Ahead of the Game
How wireless tech is transforming sports performance
Welcome

Svenn-Tore Larsen
CEO

When we planned this edition of Wireless Quarter, coronavirus and the disease it causes, COVID-19, was just breaking out in China. It wasn’t apparent then that the virus would cause the pandemic that currently affects the world. Because of the status of the virus at that time we didn’t include anything in this edition about it or its implications. But we have now changed the planned Welcome column because it’s vital to acknowledge the huge challenge the world faces and the tens of thousands that have already lost their lives to COVID-19. Like the business community across the globe at this challenging time, Nordic places the safety and protection of its staff and community at the top of its priorities. For example, employees are now working remotely to limit exposure to coronavirus. And we are committed to doing our best to contribute to the wellbeing of other people and businesses, in all ways possible.

Bright lights during this crisis are the Nordic customers using our tech to fight the coronavirus. For example, the tech is being used to notify when people have come into contact with infected people and reinforce hygiene regimes. You can read more about this on the news feed at the Nordic website and in our blog. And the next edition of WQ will include a deeper analysis of the wireless technology being used to fight the virus.

While today’s challenge is tough, there will be a time when it’s over. In preparation for that day, our operation is largely continuing as previously planned. And we’ll continue to develop strong customer relationships and deliver on their expectations.

We believe the technology being developed today will not only help us to fight the current pandemic, but also put us in a better position to fight the next one. Stay safe.

Bright lights during this crisis are the Nordic customers using our technology to fight the coronavirus.

Nordic and Amazon partner to speed smart home products

Nordic Semiconductor is working with Amazon Common Software (ACS) to help accelerate the development of smart home and other wireless products. ACS provides a single, unified API integration layer for multiple Amazon SKUs including providing components that are prevalidated and memory optimized for common smart home product functions. Amazon says ACS is designed to benefit any developer building products using Amazon SKDs by giving them the ability to use prebuilt and prehardened software components. This will accelerate integration of the SKDs and help reduce both development and maintenance costs.

Amazon says ACS includes an extensive test suite that can be used to verify and debug an ACS implementation. By building on ACS, developers can expect to launch devices more quickly and easily than before, using some of the same technology that Amazon uses in its own devices.

Nordic intends to provide and maintain a Device Porting Kit (DPK) for its wireless chips that allows them to be easily and natively integrated into ACS as a reference platform. Initial DPKs will be based on Bluetooth LE, with other wireless technologies following in the future. “We’re happy that Amazon recognizes the value that Nordic brings through our multiple award-winning wireless chips and extensive customer base,” says Kjell Holstad, Director of Product Management at Nordic.

“Our marked leading nRF5 Series and the newly released nRF53 Z-Wave” says Nordic CEO, Svenn-Tore Larsen. “And Bluetooth LE devices offer very low power consumption, stellar security performance and a high amount of on-chip memory which makes them perfect for the type of advanced smart home products Amazon envisions for [ACS]. We’re looking forward to working with Amazon and the device makers using its services to build some great new applications.”

Nordic awards at the double

For the second year in a row and the third time in total, Nordic Semiconductor has been named the Most respected emerging public semiconductor company achieving $100 million to $500 million in annual sales by the members of the Global Semiconductor Alliance (GSA).

Launched in 1996, the GSA Awards recognize the achievements of top-performing semiconductor companies. They are widely considered one of the most prestigious awards in the industry.

“We are delighted to receive such high independent recognition... from the GSA,” says Nordic CEO, Svenn-Tore Larsen. Meanwhile the company’s Thingy91 cellular IoT prototyping platform has won the Technical Innovation Award in the ESP32 Innovation Awards 2020. It is the second year running Nordic has claimed the respected award, last year winning with its nRF Connect for Cloud development tool.

Logistics & Transport

Cellular IoT and Bluetooth LE asset tracker offers world leading battery life

Norwegian asset tracking specialist, Meshtech, is employing a Nordic nRF9160 chip and a nRF52832 micro in the world’s first environmental asset tracker to combine cellular IoT and Bluetooth wireless tech with a five-year battery life. The Meshtech Cloud Tracker prevents the ongoing compensation costs routinely incurred in the supply of perishable goods at risk of spilling, being delivered to wrong customer locations or delivered in the wrong quantities.

“Our Cloud Tracker [detects] delivery or storage issues quickly enough that they can be corrected without jeopardizing an entire consignment,” says Meshtech Interim CEO, Preben Skretteberg. “This means perishable goods suppliers now have a viable way to prevent unnecessary compensation costs, while also being able to exceed both current and [increasingly strict] future regulations.”

The Meshtech Cloud Tracker not only continuously monitors environmental parameters, but also whether a consignment has been dropped, tilted, or folded, the Meshtech Cloud Tracker manages the monthly compensation costs of individual items within a consignment, the order in which they were loaded and unloaded and the location of the consignment.

“Suppliers [now have] environmental data driven insights into how their goods are loaded, stored, and shipped that could eliminate the majority of their compensation losses,” adds Skretteberg. “None of this was viable before the advent of cellular IoT. With that, we have made environmental asset tracking feasible and scalable in a way that wasn’t possible before.”

The performance of Nordic’s nRF5 Series and the newly released nRF53

Northern Ireland cycling startup, See.Sense, has launched the world’s first cellular bike security tracker. The tracker uses both NB-IoT and GPS to locate and track bikes from a user’s smartphone for up to three months on a single charge from an internal rechargeable lithium polymer battery.

The 8 g See.Sense AIR is about half the size of a deck of playing cards and is designed to fit securely under any bike’s seat or bottle cage. The product incorporates Nordic Semiconductor’s nRF52840 SoC with integrated LTE-M/ NB-IoT modem and GPS.

“We’re totally fed up with instances of vandalism and theft,” says See.Sense CEO, Philip McAleese. “AIR was developed after listening to what the cycling community wanted. If the bike is moved or tampered with, AIR will sound an alarm and immediately text message the rider: we call this ‘Flight’ mode.

“If the bike is stolen, AIR will detect this and switch into ‘Flight’ mode setting, rapidly transmitting highly accurate GPS signals to allow the owner to quickly and accurately locate their bike to the nearest couple of meters. This way, active intervention can then be passed to local law enforcement increasing the chances of recovery.”

The Sentrius BT510 long-range sensor platform

India-based IoT company, Zenetix Solutions, has released a mesh-enabled sensor network based on Thread, an open source wireless mesh RP software protocol with native support for IPv6.

