negate its development and deployment footprint? In part because IoT solutions are strategically designed to deliver power saving advantages, claims Jim Morrish, Founding Partner of Transforma Insights. “Many enterprise applications are deployed to increase efficiency, and those gains generally outweigh the energy footprints of the solutions themselves,” he says. Moreover, the benefits of big data are expected to be crucial. When combined effectively with ML applications, for example, the IoT will generate swathes of information to help people and organizations better understand energy costs, and subsequently to make better environmental decisions.

### The benefits of enterprise IoT

The key environmental benefits from the IoT will largely come from enterprise solutions. This is because IoT consumer devices are intended to deliver an enhanced value proposition to consumers, while enterprise solutions are generally associated with some level of increased efficiency. These efficiency savings will often take the form of reduced electricity consumption, or reduced water usage. For example, by 2030 the most impactful electricity saving applications will be associated with smart electricity grid operations, the report predicts. IoT applications could enable these savings to be made directly by enabling tasks to be completed more efficiently, or indirectly by saving consumption in related areas. An example of the latter is smart city traffic congestion mitigation where the savings come in part from vehicle fuel savings and in part from reduced health costs due to lower respiratory problems for citizens. The report estimates that savings from enterprise IoT will account for 95 percent of electricity savings from all IoT solutions. However, there are notable exceptions, including building automation and smart lighting, which will generate significant sustainability benefits in both consumer and enterprise applications. Utilities aren’t waiting until the end of the decade to realize the IoT’s benefits; they’re already changing how they do things to enhance grid performance and maximize efficiency. For example, the Nordic (BGRIV) NR-powered Agility Any solution enables a domestic water heater to be controlled remotely across an LTE-M/Wi-Fi, limiting electricity consumption during peak periods. Such management can help the utility avoid firing up costly and inefficient auxiliary power stations to meet extra load. Elsewhere, Itras is using Nordic cellular IoT tech in its RAM-1. The device is helping utilities monitor smart grids to enhance their efficiency and make it easier to connect renewable energy resources to the network. (See *WQ* Issue 2, 2021 pg22)

### Birth of a massive IoT standard

When established wireless technologies don’t match the demands of novel applications, new specifications are created. Multiple wireless technologies exist because no single solution perfectly suits all use cases. But occasionally an engineer comes up with an idea that’s not covered by any of the existing solutions. One example of this is applications that demand high density, low latency, high reliability and range like building automation, utility metering, process automation and logistics.

*Before now, building a private 5G network required a lot of investment*

Nordic Semiconductor is a key contributor to the new wireless standard that targets these “gaps” in the current 5G ecosystem. For example, Nordic’s NB-IoT standard is such that the International Telecommunication Union (ITU) has included it as part of the 5G standard. Notably, DECT-2020 NR is the first non-cellular 5G standard included in the ITU’s document. The DECT-2020 NR standard will effectively enable enterprises to easily set up managed and critical IoT applications, while maintaining their private 5G network and running on a single core.

Svein-Egil Nielsen
CTO/EVP R&D and Strategy

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Many enterprise applications are deployed to increase efficiency and those gains generally outweigh the energy footprints of the solutions themselves.
### Living the Dream

Matter, a new unifying connectivity standard with support from the biggest tech companies in the world, stands to revolutionize the smart home.

### A Long-Standing Problem

For modern homeowners, most of who are well-adapted to using technology but who have been groomed to expect ‘plug-and-play’ performance, the interoperability of today’s smart home devices is a recipe for disillusionment. Frustrations commence early, even before buying the product. Prior to making a purchase, consumers must decipher which devices are compatible with which ecosystems, networks, and home assistants.

Because that’s far from easy, some resign themselves to staying within the one ‘walled garden’; solely buying products compatible with a single manufacturer, such as those targeted at Amazon’s Alexa or Apple’s HomeKit. But in doing so, they limit their choice of products and suppliers. Others opt for the ability to choose from a wider selection of manufacturers, but then take on the unenviable task of troubleshooting and seeking workarounds to the inevitable compatibility and interoperability issues that arise. And even where a device boasts compatibility with multiple ecosystems, it still may not support all features on all ecosystems to the same degree. These adventuresome consumers learn to live with the disappointment of an unrealized dream – that of the fully integrated smart home.

The problems radiate beyond consumers. To minimize interoperability and fragmentation issues, product developers and manufacturers create largely identical versions of their products but tweaked to work with different ecosystems. This a duplication of effort, additional cost and unnecessarily increased complexity. Even retailers and distributors are affected, with display and storage space taken up by these duplicate versions of the same smart home product.

**By the Numbers**

- **Global smart home penetration 2021**: 12.2%
  
- **Bluetooth smart home device shipments in 2025**: $670 million
  
- **Smart home global market value in 2025**: $182.4 billion

The issues with interoperability have been known and talked about in the smart home industry for years. Failure to overcome the challenge has seen a state of malaise set in, among even analysts and commentators closely tied to the industry. “The smart home is dead,” declared renowned expert in all things IoT, Stacey Higginbotham, in her publication *Graffiti on the Wall*. “I thought that we would have solved interoperability challenges by now, and made the connected home easier for mainstream consumers to use.”

**By some estimates, there are around 175 million individual smart home devices in the world today and there will be more than 13 billion in active use by 2025.**

### In Short

The promise of the fully integrated smart home has fallen short, with disjointed and inconsistent consumer experiences and manufacturers facing increased complexity. Matter is a new open-sourced connectivity standard developed for disparate ecosystems and manufacturers facing interoperability challenges. This a duplication of effort, additional cost and unnecessarily increased complexity. Even retailers and distributors are affected, with display and storage space taken up by these duplicate versions of the same smart home product.

Matter will drive improvements by freeing developers and manufacturers from grappling with interoperability and allowing them to focus on their core competencies.

**During the summer of 1959, the U.S. took the American National Exhibition to Eastern Europe, with the aim of showing communist nations the kind of advances made possible by capitalism. In one display was a demonstration kitchen featuring centrally controlled lights, a robot floor cleaner and a moving dishwasher that not only cleaned and dried dishes, but even put them away. But the so-called ‘Miracle Kitchen’ was just that – a fantasy constructed less from technology than from trickery, with the primary aim of persuading the audience that the future belonged to the West.**

**Fortunately, genuine strides forward in home automation were not far off. Less than a decade after the Eastern European event, Westinghouse engineer James Sutherland designed the Echo IV, a prototype automation system that could control the temperature and turn on appliances in his home. And by 1984, the term ‘smart house’ had been coined by the American Association of House Builders.**

**Since then, a flurry of wirelessly-connected smart devices have rolled into the home, bringing automation and convenience to domestic life. Think of connected speakers, light bulbs and blinds, all able to be remotely activated by smartphones or dedicated home assistants. By some estimates, there are around 175 million individual smart homes in the world today and there will be more than 13 billion smart home devices in active use by 2025.**

**Though it sounds impressive, at least some of this progress is a mirage. While there’s no doubt that individual connected products do provide homeowners with benefits, the promise of the fully integrated smart home has fallen short, with consumer experiences of the technology commonly disjointed, inconsistent and downright irritating.**

**The core issue is that smart home devices often don’t work well together. Products built for one ecosystem won’t always work as planned in another. For example, a digital voice assistant from one manufacturer often encounters issues when trying to configure and control smart lights or a home alarm system sold by another vendor. It’s a problem that’s not going away as hundreds of brands operate across dozens of device types in the smart home space.**
A RENAISSANCE COMING

But amid this gloom, a new hope for the smart home is emerging. The industry is facing the largest barriers to widespread adoption, and technological fragmentation is one of the biggest hurdles. This new hope is embodied in Matter, a connectivity standard for the smart home.

Matter, a Connectivity Standard for the Smart Home

Matter is a connectivity standard developed by Connectivity Standards Alliance (CSA), formerly known as Project Connected Home over IP (CHIP). It aims to simplify the selection, setup, and control of smart home devices, while also providing interoperability among different brands and devices. One of the strongest selling points for Matter is the potential for consumers to have a single standard that simplifies selection, setup, and control, and makes it easier for device makers to innovate and compete.

For a standard to have successful uptake and long-term viability, it must have industry buy-in, and Matter’s level of support gives it immense credibility and momentum. The stature and breadth of the alliance have rightly been described as an “unprecedented industry coalition”. For many of the industry players involved, the incentives are plain to see. Having invested considerable resources in the smart home market, the prospect of a standard that could turbocharge the growth of the industry is highly appealing. These companies have also realized the role they must play in driving the change needed. “It’s up to us to simplify the smart home, and to start we must change the way device makers build products,” says Michele Turner, senior director at Google Smart Home. “There should be one standard that simplifies selection, setup, and control, and makes it easy for our partners to create products and experiences for your home.”

A POWERFUL ALLIANCE

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A LOOK UNDER THE HOOD

Various connectivity standards have emerged as the home automation and smart home industry has matured over the years, among them Zigbee, HomeKit, and Thread. These standards have existed for years, but they have not yet met the mark in terms of widespread adoption. One of the reasons for this is the lack of interoperability among devices from different manufacturers. This is where Matter comes in.

Matter simplifies the selection, setup, and control of smart home devices by providing a common data model to develop to, ultimately guaranteeing the compatibility and interoperability of their products. For consumers, Matter promises greater simplicity, as they don’t have to worry about whether their devices will work together. The Matter seal of approval on devices they purchase and have confidence they will work together – from set-up through to use. As a result, Matter has been met with widespread support from the industry.

Special Report: Smart Home
Matter solves this by providing interoperability between existing connectivity protocols—specifically Wi-Fi, Thread and Ethernet. Moreover, since Matter is IP-based, it provides developers with a common and well established foundation for communication.

Thread is one of Matter’s primary connectivity protocols because it is a secure wireless mesh network specifically developed for the smart home by the Thread Group (which included Google as a founder member), and as a result it is tuned for reliability and low latency. Thread also works particularly well for lower power devices such as sensors and door locks—the kind that must run for several years on small batteries and are categorized as ‘Sleepy End Devices’ (SEDs). Lower power Matter devices will typically run across a Thread network, while devices with higher power and data bandwidth needs will use Wi-Fi. Thread border routers—key parts of the network which bridge from the Thread mesh to Wi-Fi, Ethernet or the Cloud—are also mainly mains powered.

Matter will initially support the Thread, Wi-Fi and Ethernet protocols for device-to-device communication with Bluetooth LE—primarily because of its mature smartphone interoperability—being used for commissioning new devices to the network.

Setting up new devices has long been a pain point for smart home users. Matter members are tackling this challenge with gusto: a key example is Amazon’s Frustration-Free Setup (FFS). According to Amazon’s DeCenzo, FFS is a “zero-touch” experience designed to enable consumers using Amazon’s ecosystems to simply take a device out of the box, plug it in, and wait for automatic connection to the smart home network. Amazon says it is working with leading brands to launch FFS on its Matter-certified devices.

THE FREEDOM OF CHOICE

The ‘Multi-Admin’ feature of the Matter spec will enable connected devices to be easily controlled by multiple smart home users. Multi-Admin liberates customers from single-vendor walled gardens and gives them the freedom to mix-and-match according to preference—for instance,
Why consumers choose smart home tech

The poster child of the smart home is the smart speaker. Apart from being convenient for playback of audio, these units act as digital assistants and increasingly powerful home automation hubs. Products from Amazon, Apple, Google and others will be found in 25 percent of U.S. households by as soon as 2025 claims Statista, a popular yet, but not all there is to the smart home. Consumers are adding automation and intelligence to their homes for five key reasons:

- Energy savings: Energy savings convenience (such as having the lights come on and blinds lowered) safety and security; automating household chores; and entertainment.