The ZenConect ecosystem can optimize operational energy efficiency for smart lighting and transport applications via automated, intelligent monitoring and control. The plug-and-play solution delivers key benefits including centralized visibility, energy savings and improved asset maintenance.

The platform incorporates a network of battery powered sensors each using Nordic’s nRF52840 SoC-based module. Each node communicates via a 2.4 GHz radio’s 4.6 mA peak power characteristics with features such as the 2.4 GHz radio’s 4.6 mA peak RX/TX currents.

Glasgow-based company, Canalys, has released Bluetooth headphones: the world’s fastest-growing category of smart devices over the next several years. With the advent of LE Audio, 72 million units are predicted to ship in 2023, the analyst said. The research said for every 100 smartphones shipping in 2023, 48 smart personal audio devices would be shipped—a comparison to 96 desk top/notebooks, 14 wearable bands, 13 smart speakers and 8 tablets.

Smart speakers will be the second fastest growing category, Canalys said.


ewable Citizen Watch and Nordic partner on solar powered custom watch

Citizen Watch, one of the world’s leading watch manufacturers, has released the Eco-Drive Riviera, a fully customizable solar powered watch employing Nordic’s nRF52810 Bluetooth LE SoC to provide the wireless connectivity.

Unlike conventional watches that have prefixed button functions, Eco-Drive Riviera allows users to not only customize the buttons to suit their own preferences, but also create up to 20 unique button actions—known as ‘keysets’—that can be activated on, or displayed on the smartwatch to suit the user’s own lifestyle and interests.

For example, from the iOS and Android compatible Eco-Drive Riviera app the user can select a ‘trigger’ (the press of a specific button on the smartwatch) to deliver a ‘service’, and an ‘action’. A specific button could be programmed to update the user on the score in a sporting event and display the score via the hands of the smartwatch. Alternatively, a press of a button could trigger the smartwatch to send the user’s current location to nominated contacts with a pre-set message, for example “I’ve arrived.”

The smartwatch will integrate Nordic’s nRF52810 with an integrated High-Jump SoC to provide Bluetooth LE mesh capability.

Wireless connectivity between the smartwatch and the user’s smartphone is provided by the Nordic SoC.

Despite its processor-intensive applications, the Eco-Drive Riviera is solar powered thanks in part to the ultra-low power characteristics of the Nordic SoC. The nRF52810 has been engineered to minimize power consumption with features such as the 2.4 GHz radio’s 4.6 mA peak RX/TX currents.

“We selected Nordic’s SoC for faultless performance of our eco-friendly device,” says Daisuke Matsush, an engineer at Citizen Watch.

‘By the Numbers’

$2 billion in revenue

Nordic Semiconductor has reported full 2019 revenue of $2.64 billion, representing growth of 6.4 percent over 2018’s full year revenue. The result comes on the back of all-time record Q4 revenue of $631 million, an increase of 36 percent on the same time last year. The strong year-on-year growth reflects its significantly higher revenue contribution from new Tier one Bluetooth LE customers, with Bluetooth revenue amounting to $221.2 million in 2019, up 42 percent from $156.1 million in 2018. The consumer electronics, wearables and building and retailmarkets continued to perform strongly in 2019.

Next generation smart building solutions are forecast to generate over $2 billion in revenue and services revenue by 2026, according to a new report from analyst ABI Research. New offerings include emerging applications in space management, environmental monitoring, asset management and cleanliness and hygiene management. The report said space management solutions are being created with a variety of sensors, including contact, motion and occupancy, while asset management solutions are becoming increasingly important within specific commercial buildings, especially healthcare. The use of such solutions for hospitals, for example, improves inventory management and lowers operating costs.
Bluetooth LE robot encourages coders of all skill levels

Consumer robotics and toy company, Sphero, has released the Sphero RVR, a programmable robot for beginners to advanced coders, Science, Technology, Engineering, Arts and Mathematics (STEAM) educators and students, as well as makers, hackers and hobbyists. The robot is an all-terrain programmable and expandable product that can be driven right out of the box and customized for unique use cases and applications. For example, RVR can be used as a home security sentry, autonomous metal detector or wirelessly controlled environment. It provides a diverse suite of sensors including ambient light, color, infrared, accelerometer and gyroscope enabling the robot to interact with its environment.

The robot employs Nordic Semiconductor’s nRF52832 Bluetooth LE SoC as the primary processor and low power wireless connectivity solution allowing users to wirelessly code RVR from the Sphero Edu app on their smartphone or tablet. Alternatively, RVR can be programmed using a Raspberry Pi, Arduino, Nordic-powered ready2code or the company’s own littleBits platform to customize the robot’s capabilities further. RVR includes a rechargeable, high capacity battery to power the robot’s motors, as well as cameras, robotic arms, air horns and other external accessories that can be fitted to the robot. The nRF52832, a low power commercial wireless microcontroller, possesses a diverse suite of sensors including ambient light, color, infrared, accelerometer and gyroscope enabling the robot to interact with its environment.

The SoC is capable of all the features of Bluetooth 5.1 and 5.2 including Long Range and high throughput 2 Mbps, Direct Mesh Network, LE Power Control and LE Isochronous Channels. The SoC also includes a USB 2.0 interface. The platform also features audio IC leader Cirrus Logic’s CS47L35 smart codec with an low latency Audio Communication Codec (LC3). Providing high quality even at low data rates, LC3 also enables design trade-offs between audio quality and power consumption.

Enabling new use cases

LE Audio introduces Multi-Stream Audio which facilitates the transmission of multiple, independent, synchronized audio streams between an audio source device and multiple audio sinks, overcoming a major drawback of Bluetooth Classic Audio. (See this issue pg10)

Other advantages of the new technology include support for the development of Bluetooth hearing aids and Streaming Audio enabling an audio source to broadcast one or more audio streams to an unlimited number of sink devices. Broadcast Audio will support the new use case of ‘Audio Sharing’ which can be personal or location-based. It is destined to be an exciting new sector for the development of Bluetooth hearing aids and Streaming Audio enabling an audio source to broadcast one or more audio streams to an unlimited number of sink devices. Broadcast Audio will support the new use case of ‘Audio Sharing’ which can be personal or location-based. It is destined to be an exciting new sector for

Nordic launches nRF52802 Bluetooth 5.2 SoC

Nordic Semiconductor has unveiled the nRF52802 Bluetooth 5.2 SoC, an addition to the lower-end of the company’s nRF52 Series. The SoC is a Bluetooth LE, Bluetooth mesh, Thread, Zigbee and 2.4 GHz proprietary wireless solution. The SoC is capable of all the features of Bluetooth 5.1 and 5.2 including Long Range and high throughput 2 Mbps, Direct Mesh Network, LE Power Control and LE Isochronous Channels. The SoC also includes a USB 2.0 interface. The platform also features audio IC leader Cirrus Logic’s CS47L35 smart codec with an low latency Audio Communication Codec (LC3). Providing high quality even at low data rates, LC3 also enables design trade-offs between audio quality and power consumption.