- Convenience

- Security

- Remote monitoring

The introduction of Matter is also influencing chip makers, with silicon and software being optimized for the new standard. The chip plays a critical role in the performance of a smart home solution, says Finn Boeotius, a Product Marketing Engineer with Nordic Semiconductor. In Matter applications, chips need to run the actual application—that is the switch, lightbulb or smart hub—as well as handle multiple wireless protocols at the same time, he says. If you have a battery-powered smart home device you’ll want it to be on a chip that’s optimized for low power but plenty of power to handle the application. While the potential of Matter is clear, it is going to take some time before it’s realized—but not as long as you might think. Boeotius says Nordic customers are actively developing Matter devices today using the company’s nRF52840 and nRF5340 SoCs, which support Thread and Bluetooth LE. And with the company’s recent expansion into Wi-Fi, Nordic Wi-Fi Products will also support Matter. Nordic has also integrated the latest Matter development tools into its JREX Connect SDK. The company is playing a pivotal role in the continued development of the Matter standard and its promotion. Of the 200+ companies involved in Matter, Nordic engineers are among those from only nine companies that can make changes to its implementation on code repository GitHub, says Krysztof Loska, Technical Product Manager at Nordic. The company also prominently showcased Matter’s interoperability capabilities at the recent CES 2022 exhibition, through a demonstration comprising a Google Nest hub controller, Google Pixel phone, Eve smart plug, Leedarson RGBW light bulb, Netatmo contact and occupancy sensor, Yale door lock and Nordic Thing S3 “weather station”, all running on the Matter standard across a Thread network. Loska also points out that the Nordic SoCs already in the field powering Thread devices can take advantage of an over-the-air-software update to become fully Matter compliant. This means manufacturers that embraced Thread early and have already shipped thousands of units can seamlessly upgrade those products to the Matter standard.

STEPping up on security

As the smart home market starts to boom, security will become ever more important. The expanding number of disparate device manufacturers entering the industry, each with varying commitments to product security, potentially creates unwelcome opportunities for cyber-attack. But with Matter gaining force as the de facto smart home standard, it becomes easier to create a baseline of standardized security expectations. “We are secure by default and in a zero-trust environment, we use specific industry-standard encryption technology, and every device gets authenticated before it joins the network,” says Michelle McInnis-Freeman, head of marketing at CSA. “Every message is secured on the network, and Matter supports secure over-the-air updates.”

As a standard Matter will continually inspected and strengthened. CSA says Matter’s security is supported by a proactive community of members that perform activities such as threat modeling and mitigation. Privacy also comes into sharper focus in a world of greater device interoperability, which will likely see greater data sharing among devices. Matter has published a set of Matter Privacy Principles that make clear its focus on privacy, particularly in its commitments to data minimization and ensuring data shared between Matter devices is restricted to the purpose of supporting the specific operation of those devices. The design of Matter, which allows devices to operate locally without needing to send data to the Cloud, is also a significant advantage in maintaining privacy.

Matter is scheduled to be completely rolled out in the middle of 2022 with the release of the final Matter specification, SDK and a certification program. Matter-certified devices should become available to consumers by the end of 2022. Previously published timeframes have been pushed back. The pandemic undoubtedly played a role, but the larger truth around these delays is the scale of the challenges involved. Creating a specification to support interoperability across several distinctively developed ecosystems involving large stakeholders understandably requires precise crafting and substantial testing. Once the standard is bedded down, Matter is expected to develop into an arms-length specification. With the issues of interoperability resolved, device manufacturers will be free to focus on their core competencies, rather than on apps and architectures to support embedding of devices to divergent networks and ecosystems. As walls garden crumble, customer lock-in will also fade away, meaning manufacturers will need to work harder to attract customers.

When it does arrive, Matter will herald a new dawn. After being little more than a niche obsession for enthusiasts and a hope for the rest of us, the smart home finally looks set for the masses to live the dream.
** Alive & Ticking **

Advanced wearables powered by sophisticated wireless tech are moving beyond fitness to deliver better health outcomes

When 45-year-old Florida resident Jason Saucier woke up feeling unwell, he didn’t as many of us did before the pandemic, and brush it off as nothing serious and went to work. When he later put on his Apple Watch it started making a sound he had never heard before. On looking at his smartwatch it told him he was in AFib or atrial fibrillation, a type of heart condition that can increase your risk of stroke and other serious heart complications. Saucier wisely decided to head to the emergency room at his local hospital where the doctors confirmed what his smartwatch had been urgently trying to tell him – he was close to going into cardiac arrest.

Saucier is not alone. With an estimated 325 million people using wearables worldwide, you don’t have to look far to find other examples of wearable technology that has saved lives. Be it smartwatches notifying emergency services when their fall-detection sensor is triggered, or electrocardiogram (ECG) functionality detecting an irregular heart rhythm, increasingly powerful wearables have evolved from the activity trackers and calorie counters of a decade ago. Today these devices not only help keep their owners fit, they also notify them of signs remotely.

The latest generation of SoCs (System on a Chip) powered by processors that can easily manage complex software algorithms and supervise the sensor hardware of high-end devices has scaled faster than imagined. In 2016 in the fitness tracker and smartwatch sector alone, 89 million devices were shipped according to analyst, CCS Insight. At the end of last year, that number was around 300 million, with no end to the growth curve in sight. When asked what their number one expectation was from their wearable in 2018 Pricewaterhouse Coopers (PwC) survey, 70 percent of respondents said they expected their device to help them live longer, albeit perhaps not in quite as dramatic a fashion as Jason Saucier’s Apple Watch did for him.

**LIVE LONG AND PROSPER**

Beyond consumer demand, other factors have also converged to drive the development and uptake of increasingly sophisticated wearables, not least COVID-19. The pandemic and the stress it placed on global healthcare systems saw the fast-tracking of countless IoT-based devices and ‘wearables’. The U.S. Food and Drug Administration (FDA) – responsible for ensuring the safety and efficacy of medical devices in the country – grappled with how to regulate the new technology that blurred the lines between consumer gadget and medical device, but at the same time had the potential to reshape how healthcare systems managed the COVID-19 crisis. Ultimately the pandemic forced a rethink.

In March 2020 the FDA issued a new policy allowing manufacturers of certain FDA-cleared, non-invasive, vital-sign-measuring devices to expand their use so healthcare providers access information about a patient’s vital signs while the patient is at home, reducing the need for hospital visits and minimizing the risk of exposure to coronavirus, FDA Principal Deputy Commissioner Amy Abernethy, M.D., Ph.D. said.

Such devices provided a key early warning system about the likelihood of COVID-19 infection by monitoring an individual’s physiological data such as blood oxygen saturation, respiratory rate, heart rate and temperature. At the same time the devices used AI and deep learning for infection surveillance in different scenarios from screening to contact tracing. The FDA’s seal of approval, while welcome, came too late for some.

“If health systems had accelerated the adoption of wearable technology available over the past few years, the magnitude of the current pandemic would likely have been much less severe,” said Asima Chanda, an early stage researcher from the Polytechnic University of Bucharest, in a paper titled The Rise of Wearable Devices during the COVID-19 Pandemic. “The potential of wearables in healthcare is enormous...but wearables must have multifunctional capabilities and be easily configurable.”

**TRANSFORMING HEALTHCARE**

While the SARS-CoV-2 virus has helped accelerate the development of multifunction wearables, they are now equally playing a vital role in the prevention and management of a host of other diseases from the physiological – diabetes, hypertension and sleep apnea, for example – to neurocognitive disorders such as Parkinson’s disease and Alzheimer’s. They are also proving their worth for drug delivery applications.

In so doing, they are driving a transition in healthcare from a conventional doctor–patient relationship, where diagnosis and treatment was previously based on a fragmented medical history and medical records, to a digitally mediated consumer-led model. That latter model makes it possible to generate rich data sets that enable health providers to offer more personalized health decisions, make earlier diagnoses, perform remote patient tracking and ensure prescription adherence.

The medical profession is largely in favor of the potential of wearables for patient care but advise caution, particularly if the onus will be on physicians to sort through the massive amount of data the devices collect. “The engineers have been able to give us all this data and create all these all these sensors,” Dr. Mohamed Elshazly, a cardiac electrophysiologist at the Cleveland Clinic told The Verge. “Now it’s up to us to analyze that data and figure out how to make clinical sense of it.”

“Engineers have been able to give us all this data and create all these sensors, now it’s up to us to analyze that data and make clinical sense of it. To do so, Dr. Eric Topol and Lionel Tarassenko, a biomedical engineer known for developing early-warning systems in critical care, said medicine needed to take a lesson from the aviation industry. (See sidebar pg 25 Aviation offers lessons for health monitoring.) Writing in the International society reviewed medical journal, JAMA, the pair said jet engines with 100,000 individual parts are monitored constantly with readings taken on temperature, pressures, shaft speeds and vibrations. Machine learning (ML) is used to detect when readings veer from established patterns and produce early warnings that unscheduled maintenance is needed.

“The full potential of health monitoring for people...
**WEARABLE AI AND ML**

While they may not be able to supervise a modern jet engine, the SoCs and SiPs that power the latest generation of advanced wearables are well equipped to oversee the requirements of even the most sophisticated medical wearables. And that includes support for the ML algorithms that will be needed to sift through volumes of data for signs that things are going wrong.

For example, Nordic Semiconductor’s nRF5340 SoC provides developers with both a high-performance application processor and a fully programmable, ultra-low power network processor. The dual processors eliminate any tradeoff between processing capability and power consumption, while Arm CryptoCell-312, Arm TrustZone technology and Secure Key Storage enable advanced root-of-trust and secure firmware updates to help defend against unwanted hacking. A partnership with Edge Impulse, a specialist in TinyML (a scaled-down form of ML algorithms), also allows developers to benefit from easy to use AI and ML features as standard.

“Computing on edge devices such as wearables is getting progressively more energy efficient and powerful while algorithms are more streamlined and energy optimized,” says Petter Myhre, Nordic’s Head of Product Marketing. “While they may not be able to supervise a modern jet engine, the user interface can be customized to make sure the alerts are meaningful and efficient.”

**MAKING SENSE OF MASSIVE DATA**

Developers are already taking heed. In response to the pandemic, Polish medical startup Warmie developed a battery-powered, medical grade wearable wireless temperature sensor. The device is designed to rapidly detect changes in body temperature, providing localized continuous temperature and infection monitoring of post-operative surgical wounds in and out of hospital.

It is designed to be easily integrated into telemedicine systems so the body temperature of many patients can be reviewed simultaneously from a single web-based dashboard, without having to attend to the patient in person. It can also be used by consumers such as parents with young children, or patients themselves who want to ensure their own health after leaving hospital.

“Because temperature measurement is traditionally taken manually several times a day, they often miss critical changes that can indicate an infection,” says Warmie’s Founder Tomasz Baraniewicz, M.D. PhD. “An infections left untreated can quickly become more widespread within the body, and thus much harder to treat.”

The ‘Warmie Sensor’ is powered by Nordic’s nRF52810 SoC and its 64 Mhz, 32-bit Arm Cortex-M4 processor that enables the device to not only record single-point temperature measurements but also evaluate patterns of temperature changes that can be spread over several parts of the body, and alert clinicians or users of potential health risks.

“Body temperature changes throughout the day – so it is more accurate to assess many time series measurements and perform pattern recognition in comparison to an individual patient’s baseline,” continues Baraniewicz. “This gives significantly more accurate results compared to traditional manual temperature measurement methods.”

Another company developing wearable products that offer benefits to both the medical sector and consumers is Norwegian tech manufacturer, Apisens. The company’s ECG24T Smart Heart Sensor is a wearable ECG heart monitor designed to detect atrial fibrillation and other cardiac arrhythmias. Medical professionals can use the platform to remotely manage and screen people who are at increased risk of stroke due to heart rhythm disorders or who have symptoms of rhythm disorders such as palpitations or fast heart rate. The solution can also be used by patients to self-test their own heart health, including during exercise or activity.

The device consists of a disposable electrode-patch to fasten the sensor to the patient’s chest and a reusable electronic component to achieve reliable electrical connection for the measurement of ECG signals. The Integrated Nordic nRF52810 SoC’s powerful Arm Cortex-M4 processor not only supervises the wearable’s integrated sensors but also supports the complex computations necessary to run the proprietary algorithms for measuring and analyzing the heart’s electrical activity.

“The uniqueness of the ECG24T is the capability for the sensor to analyze in real time for arrhythmia episodes and give both the patient and doctor an immediate result,” says Ford Yttrdahl, CEO of Apisens. “Patients obtain a quick medical response; at the same time clinicians gain remote diagnostics and telemedicine services.”