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Oral hygiene is a worldwide concern. The Global Burden of Disease Study 2016 estimated that 50 percent of the world’s population (approximately 3.58 billion people at the time of research) is affected by oral disease. Dental caries (commonly known as tooth decay) is the most prevalent condition, with around 2.4 billion people suffering from cavities of permanent teeth. In the U.S., alone, more than 80 percent of people have had at least one cavity by the age of 34, while over 47 percent of adults aged 30 and above have fillings, moderate or severe gum disease, according to the Centers for Disease Control and Prevention (CDC). It would appear the global community has neither the know-how nor the capability and resources to look after its teeth and gums effectively.

The overall health implications of poor oral hygiene, compounded by inadequate exposure to fluoride through sources of treated drinking water, are serious. Oral diseases are the most common communicable diseases and they can impact people for life. Gum disease, for example, affects the gum tissue and bone supporting the teeth and if left untreated can lead to tooth loss that ultimately gives these devices their edge.

Therapy:刷毛的感应器可以提供质量反馈和指导，让用户能够在刷牙时实时了解自己的刷牙情况。这些数据将发送到新固电子的Colgate Connect应用程序，该应用程序可以显示和存储所有的刷牙事件，以及用户可能感兴趣的信息和建议。

刷牙的挑战：挑战的解决方法是开发具有感应器的智能牙刷。Colgate的全球口腔卫生专家已经进行了相关研究，结果表明最有效的刷牙方法是在口腔中刷牙。

“刷牙是口腔护理中最重要的环节。如果使用不正确的刷牙方法，可能会导致牙菌斑和食物残渣积聚，从而引发口腔疾病。”

“几乎所有的人都应该知道如何刷牙。然而，在美国，只有50%的人认为自己能够正确地刷牙。所以我们设计了智能牙刷，它可以帮助人们更好地了解自己的刷牙习惯。”

“通过使用这些数据，我们能够提供个性化的反馈和建议，帮助人们改善他们的刷牙习惯。”

North America, still use manual toothbrushes, and the fact is the average user simply does not brush well

The majority of people worldwide, even in North America, still use manual toothbrushes, and the fact is the average user simply does not brush well

2020 will be the year that cellular IoT comes of age

After a long wait, commercial 4G LTE-M and NB-IoT solutions are hitting the mainstream

At the start of 2019 the only thing operating on cellular networks were cellphones and a few hundred 2G-based devices such as security cameras, and several IoT products (where cellular was seen as a last line of communication).

But now, in early 2020, the networks support battery powered security alarms, herding animal trackers, industrial grade asset trackers and environmental sensors, to name but a few. The list grows continuously. By this time next year, I predict we will be able to see the full potential of all the new cellular IoT products and applications on a single page.

What’s changed in the last 12 months? The answer is the large-scale rollout of the new IoT standards.

Lumotive’s vision for the future: “We believe that the technology developed for cellular IoT can be applied in a variety of industries, including healthcare, agriculture, energy, and transport.”

Cellular IoT is a revolution that will transform the way we live and work.

The potential of cellular IoT is enormous. With the right solutions, we can connect almost anything to the internet of things, from vehicles to health monitoring devices. This opens up a world of possibilities that were previously unimaginable.

But what does this mean for businesses? What are the opportunities and challenges? In this article, we will explore the potential benefits of cellular IoT and discuss some of the key factors that will drive its adoption.

Cellular IoT is the future of wireless technology and it is here to stay. With the right partners and solutions, businesses can reap the rewards of this exciting new world.
Ahead of the Game

Sports equipment that tracks individual performance is changing the game for athletes and coaches

In Short

Coaches often say that ‘practice makes perfect’ and ‘you get what you train’. In the aspirational world of sport, these mantras promote an ideal of what it takes to be successful. The message from trainers to competitors is clear – reaching your full potential takes 100 percent commitment and attention to detail. 100 percent of the time. While games aren’t played every day, good preparation never takes a break.

Yet until recently the process of continually analyzing skills and techniques in order to track improvements could be described as hit and miss. From relying on empirical evidence and putting faith in what a coach sees with their own eyes, to scrutinizing video footage and eventually evidence and putting faith in what a coach sees with their own eyes.

In the past few years, however, the game has started to change. Wireless technology is now being incorporated into sports equipment, adding new dimensions to coaching and performance analysis at all levels of sport from junior and amateur participation to professional leagues. It has suddenly become possible to track, generate, review and learn from comprehensive data based on the precise location and movement of equipment and accessories in action. Whether it’s a bat, ball, boot, puck or anything else used to play sport or engage in physical activity, it can be designed to provide a wide range of advanced custom metrics that help boost performance. And all without the individual is practicing in a suboptimal manner. Reinforcing bad habits is naturally counterproductive.

The first commercial application of the product is a smart baseball to help pitchers and coaches at any level of the sport. The pitchLogic system uses proprietary algorithms employing 15 channels of built-in sensor data to provide a set of 12 key body movement and pitch performance metrics after each individual throw. These metrics include ball spin rates, acceleration rates, launch angles and braking force. Thanks to Bluetooth LE connectivity, users can instantly access this information through a partner app on a smartphone or tablet app via a Nordic SoC-enabled Bluetooth LE link.

The pitchLogic platform “helps players improve their game while reducing the number of practice pitches,” says David Rankin, CEO of F5 Sports. “Because the information is available within a second of each pitch, the very next pitch can be an improvement. This helps a player practice efficiently with measurable progress in each session and less time spent practicing the wrong way.”