As wireless wearables transition to multifunction medical solutions, their ability to further disrupt healthcare will in part depend on the AI, ML and ML algorithms to perform ‘novelty detection’ on flight data. This enables them to identify problems that fall outside of clearly defined vibration tolerances and performance parameters, without having to wade through gigabytes of non-essential data.

As advanced health wearables mature and bring with them the promise of doctors using these devices to support the diagnoses, the medical profession is faced with an even trickier predication than their aviation counterparts. Engineers knew well that a run in the car could cause yet another problem if the human body normal is not well defined.

“Then how to best use the vast quantity of data wearables collect and ensure it can be used productively to support a diagnosis and not generate false alarms?”

According to researcher Dr Eric Topol, the key will be to follow aviation’s lead and employ AI and ML algorithms to rely to extract clinically meaningful data from the rest.

The processor in today’s advanced wearables make AI and ML easily accessible to developers, even on the optimized wireless SoCs that needs to fit in a minimized footprint of a wearable. And in so doing, wearables can help physicians more clearly determine what patient physiological data is normal and therefore not pertinent to a diagnosis, and more importantly what data is not, and thus justifies further investigation.

**Aviation offers lessons for health monitoring**

Comprising 78 organs, 206 bones and a central nervous system that receives information from the organs and transmits it through the spinal cord before processing it in the brain, the human body is by any measure a complex piece of engineering. When something goes wrong, and it can, it takes all of time and sleuthing on the part of a physician to pinpoint the problem and fix it. A thought then for an avionics engineer.

A Boeing 747 is made up of approximately six million parts, with 100,000 odd in each jet engine alone. And there are four of those. Diagnosing problems can be an incredibly complex process, with end of flight summary reports potentially requiring maintenance engineers to sift through a myriad of data to locate a potential fault. And then to avoid any usually grave consequences if left undetected as a medical issue.

To overcome this, avionics engineers employ advanced signal processing and machine learning (ML) algorithms to perform ‘novelty detection’ on flight data. This enables them to identify problems that fall outside of clearly defined vibration tolerances and performance parameters, without having to wade through gigabytes of non-essential data.

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Feature: LE Audio

Making Waves

LE Audio is nearing commercialization and will deliver superior sound and longer battery life for both the hard of hearing and music lovers.

A pair of Moon Audio Opulence speakers will lighten the buyer’s wallet by a cool $1.1 million, according to What Hi-Fi. The specialist magazine reports that just ten pairs of the speakers were produced, and each boasted a rather ominous-sounding ‘Dark Star’ feature. The maker noted the speakers offer “an optional second way of experiencing [sound] which delivers music into the listener’s brain, bypassing the ears”. The company also helpfully suggested that the speakers were “not meant for an ordinary living room”. That’s likely not a problem for prospective buyers.

Consumers without the disposable income to buy a pair of the Opulences and with conventional domestic facilities still crave decent audio quality. Wireless headphones, while perhaps lacking the essence of Dark Star, offer a considerably more affordable, convenient and discrete solution. And, while demanding the owner has some actual ears, the sound quality of reasonably-priced wireless products is perfectly acceptable for anyone bar the most discerning audiophiles.

But superior wireless sound is only months away. LE Audio, launched by the Bluetooth SIG back in January 2020 and with key specifications following during that year, is approaching commercialization and will start appearing in earbuds and headphones in late 2022.

“LE Audio represents one of those rare occasions where there’s no technical trade-offs limiting what a designer can do. It brings better audio quality, including True Wireless Stereo [TWS], more robust wireless connectivity and vastly improved battery life.” says Vince Hagen, Business Development Manager for LE Audio with leading Bluetooth LE chipmaker Nordic Semiconductor. “An engineer can, for example, design earbuds with incredible sound quality and extended battery life by replacing Classic Audio with LE Audio. Alternatively, they can use smaller batteries to shrink their product’s form factor and direct material costs, while still matching the original product’s playtime. These use cases mean LE Audio will not only improve the pleasure of music lovers, but will also bring families closer through Audio Sharing by allowing each member to watch the same film through their own headphones. Attendees at plays and conferences will also benefit. “With LE Audio, places like theater and lecture halls will be able to provide high-quality audio in multiple languages,” said Peter Liu of Bose Corporation and member of the Bluetooth Special Interest Group (SIG) Board of Directors, in a statement.

WIRELESS AUDIO ORIGINS

The invention of Thomas Edison’s phonograph—which used a needle to etch a groove which could then be played back by another needle following the groove’s indentations—was among the first devices that allowed for the reproduction of recorded sound. Grooves, first on wax with mechanical playback and then on vinyl with electrical playback, continued as the mainstream of recorded sound until after World War II. Post-conflict, the German invention of magnetic tape became internationally available and was adopted as the preferred medium for original recordings. Tape lasted until the mid-1970s when the analogue era was brushed aside by digital recording using technology pioneered by Sony. Today, the benchmark for high quality digital sound is the CD. But while the high bitrate of CD technology is still beyond the capability of audio streaming, it turns out that most listeners don’t care. They are perfectly happy with the quality delivered by the more modest bitrates supported by compressed audio formats that can easily be handled by wireless devices. The Bluetooth SIG, custodian of the Bluetooth LE specification, introduced its own low-complexity sub-band codec (SBC) to boost audio quality at low-to-medium bit rates with additional firmware to customize the Bluetooth protocol for audio applications, back in 2003. Called the Advanced Audio Distribution Profile (A2DP), it facilitated advanced audio streaming between two Bluetooth devices. However, the SIG’s technology suffered from a few drawbacks. Among these was a channel limitation that only allowed the technology to stream audio to a single device such as the left-hand unit of a pair of earbuds. Engineers overcame the problem by processing the incoming Bluetooth audio stream in one earbud and then wirelessly retransmitting the second channel to the other earbud. The technique worked okay but was processor intensive and shortened battery life. Consumers demanded better.

A NEW LEASE OF LIFE

But it wasn’t the music lovers that commercial outfits were really listening to, rather it was the hard of hearing that kick started the development of better wireless audio. According to consultant Nick Hunn, in his book Introducing Bluetooth LE Audio, hearing aid users have always wanted to connect to smartphones and other Bluetooth-equipped devices, but the relatively high power consumption of Classic Bluetooth proved challenging. Hearing aids are worn for many hours each day and only have space for small batteries so low power consumption is critical. In his book, Hunn explains that Apple launched a proprietary solution based on Bluetooth LE in 2013 which was then licensed to hearing aid makers. Unfortunately, the system was unidirectional and only worked with Apple’s own handsets. The Bluetooth SIG started work the same year on a Bluetooth standard for audio which would bring interoperability to the hearing aid ecosystem. Today, the LE Audio specification features improved battery life compared with Classic Audio for all use cases. But because the technology allows engineers to further trade-off audio quality against battery life, hearing aid applications where sound quality is not so critical as daily power, can gain a remarkable increase in battery life too. Consumer audio companies soon realized that the hearing aid use cases were equally applicable to their market. LE Audio gained further momentum and the project expanded such that in the nine years since, the initiative has evolved into the Bluetooth SIG’s largest ever specification development project.

“LE Audio represents one of those rare occasions where there’s no technical trade-offs limiting what a designer can do.”
**Tech Check**

The nRF5340 Audio DK supports LE Audio applications with Nordic’s powerful nRF5340 SoC and Cypress Logic’s LCA455 high-performance, low-power audio DSP. The DK can function as a USB debug or receive audio data or from a connected IPC or from a PC as a host as a microphone and speaker. Two DKs are required for Bluetooth audio streaming codecs.

**Additional Reading**

- [LE Audio](https://www.bluetooth.com/le-audio)
- [LE Audio SDK](https://www.bluetooth.com/le-audio-sdk)
- [LE Audio Specification](https://www.bluetooth.com/le-audio-specification)
- [LE Audio Developer Resources](https://www.bluetooth.com/le-audio-developer-resources)
- [LE Audio FAQs](https://www.bluetooth.com/le-audio-faqs)
The algorithms enabled by the nRF52832 SoC’s Arm Cortex M4 processor with floating point (FP) unit enable BERG AirHive to learn new tricks over time, and provide feedback to the user based on learned data. The SoC’s Arm processor has ample overhead to deal with the computations demanded by high end wireless applications.
Drone technology developed from the mid-1800s, and took the form of balloons, torpedoes and aerial targets. Through the following 150 years, even as the inventions became increasingly innovative and robust, drones continued to be deployed almost entirely for military purposes. That changed when the first commercial drone permits were issued around 15 years ago. Since then, government agencies and commercial organizations have been able to use modern drones — officially known as unmanned aerial vehicles (UAVs) — for a wide array of applications, including emergency response, border and security surveillance, industrial site and pipeline inspections, crop monitoring, infrastructure monitoring, small farm deliveries, mapping and more.

Today, flight approval for drone operation demands compliance with local regulations. These regulations came into force due to concerns over coordination and safety as the number of drones buzzing overhead escalated. In Europe, for example, the U-Space Regulation (EU) 2021/664 adopted by the European Commission, which comes into effect from January 2023, stipulates that all airspace participants must be able to remotely identify their drones and the operators. These regulations, and the restrictions they bring, could present a compliance challenge for operators of existing UAVs and see the deployment of drones stall in affected regions. Fortunately, IoT innovation is helping to fast track the flight path meeting compliance with new regulations and more effective drone monitoring.

Remote ID for drones

Czech startup Dronetag—a company that works in conjunction with the European Space Agency (ESA)—has developed a compact and lightweight remote ID device for UAVs through the ASPIRE WITH ESA program. The program aims to give private enterprises the chance to come up with solutions to space and aerospace problems. The Dronetag Mini solution ensures a drone is detectable to all air traffic participants. Once attached, the device brings any drone from any manufacturer into line with new regulations and more effective drone monitoring.

The Dronetag Mini

The Dronetag Mini is a 160 mm wide, 50 mm high, 23 mm thick, and weighs 160 grams. It is a compact and lightweight remote ID solution for drones. The device is powered by a rechargeable lithium-ion battery providing up to 14 hours of flight time between recharge. The device is designed to be recharged using a vehicle’s 12V charging port. The device can be remotely controlled via a smartphone app, allowing drone operators to monitor and control their drones from anywhere in the world. The Dronetag Mini is highly durable and can withstand harsh conditions, making it ideal for use in various environments. The device can be easily mounted to drones using a dedicated mount, ensuring secure attachment and reliable performance in flight.

Connectivity

Dronetag Mini connects to the drone’s flight controller using Bluetooth Low Energy (BLE) technology. This enables real-time communication between the drone and the device, allowing drone operators to receive real-time flight data and monitor their drones remotely. The BLE connection also allows for easy data transfer, ensuring that critical information is transmitted quickly and reliably. The device is compatible with a wide range of drone models and flight controllers, making it a versatile and adaptable solution for drone operators.

Power

The Dronetag Mini is powered by a rechargeable lithium-ion battery, providing up to 14 hours of flight time between recharge. This ensures that drone operators can fly their drones for extended periods without the need for frequent recharging. The device is designed to be highly energy efficient, minimizing power consumption during flight and prolonging battery life. The device can be easily charged using a standard USB cable, ensuring that drone operators can charge their devices quickly and conveniently.

Software

The Dronetag Mini is equipped with advanced software features to enhance drone operation and compliance. The device includes a built-in GPS receiver, allowing for accurate positioning and navigation. It also supports a variety of communication protocols, including 2.4 GHz and 5 GHz Wi-Fi, enabling efficient data transfer and connectivity. The device can be easily configured using a smartphone app, allowing drone operators to set up and customize their flights with ease. The device also includes a built-in accelerometer and gyroscope, providing real-time data on drone orientation and movement.

The Dronetag Mini is a powerful and versatile remote ID solution designed to meet the needs of drone operators. Its compact and lightweight design, long flight time, and advanced features make it an ideal solution for drone enthusiasts and professionals alike.
German venture studio, Next Big Thing AG (NBT), has launched an IoT sensor development platform designed to simplify a sensor development process for developers of cellular- IoT- and Cloud-based solutions. The platform supports development across a wide range of industrial applications including manufacturing, pharmaceutical, and logistics sectors.