Commercial solutions are increasingly emerging to capitalize on these capabilities in different sports around the world. For example, sports technology startup, F5 Sports, has developed a Bluetooth LE-enabled smart baseball to help pitchers and coaches at any level of the sport. The F5 Smartbat is an embedded sensor using an inertial movement system comprising two accelerometers, a gyroscope and a magnetometer, along with proprietary Cloud based algorithms, to track movement data such as ball speed and spin rate. Like the pitchLogic baseball, the F5 Smartbat delivers a variety of useful information and analytics about the precise behavior of the ball to a smartphone or tablet app via a Nordic SoC-enabled Bluetooth LE link.

StanceBeam Striker is ready for use in a competitive cricket bat handle and uses its integrated sensors to capture the motion of the bat in action and record 360-degree batting performance data analytics in real time. The product then provides live analysis of the player’s batting technique and performance through the associated StanceBeam app.

Tracking genuine progress helps athletes stay motivated to continue to push themselves.

This evolution in the sports market matters more than you might think. An athlete can hone skills for hours a day, a coach can implement the most challenging drills, but no amount of effort will lead to meaningful progress if the individual is practicing in a suboptimal manner. Reinforcing bad habits is naturally counterproductive.

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Austria-based sports technology startup, Sportcor, is doing something similar. The Sportcor Smartball is an embedded sensor using an inertial movement system comprising two accelerometers, a gyroscope and a magnetometer, along with proprietary Cloud based algorithms, to track movement data such as ball speed and spin rate. Like the pitchLogic baseball, the Sportcor Smartball delivers a variety of useful information and analytics about the precise behavior of the ball to a smartphone or tablet app via a Nordic SoC-enabled Bluetooth LE link.

The first commercial application of the product is a smart cricket bat developed by Sportcor in partnership with leading cricket equipment manufacturer, Kookaburra Sports. The two companies hope the ball will be adopted by cricket players, coaches, teams, leagues and broadcasters around the world for a multitude of purposes including information and engagement. The amateur and elite bowlers alike will benefit from deeper performance analytics and will be able to experiment with different wrist positions, release points and delivery ‘actions’ to discover what works best.

Cricket is a game of ball against bat, and India-based sports technology company, StanceBeam, has also teamed up with Kookaburra Sports to develop a cricket bat sensor for both recreational and professional cricketers. Known as StanceBeam Striker, the device attaches to any cricket bat handle and uses its integrated sensors to capture the motion of the bat in action and record 360-degree batting performance data analytics in real time. The product then provides live analysis of the player’s batting technique and performance through the associated StanceBeam app.

Metrics include backlift and downswing angle, speed at impact and ‘shot efficiency’ (a comparison between the maximum speed of the swing and the speed at impact with the ball). Using the companion app as a ‘virtual coach’, the player can easily review each shot ball by ball, recreate and analyze each shot in 3D, and access tailored drills to improve along the way. Users can also conduct a post-session review, produce a summary report and even compare their results against peers or elite players.

StanceBeam Striker is ready for use in a competitive cricket match, where batters rely on their ‘timing’ and power to launch the ball over the boundary for six runs, particularly in the shortest format of the sport, Twenty20.
For such innovations to be commercially viable, they must be able to function effectively in match conditions and behave identically to the conventional equipment used in a sport.

Commercial Viability

For such innovations to be commercially viable, they must be able to function effectively in match conditions and behave identically to the conventional equipment used in a sport. To achieve this goal, developers need the support of compact wireless technologies. The low power consumption provided by wireless protocols like Bluetooth LE allow for smaller batteries, so devices can be built with much compact form factors and integrated seamlessly into a range of specialized and product that will stand the test of time and frequent usage. Moreover, advanced low power wireless connectivity solutions, such as Nordic SoCs and their powerful processors, are able to support the complex applications running computationally intensive— and therefore power hungry—movement tracking, signal processing or direction finding algorithms. Generating useful data is one thing, but ensuring that data is readily available through low latency equipment-to-smartphone connectivity, over a decent range and for a reasonable amount of time before recharge, is the domain of Bluetooth LE wireless technology.

The pitchLogic baseball, for example, uses a rechargeable 40 mAh battery that currently achieves three hours of active use and 10 days of standby time before wireless recharge using Q, a wireless charging standard that eliminates the need for a micro USB interface in the baseball. The Hawx Connected ski boot employs a Li-Poly battery that provides up to four-and-a-half days of operation in typical usage between recharge. This extended battery life is a major value-add for highly active skiers who spend long days on the ski fields, with performance data continuing to be recorded as long as the ski boot maintains power.

For the Sportcor Smartball, developers placed a strong emphasis not only on battery life, but on the product’s ability to keep working for as long as the boot itself remains usable. After all, the average wireless device isn't necessarily built to absorb a constant barrage of blows from a heavy bat.

"What we supply is a core that replaces the traditional core of a cricket ball. This includes the protective housing for the electronics to make sure they survive the impact of day-to-day use," explains Ben Tattersfield, Founder of Sportcor. "Power management was crucial as we had to get a good life out of the Sportcor Smartball while also maintaining the smallest possible form factor and light weight to ensure we didn't upset the characteristics of the end product, the cricket ball."

What impact could these technologies have on the overall sport’s tracking and performance market moving forward? "Athlete engagement is the exciting part, in particular across the junior to intermediate levels of sport,” suggests Tattersfield. “Features that were only available to professionals are now available to almost everyone, including coaches in amateur and junior leagues.”

There is virtually limitless to the potential of placing wireless tech and sensors inside modern sports equipment. As further advancements are made in training, development and coaching methods at all levels of sport, innovators need only strike the right balance between providing useful data and successfully monetizing and democratizing their solutions. As such a new mantra, training methods can now become an exponential offer on-pitch hour,” while "it's nearly impossible to show cause and effect with observational or quasi-experimental data," even with the most powerful tech, perfectly designed training guarantee a top athlete?

With this in mind, could the strategic use of such technologies potentially help circumvent the 10,000-hour rule entirely? Moreover, what impact might wireless tech-based solutions have on the next generation’s practice? If "smart" equipment including bats and balls continues to evolve into effective and affordable digital coaching assets, perhaps the performance levels of countless athletes around the globe will soar to greater heights in significantly less time.

The 10,000-hour rule: Merit or myth?

How much dedication or practice is required to attain ‘expert’ status in a particular field? This question has led to considerable debate since its study by Dr. K. Anders Ericsson was popularized by shelf book "Outliers" in 2008, in which author Malcolm Gladwell claims that becoming truly elite at something requires a commitment of 10,000 hours. The so-called 10,000-hour rule has been loosely applied to explain the remarkable achievements of people like Tiger Woods, Bill Gates, the Beatles and others in the fields of sport, science and technology, and art.