The Prometheus development platform is powered by Nordic’s nRF5580 low power SiP with integrated LTE-M/NB-IoT modem and GNSS. The nRF5580 SiP’s 64 MHz Arm Cortex-M33 dedicated application processor provides ample computational power to supervise the most complex cellular IoT product functionality. NBT’s IoT development platform comprises a hardware and embedded software platform (Prometheus), and the Cloud-based software platform (NBT Software Platform). The standard configuration of Prometheus consists of a range of sensors, for example temperature sensor(s) (analog and digital), accelerometer, magnetometer, gyroscope, air quality sensor, ambient light sensor and humidity sensor. The extended version of Prometheus also includes Nordic’s nRF51822 Bluetooth LE SoC to provide support for Bluetooth LE connectivity, as well as USB, GPS, radar, an adjustable antenna tuner and extended temperature range.

In addition to the Nordic SiP and the sensors, the CE-certified development platform also features a stable embedded software stack, fully encrypted communication, mesh connectivity for short-range communication, automatic switching between NB-IoT and LTE-M cellular IoT connectivity, and advanced provisioning tools.

The solution is optimized for low power consumption and provides an industrial temperature range of -40 to +85°C.

Smart Home

Contest encourages smart home designs

Nordic has launched a contest to find the best cellular IoT design project for a smart home or smart city application in partnership with maker community website, Electrotutor.

The Make It Smart with Nordic Things’03 design contest asks entrants to demonstrate their prototype or Proof-of-Concept using the Nordic Thingy’03 or nRF5638 DK to send data from the application to the Cloud. Submissions can incorporate ML using Edge Impulse Studio.

The top 50 project ideas were issued with free Nordic Thingy’03 hardware from which to develop their design, with judging criteria covering creativity, completeness and complexity. Winners of the $3000 prize pool will be announced on April 27, 2022.

Logistics & Transport

Gateway simplifies global Cloud communication

U.S. tech company, Sensor Maestro, has launched a wearable sensor fusion module that integrates a nine-degree-of-freedom IMU— including a gyroscope, accelerometer and magnetometer—to deliver accurate absolute orientation data, as well as pressure/altitude, temperature and humidity sensors.

Powered by Nordic’s nRF52832 SoC, the SFM2 provides up to an 853 Hz sensor fusion output data rate (ODR) and up to 1667 Hz ODR for raw accelerometer and gyroscope output. Five or more SFM2 devices can be used and synchronized by the firm’s smSENSR-LOGR smartphone app.

The SFM2 uses the nRF52832 SoC’s Bluetooth LE throughput capability to provide data rates approaching 50 Kbps, claims Sensor Maestro. The company says SFM2 is the smallest and lowest power wearable IMU on the market to provide both Bluetooth LE and USB connectivity.

Cellular IoT

Cellular IoT power controller monitors batteries on remote IoT equipment

A cellular IoT power controller that can monitor batteries on remote IoT equipment and turn connected devices on and off to maximize battery life has been launched by Dublin-based NEST iON.

Designed for applications where the ability to monitor battery levels is extremely difficult, the rugged IP67-rated IoT Power Controller uses a Nordic nRF9160 SiP to provide both NB-IoT and LTE-M connectivity.

“Our controller conserves battery life by only having remote sensors and equipment on when you need them to be on,” explains NEST iON CEO, Karl Peters. “By using intelligent sleep mode scheduling, for example, we can hugely extend battery operating life. And by monitoring battery levels remotely we can schedule battery replacements with precision to avoid outages being the only indicator that a battery has drained down, which is too late.”

In operation, the IOT Power Controller searches for an NB-IoT signal first because it is the lowest power cellular IoT option. If it can’t find a signal, it will use the dual-mode functionality of the Nordic nRF9160 SiP to automatically switch to searching for an LTE-M signal instead.

The IoT Power Controller can be configured to wake and connect to the cellular network from deep sleep mode if it detects motion using an accelerometer. The product also operates in underground locations such as car parks, basements or buried equipment locations.

A partner Android app gives critical battery data including percentage charge left and days of operation remaining, battery voltage, current and current used, plus the state of the IoT Power Controller’s internal relay.

Modules

Tiny Bluetooth LE module supports complex applications

An ultra miniaturized module based on Nordic Semiconductor’s nRF5340 SoC or smart SoC has been launched by Insight SIP. The ISP2053-AX fully integrated module is offered in an 8 by 8 by 1 mm package size, and is described by the company as the world’s smallest nRF5340 SoC-based module. The nRF5340 DB is a dual-kit development bundle for the nRF52 and nRF53 Series SoCs.

nRF21540 DB is a dual-kit development bundle for the nRF21540 RF front-end module, enabling range extension on all nRF52 and nRF53 Series SoCs.

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Nordic’s nRF52 Series and nRF53 Series SoCs are designed from the ground up to minimize power consumption for long battery life. However, the SoCs are also frequently used for applications where extended range or coping with a challenging RF environment are more important than battery life. One example is asset tracking in a large warehouse where a tracker with longer range allows for fewer devices to cover the space, cutting costs. A second example is the smart home where other devices transmitting on the 2.4 GHz band— including those using classic Bluetooth and Wi-Fi — and cordless phones — make for a challenging RF environment for Bluetooth LE, Thread and Zigbee products. In such a situation it is common for interference to result in missed packets and subsequent retransmits which have a detrimental impact on battery life. There are many factors that impact the range of a wireless connection, but the key determinant is the transmit power of the transmitter and the sensitivity of the receiver that combine to offer the ‘link budget’ which is measured in dBm. In a like-for-like application, increasing the link budget will extend range. Moreover, for two products with a wireless connection over a fixed distance, the device with the greater link budget will be less prone to interference and lost packets. In particularly demanding RF environments, or where the application is operating close to its range limit, it can actually be more energy efficient to boost transmit power than continuously retransmitting unreceived packets.