Yet a number of thought leaders have at times debunked this theory by countering that multiple factors probably contribute to reaching such a high level of success. One famous opponent is American entrepreneur, educational activist and author of bestselling self-help book "The 4-Hour Workweek," Tim Ferriss, who claims that an individual can actually become ‘world-class’ (among the top five percent in a given field) within six months — compared to the 10 years of 20 hours per week it would take to hit the 10,000-hour mark. Among his list of arguments, Ferriss asserts: “training method can have an exponential impact on on-pitch hour,” while "it’s nearly impossible to show cause and effect with observational or quasi-experimental data." Even with the top athlete has predictably trained for 10,000 hours in their lifetime, does 10,000 hours of training guarantee a top athlete?

According to Ferriss and others, accomplishments are ultimately determined by individual abilities, the nature of the practice itself, the learning tools available and yes, to extend our time spent practicing or studying. Essentially, quality beats quantity.

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Capture the essence of a high-fidelity wireless world. Bluetooth, the wireless technology that revolutionized the way we connect devices, is undergoing a new phase of innovation with LE Audio, promising enhanced audio quality, extended battery life, and novel features. The Bluetooth SIG, the organization responsible for developing and promoting the wireless technology, has introduced LE Audio as the next generation of Bluetooth audio. This profile aims to leverage the capabilities of Bluetooth to address the limitations of traditional audio streaming, such as the lack of flexibility and potential for dropped audio packets.

### In Short
- Bluetooth wireless headphones for transmitting voice were one of the early applications of the technology.
- The development of the MP3 compression format increased consumer demand for digital audio.
- An advanced audio profile and commercial codecs unpinched the Bluetooth audio streaming headphone sector, but sound quality remained modest.
- LE Audio promises an optimized codec and low-latency channel to enhance sound quality, reduce power and introduce new features such as audio sharing.

### MUSIC EVERYWHERE
In 1987, the Fraunhofer Institute in Germany began researching high-quality audio bit rate coding. The aim was to come up with a method of compressing audio files such that they could be easily stored and moved between the bandwidth and memory constrained computers of the era. In early 1988, the Moving Picture Experts Group (MPEG) established a group called for an industry wide audio coding standard. Soon after, coding developed by Dieter Zetter, who helped Fraunhofer with its research, was integrated into the MPEG standard, along with software from co-contributors. (See sidebar: the science of digital sound)

MP3 spawned a huge new business whereby tracks ripped from purchased CDs could easily be shared across the Internet. Initially, music companies claimed this amounted to piracy, but the industry was legitimized by commercial offerings such as Apple’s iTunes.

Early MP3 players were equipped with wired headphones, but even then, consumers craved the convenience of wireless. Later, as consumers migrated their MP3 libraries over to Bluetooth equipped smartphones, the Bluetooth SIG recognized the opportunity and pushed through A2DP, a protocol to support manufacturer-defined codecs, such as the Qualcomm-owned aptX and aptX-HD which is available to wireless headphone makers.

### LE Audio
- Promises enhanced audio quality with features such as isochronous channels to ensure the stream is uninterrupted.
- Optimized codecs to support the high demands of audio streaming.
- Enhanced sound quality and reduced power consumption.

### In Practice
- LE Audio promises an optimized codec and low-latency channel to enhance sound quality, reduce power and introduce new features such as audio sharing, making it ideal for wireless audio applications.

### With close to one billion Bluetooth audio products shipped last year, wireless audio is the largest Bluetooth market

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Despite the impressive growth of Bluetooth in the consumer electronics market, especially in the realm of audio, the technology has faced challenges in higher-end audio applications. The maximum raw data rate of Bluetooth (1 Mbps) was insufficient to support high-fidelity audio because of the intentional transmission delays built into the protocol. This limitation, combined with the need for a more flexible and efficient audio streaming solution, led to the development of LE Audio.

- LE Audio promises enhanced audio quality, extended battery life, and new features.
- It leverages Bluetooth’s existing capabilities to address the limitations of traditional audio streaming.
- With close to one billion Bluetooth audio products shipped last year, wireless audio is the largest Bluetooth market.

### Feature: Audio & Music
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### With close to one billion Bluetooth audio products shipped last year, wireless audio is the largest Bluetooth market
Global Music Report 2019, streaming consume music. According to the IFPI Digital music has revolutionized how we
Global Recorded Music State of Play from ‘physical’ (CD and vinyl) sales offset a 10.1 per cent decline in revenue
2018 accounting for 37 per cent of music paid streaming services at the end of
nearly exclusively done by digitizing audio signals. Digitizing is achieving sampling the signal from a
transducer—a microphone—to record both audio and temporal information about the sound waves. The sampling rate
CD–quality sound, the original signals sampled at 44.1 kHz with 16-bit precision. 16-bit precision allows the amplitude of the signal to
be subdivided across 216 (65,536) levels between the pre-determined maximum and minimum amplitudes. The resulting data output
rate is 1.411 Mbps (44.1 kHz × 16 bits × 2 channels × 0.1). This level of digitization is sufficient to capture all the sound humans are capable of hearing, across the 20 kHz bandwidth of the ear.
Engineers can choose to trade off sampling rate and precision depending on the application. For example, voice–only systems can take advantage of the ear’s particular sensitivity to sound with a frequency between 800 Hz and 4 kHz. This bandwidth of 3.2 kHz is sufficient to encompass 80 percent of information carried by the sound wave and more than adequate for the listener to understand speech. The reduction in this bandwidth requirement allows engineers to reduce the sampling rate to 8 kHz. Even with 16-bit precision such a sampling rate reduces the data output
requirement to 128 kbps for accurate monaural reproduction. The sampling rate required for satisfactory stereo sound
streaming results in much larger files, too big for easy transfer and storage. Demand for quick downloads from the early Internet provided the catalyst for compression formats such as MP3. The format relies on ‘perceptual coding’, which is based on psychoacoustic models that permit the software to discard or remove the precise audio components that are less audible to human hearing, and therefore not essential for the brain to decipher the reproduced sound. MP3 compression is highly efficient. For example, an MP3 encoded at a constant bitrate of 128 kbps will result in a file approximately nine per cent the size of a CD quality recording of the same audio while still retaining an acceptable level of reproduction for playback.

**State of Play**

**Global Recorded Music by Segment 2018**

Digital music has revolutionized how we consume music. According to the Global Music Report 2019, streaming revenue in 2018 grew by 34 per cent and accounted for almost half of global revenue, driving a 33 per cent increase in paid subscription streaming. The report says there were 255 million subscribers of paid streaming services at the end of 2018 accounting for 37 per cent of music revenue. Growth in streaming more than offset a 10.1 per cent decline in revenue from ‘physical’ (CD and vinyl) sales.

2% Synchronization of revenues
14% Performance rights
12% Download & other digital
10% Ad-supported streams
37% Subscription audio streams
26% Physical

**The science of digital sound**

Humans experience sound through analog sensors. According to Steven W. Smith, PhD, in his book _The Scientist and Engineer’s Guide to Digital Signal Processing_, the human ear is capable of detecting sound waves across a continuous frequency range of 20 Hz to 20 kHz. Smith says the separation of the two ears enables humans to detect the difference between two sound sources that are spaced as little as three degrees apart.

But while we use analog sensors to generate sound, recording and reproductions now almost exclusively done by digitizing audio signals. Digitizing is achieving sampling the signal from a
transducer—a microphone—to record both audio and temporal information about the sound waves. The sampling rate (Hz) and precision (bits) determines how much information from the original sound waves is retained and how well it can be reproduced. The benchmark for digital audio reproduction is the CD. For CD–quality sound, the original signals sampled at 44.1 kHz with 16-bit precision. 16-bit precision allows the amplitude of the signal to
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**Tech Check**

Bluetooth 5.2 brings much more than LE Isochronous Channels to the technology. Other enhancements include LE Power Control which makes it possible for devices to dynamically optimize the transmission power used in communication between connected devices. Nordic’s nRF52840 and nRF52832 Series (including the nRF52832 wearable) and Bluetooth 5.2 are compatible.
The AI of Things

The IoT generates so much raw data that traditional analysis methods struggle to cope. AI is the answer.

Tens of thousands of companies have recognized the power of the IoT to solve previously intractable problems and move towards new ways of optimizing their businesses. Momentum continues to build because once one company gains a competitive advantage by successfully implementing IoT technologies, its competitors or counterparts are compelled to follow suit or risk being left behind.

The sensors, processors, and wireless technology building blocks of the IoT have made it technologically and commercially viable to monitor, measure and ‘digitalize’ almost everything and anything generating a constant stream of fine-grained data. The pay-offs from this ‘big data’ are boosts in efficiency, convenience, safety, security and cost savings; the downside is data overload.

“The IoT comes with the unintended cost of producing more data than that we can cope with,” says wireless IoT chipmaker Nordic Semiconductor’s CTO, Svein-Egil Nielsen. “If you’re just starting out and want a career with healthy employment prospects look no further.) But how will AI resolve the data overflow from the IoT? The answer is in making decisions based on programmable intelligence.

The AI-driven networking solution market is expected to reach $50.8 billion at 42 per cent CAGR and over 50 per cent of enterprise organizations will leverage AI technology for networking.

THE BIG AND SMALL OF AI

“I would define AI in the IoT as any programmable intelligence that takes in data and then makes a decision based on that data,” explains Steve Poulsen, President of U.S. embedded design consultant, Signetik. “This allows measurements to be taken much more frequently and cost effectively because the AI reduces or eliminates the data overload and the IoT reduces or eliminates the need for a human to go out and do it. It also allows anomalies or trends in that data to be spotted more quickly and reliably.”

“Because in the IoT most communication with the Cloud is carried on a cost and power consumption overhead, you do all the big [complex] AI in the Cloud,” Poulsen says that where small AI comes into its own is for filtering data at the edge. “If you put a sensor out there that collects data you want to do small [simple] AI locally as much as possible and do all the big [complex] AI in the Cloud.”

Poulsen cites examples of small AI that his customers are implementing in their devices. “If you put a sensor in a gunshot detection system designed for high crime inner-city neighborhoods that automatically alerts local law enforcement, Poulsen says that city inhabitants often don’t report such incidents making the data generated by automated systems even more crucial to law enforcement.

In Short

In the IoT, sensors are monitoring and measuring almost everything creating an avalanche of fine-grained data. AI can help resolve the IoT’s data overload by making decisions based on programmable intelligence.

Sensors that use AI to filter data at the edge rather than relying everything in the Cloud saves power and cost.

By the Numbers

By 2023...

IoT will represent 83% of the entire AI chips market

The global ‘AI in embedded IoT devices’ market will approach $16.2 billion

The worldwide general AI market will reach $50.8 billion

The AI-driven networking solution market is expected to reach $5.8 billion

Source: Research And Markets

Feature: Data Analytics

Source: Research And Markets

Feature: Data Analytics
“AI and the IoT go hand-in-hand because the IoT generates too much data for a human to reliably and quickly analyze,” explains Poulsen. “At present we estimate around 20 percent of our customers use Atil’s IoT applications, and based on current trends we see this rising to over 50 percent within the next few years. However, we’ve been working on IoT applications for over 20 years – long before it was called IoT.”

“What’s changed is the commercial viability of powerful but low-cost sensors and LPWAN wireless technologies as a means to collect data from them. The latter now includes cellular IoT for long-distance LPWAN gateway-free connectivity. And cellular IoT is far by the far the best LPWAN wireless technology out there today, and the one we plan to standardize upon moving forward.”

The goal for this project was to create a low power embedded application that could accurately classify five different hand gestures in real time using radar data, with one of the gestures being woken up to wake the application, explains Hardebring.

“Gesture control may not seem like much, but to get to where the perfect control button like ‘always works’ requires extreme precision. This is why in this application radar was selected.”

Hardebring explains that this level of precision also requires a lot of real-time data collection and processing. “On a pair of battery powered headphones you wouldn’t want to send this amount of data up to the Cloud in an ever-increasing sea of data,” says Anders Hardebring, CEO and Co-Founder at edge-AI startup, Imagimob.

“The A111 radar sensor is optimized for high precision millimeter-level distance ranging and physical detection and features a small footprint and ultra-low power consumption. Inside the headphone, the A111 radar sensor is housed on a module called the XMM2210/11 module. That also incorporates Nordic’s nRF52840 advanced Bluetooth LE SoC and is claimed to be the world’s first radar system that can run on a coin-cell battery.”