A proven method to raise the link budget of a wireless connection is to boost transmit power with a power amplifier (PA) and increase receive sensitivity with a low noise amplifier (LNA). The LNA boosts a weak signal without adding significant additional noise; its key attributes are gain (a measure of how much the signal is amplified) and noise figure (NF, a measure of how much noise is added during amplification).

An RF front-end module for Nordic SoCs Nordic’s nRF21540 RF front-end module (FEM) is a PA/LNA designed to co-exist seamlessly with Nordic’s nRF52 and nRF53 Series SoCs. In addition to the Nordic SoCs running Bluetooth LE, Bluetooth mesh, Thread, Zigbee or 2.4 GHz proprietary, the FEM is also suitable for non-Nordic short range wireless SoCs running the same protocols. In addition to increasing the range of the wireless transmission, the Nordic FEM enhances the robustness of the wireless link — reducing packet losses and in turn lowering link latency; enhancing throughput and reducing power consumption.

The FEM’s PA offers an adjustable TX power boost up to +21 dBm and the LNA provides a +13 dB Rx gain with a low NF of 2.7 dB. The FEM also supports antenna diversity for improvements to link robustness in static installations. The PA can be configured for ARIB, ITU and/or FCC approval. There are interfaces for GPDO control as well as SPI control, and 50 Ω matched input and output. Supply range is 3.7 to 3.6 V and temperature range is -40 to 105°C. The FEM is supplied in a 4 by 4 mm QFN package.

To accompany the nRF21540/RF FEM, Nordic has released the nRF21540 Development Bundle (DB), design tools for verification and testing of applications taking advantage of the FEM’s capabilities. The nRF21540 DB comprises the nRF21540 Development Kit (DK) and the nRF21540 Evaluation Kit (EK).

The DK is based on Nordic’s nRF52840 DK and features the nRF21540 RF FEM. The DK has two chip antennas with ports for antenna diversity plus SWF connectors for making RF measurements. The DK’s FEM is connected to and controlled by the onboard nRF21540 SoC.

The nRF21540 EK is a shield which can be connected directly to an nRF52 or nRF53 Series SoC antenna output or to any of the Nordic SoC DKs via their Arduino Uno Rev 3 header pins. The EK’s nRF21540’s gain control, antenna switching and operational modes are controlled via GPIO or SPI, or a combination of both, accessible through the nRF21540 USB DB.

SDK development support

In addition to the DK and EK, development support for the nRF21540 FEM is integrated into Nordic’s nRF Connect SDK (for projects using Bluetooth plus Thread and/or Zigbee). The support is built into the SDK’s multiprotocol service layer (MPSL). Driver support is also included — allowing the engineer to run the FEM together with the various RF stacks during development.

Cycling through the FEM’s operational states must be tightly synchronized with the radio’s operation. Poor timing can lead to increased power consumption and potentially problems with regulatory compliance. Because of timing criticality, cycling is controlled by software delivered from Nordic as part of the SDK. Cycling is triggered via the PK, RX and TX pins. In the future version of the SDK, cycling will also be possible via SPI.

A Nordic technical webinar entitled Introduction to the nRF21540 RF FEM for range extension is available here: bit.ly/3vHf8dQ
Nordic’s IoT solutions

This handy summary describes all of Nordic’s IoT solutions.

### Nordic’s RF SoCs and SiPs

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<tr>
<th>Nordic’s RF SoCs and SiPs</th>
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### Range Extender

**nRF21540**

**Description:** The nRF21540 is an RF front-end module (FEM) that improves range and connection robustness for Nordic nRF52 and nRF9160 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 is designed for industrial applications such as professional lighting.

**Operation:** The nRF21540 supports Bluetooth LE, BLE mesh, Thread, Zigbee and 2.4 GHz proprietary protocol applications. The RF FEM’s TX output power is dynamically adjustable and can be set in small increments to comply with the allowable range across all geographical regions. The RF FEM can be used with Nordic’s extended temperature qualified nRF52832, nRF9160 and nRF52850 SoCs in industrial applications such as professional lighting.

### Power Management

**nPM1100**

**Description:** The nPM1100 is a dedicated power management IC (PMIC) with dual-mode configurable buck regulator and integrated battery charger. It is designed to work with Nordic’s nRF52 and nRF9160 Series SoCs. It offers a reliable and stable power delivery, while maximizing battery life through high-efficient and low quiescent currents. The product can also be used as a generic PMIC for rechargeable applications. Its compact form-factor makes it ideal for advanced wearables, medical devices, and other size-constrained devices. When optimized for size, PCB usage is around 23 mm² including passives. This increases to around 27 mm² when optimized for performance.

**Operation:** The dual-mode regulator operates at up to 62 percent power conversion efficiency, prolonging battery life of Nordic SoC-based applications using a rechargeable battery. Hysteretic mode reduces current consumption for low loads, while PWM mode allows for cleaner power operation and better performance for higher loads. The regulator can deliver up to 150 mA, providing ample current for the SoCs plus additional circuits.

### Cloud Services

**nRF Cloud**

**Description:** nRF Cloud is a versatile IoT connectivity platform that can be directly used with Nordic’s cellular IoT devices or with the nRF52 and nRF9160 Series via a gateway. nRF Cloud services support Device-to-Cloud or Cloud-to-Cloud use cases. In the former, the device connects directly to nRF Cloud. In the latter, the device connects to a customer’s Cloud that then connects to nRF Cloud’s REST API.

**Services:** nRF Cloud Location Services are offered in nRF Cloud and include GPS and cell based location services. The product supplies accurate and rapid location data for customer connected devices. The A-GPS service can reduce time-to-first-fix significantly compared with regular GPS. The result is lower latency and improved power consumption. P-GPS downloads predictive data, extending validity of assistance data. Cell based services use bare stations to predict location. SCELL uses a nearby cell tower, whereas MCCELL uses multiple cell towers to triangulate a position. If power saving is more important than location accuracy, the cell based services are a good option. They are also useful for indoor positioning.
The nRF5340 SoC

with dual-core setup, a dedicated audio oscillator, I2S, and PDM interface

Ideally suited for LE Audio applications

BUY IT NOW
nordicsemi.com/nRF5340

2.4 GHz