“To achieve this level of accuracy we need to look at how the AI is just left to its own devices to learn what data patterns it needs to look for in order to correctly identify or perform a certain task. This is the AI used to develop the Imagimob gesture recognition used in the ‘virtual’ button headphones described in this article.”

Types of AI
AI is a comprehensive academic research area as full of scientific terms for various features and functions. However, today there are three general categories of AI (and even the most advanced of these is considered only the simplest form of what AI could one day become). All use software algorithms to identify patterns in data.

“Simple AI” is programmed completely by humans and has no intelligence of its own. Its intelligence comes solely from human programmers who tell it exactly what to look for in a given set of data, and what to do if it finds it. Even the format in which the data presented to the AI cannot change. This is the AI for example, that makes boxes go red if you fail to fill in a ‘mandatory’ field within an online form.

“Feature-based machine learning” is the next step up and although again has to be programmed by humans to be directed what to look for in raw data sets (called feature generation), once programmed it can further improve its pattern detection accuracy and speed by apriori of trial and error. This type of AI powers based on your viewing history you might like predictions that are common to many modern TV streaming platforms.

Deep Learning is the domain of neural networks and removes any of the manual feature generation work that’s required for the creation of the machine learning AI described above. This time the AI just looks to its own devices to infer what data patterns it needs to look for in order to correctly identify or perform a certain task. This is the AI used to develop the Imagimob gesture recognition used in the ‘virtual’ button headphones described in this article.
Get Smart

Cellular IoT and Bluetooth LE wireless tech are together bringing precision to energy management

The cost of electricity in the U.S. has risen more than 50 percent in the last 30 years, while household income has not. According to Statista, household income has barely managed 15 percent growth in the same period, and on the graph of power prices versus wage growth, the two lines have been diverging for most of our lifetimes. They continue to do so.

In the hierarchy of unwelcome bills, behind housing and transportation, utility bills are the next biggest drain on our lifetimes. They continue to do so.

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Early connectivity solutions such as PLC and M-BUS had their limitations, but now we are at a tipping point. Cellular IoT—a LPWAN technology supported by two versions, LTE-M and NB-IoT—now presents an ideal solution for meter connectivity to the Cloud, while Bluetooth LE offers a consumer friendly, smartphone compatible link between the homeowner and their power consumption data.

"For Cloud connectivity from the meter to the utility, cellular IoT is the best solution because it brings simplicity, security, and speeds up the rollout," says Lorenzo Amicucci, a Business Development Manager with wireless chipmaker Nordic Semiconductor. "A list of companies have been trying to find proprietary solutions to connect meters, but with cellular you have a solution backed by a lot of companies so it’s a future proofed and standardized tech. “Bluetooth LE is useful for installation and commissioning, and of course if the user wants to connect to the meter, every smartphone has it built in. In some markets there are prepaid meters and Bluetooth LE could be used to recharge the meter, or you can use it to connect the meter to other sensors or switches. Bluetooth LE is getting more popular for smart metering for the human interaction element.”

DRIVING ADOPTION

Wireless solutions that provide a simple and manageable means for utility companies and their customers to access and action their power consumption data is in theory a win-win for both parties, but it is not yet a marriage of equals, and the power companies are the ones driving smart meter adoption.

Utilities want connected meters because they want to be able to accurately bill their customers; they want to know in real time how much each household is using and that consumers are paying for their energy rather than stealing it. The data can also be used to perform advanced analytics and demand response modeling to ensure the grid is performing to its peak and optimized for full profit potential.

What power companies care less about is that customers have access to the same data. “It’s governments that want utilities to share the data with their users, not the utilities themselves,” says Amicucci.

While the profit motive makes power companies unconcerned about providing their customers with the tools to moderate their energy use, or schedule it around offpeak pricing, the benefits for the customer are obvious.

"Sharing the data with the consumer gives them a choice,” explains Amicucci. “It enables them to decide when’s it’s the best time to charge the car or use the washing machine. Consumers can now connect to the meter and know how much power they are using every minute.

“Giving consumers the power to manage their own energy consumption can be good for the utility companies too. In a period of peak demand, if everybody turns everything on at the same time the electricity company has a problem. But if consumers have the ability to respond to their own usage based on live pricing some will back away when the cost surges at times of high demand, and the grid will perform better as a whole.”

Smart metering in its true sense—beyond ‘basic’ connectivity to data collection, analysis and live feedback—is still a developing sector, but there are solutions serving both utilities and their customers that are already delivering on this promise. In 2018, Polish startup OneMeter launched its OneMeter Beacon, a device that allows users to monitor and manage their real time energy usage. Orignally designed for use in industrial and commercial environments, the solution is now available for the domestic market. It works by simply plugging the device into an existing electronic electricity meter via an optical port interface – enabling the beacon to receive energy usage data from the meter using the IEC 62056-21– IEC 1077 protocol.

Once installed, the beacon is paired to a smartphone or tablet using Nordic Bluetooth LE wireless connectivity and allows the user to review the data including active and reactive energy consumption parameters, as well as daily, weekly, and monthly energy usage charts. Companies can perform accurate energy usage cost estimation and avoid penalties for exceeding contracted power by defining power parameter alerts. Certified measurement data can also be shared with energy vendors enabling invoices to be settled based on actual usage instead of forecasts.

ONLY THE BEGINNING

The next step for smart meters, Amicucci believes, will be for them to move beyond standalone devices, to part of the broader smart home ecosystem. In Norway, for example, you can already buy a device that attaches to a smart meter that can connect over the Internet to an electric vehicle charger, and in turn make smart decisions about the most economical time to charge the car.

“How we connect the smart meter to other objects in the house and for what benefit is the next step,” says Amicucci. “The key question is which protocol will be used. The market for the protocol that’s chosen will be huge.”

Tech Check

Guru, employing Nordic nRF52832 µIP, has produced an open-source proof-of-concept PoC) Smart electricity meter for cellular IoT smart meter reading. The PoC is designed for use with DLMS meter and complies. A cable that connects to the nRF52832 to the meter (optical power meter or direct serial port connection): the nRF52832 programmed with a GaraMQT Bridge example on MQTT Broker, and the client application based on GDX. M36 Director. (See WQ Issue 1.2019 pg28.)

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By the Numbers

The global smart meter total will rise from 665 million in 2017 to more than 1.2 billion by the end of 2024.

Source: Wood Mackenzie

"Giving consumers the power to manage their own energy consumption can be good for the utility companies too."
PitPat employs Nordic’s nRF52810 Bluetooth LE multiprotocol SoC to provide low latency wireless connectivity between the device and the dog owner’s smartphone. The SoC has the lowest power consumption and smallest size (2.482 by 2.464 mm for the CSP package) in Nordic’s nRF52 Series, and brings the 2 Mbps higher throughput and improved coexistence benefits of Bluetooth 5 to cost-sensitive, high volume applications.

All dogs require exercise, but some need a lot more than others. At the lazy end of the scale is the bassett hound which with its large body and short legs was built for comfort rather than speed. A cattle dog, however, was bred to spend all day chasing a herd, and their endless energy means they need to be on the go and exercising at least two hours a day.

Dogs possess up to 300 million olfactory receptors in their noses and can detect some odors in parts per trillion, meaning their sense of smell is up to 100,000 times as acute as a human. Making the analogy to vision, if a human could see clearly up to 0.5 km away, a dog could see just as clearly up to 50,000 km away.

This Bluetooth LE wearable canine activity tracker monitors pet exercise data to help keep dogs fit and healthy. According to analyst Research and Markets, connected wearables have entered a strong growth phase that will see shipments grow from 116 million units in 2018, to 238 million units by 2023. Fitness and activity trackers currently account for more than 50 percent of these shipments, and with an estimated 900 million dogs on the planet, the non-human wearable market has large potential.
Multiprotocol equine monitoring solution helps farmers monitor horses’ health

Using concurrent Bluetooth LE and Thread wireless connectivity, the Farm Jenny for Horses platform allows horse owners to track the location and wellbeing of animals.

For centuries farmers and ranchers had no option but to manually monitor, protect and care for their horses as best they could utilizing limited resources. It’s a tough job, especially for those at the smaller end of the commercial farming scale. Thankfully, emerging tech can help reduce the heavy workload and alleviate the reliance on sporadic observations and imperfect recollections of each animal’s unique behavior patterns.

Horse owners, for example, cannot take advantage of the benefits of a wireless herd tracking solution like Farm Jenny for Horses, an animal wearable and connected equine monitoring platform. Developed by Pittsburgh-based agricultural technology company Farm Jenny, the solution is designed to help horse owners keep a closer eye on the various activities and behavior indicative of a horse’s overall health status and potential medical issues. The user tracks this information from either a web-based dashboard or the Farm Jenny iOS or Android app on their smartphone or tablet.

“Farm Jenny for Horses provides freedom and peace of mind by bringing the power of machine learning to small farms,” says Rob Crouthamel, Co-founder and COO, Farm Jenny. “Our solution addresses the everyday worries of horse owners such as a horse bolting out in bad weather and the number one horse emergency, ‘calsic’ (a generic term referring to a combination of symptoms of oftentimes fatal abdominal problems in a horse.)

The sensor-based platform records animal activity levels including walking, lying down, rolling, grating or running, as well as changes over the past day, week or month. This behavior analysis is a high-level signal of potential signs of illness or injury. In addition, the device’s built-in sensors record temperature, humidity and atmospheric pressure, which helps determine the horse’s comfort and provides context for evaluating animal behavior. Farm Jenny for Horses also tracks the animal’s location, allowing the owner to follow its position in relation to facilities, food and water sources. Farm Jenny’s Field Receiver, one of the world’s first ‘Built on Thread’ certified devices, uses a Thread-powered wireless mesh network providing farmland wireless connectivity. Both the field receivers and the gateway employ Nordic’s nRF52840 advanced multi-protocol SoC with a Thread/Bluetooth LE/Thread concurrent SoC, a dynamic multi-protocol feature that uniquely supports concurrent Bluetooth LE/Thread connectivity.

The wearable can relay the sensor data directly to the gateway if the horse is in a barn to the Cloud via the companion app on a smartphone or tablet if the horse is roaming at large or at a show; and to any nearby solar powered field receiver if the horse is in pasture. In turn, the field receiver relays the data to a central gateway that then forwards the data via LTE-M or NB-IoT cellular connectivity to the Cloud for review. In all cases, Bluetooth LE connectivity is used for the “first hop” of data from the animal’s wearable sensor to the connected farm system. The solution uses an “opportunistic communications system designed to maximize battery run time of the animal sensor,” says Crouthamel. “For the wearable, the SoC’s generous memory and processing capability allows us to do more behavior processing on the animal, so we save power by not transmitting as often as everything is okay.”

The company is full of praise for Nordic’s support and multiprotocol low power solutions. “All of our robots run Nordic’s S132 SoftDevice, a proven Bluetooth LE applications. Nordic’s unique software architecture maintains a clear separation between this stack and the customer’s application code, ensuring it can’t be corrupted during firmware updates. This arrangement significantly simplifies the systems integration process. Bringing code to life and the customer’s application code, documentation and support pages provided are extremely useful,” adds Wiencrot.

“Nordic is a fantastic company to work with and an ideal partner for a company like Sphero.”

Since horse owners can’t be with their horses 24/7, Farm Jenny provides all of the information they need in one place or tablet. The nRF52832 SoC at the heart of Sphero’s RVR Soft Device, a proven Bluetooth LE solution leveraging the Thread protocol and LE applications, Nordic’s unique software architecture maintains a clear separation between the stack and the customer’s application code, ensuring it can’t be corrupted during firmware updates. This arrangement significantly simplifies the system integration process. Bringing code to life requires that the RVR be able to communicate with the system through the robot itself. More than any computer program, robots bring code to life and can help solve problems and develop solutions that are currently being taught in the classroom.

“Educators are looking for ways to teach the ‘Four Cs’ of critical thinking, collaboration, communication and creativity,” says Wiencrot. “They’re seeing the value of robots in classrooms to support students in creatively solving problems and developing solutions through the robot itself. More than any computer program, robots bring code to life and can help solve problems and topics that are currently being taught in the classroom.

“We’ll use this emerging e company as an example. Sphero create curriculums that can be used in traditional classrooms to support teachers in integrating robotics and coding.”

Building programmable robots for educators

Supported by Nordic’s development tools, Sphero created the RVR smart robot in the fledgling smart toy sector. Boulder, CO-based Sphero has developed a programmable and easily accessible robot that’s suited for beginner to advanced coders, STEAM educators and students, makers, hackers and hobbyists alike. The sensor-packed device is called Sphero RVR and it’s designed to be used in a wide array of unique user-coded applications, from a home security sentry to an environmental sensor.

But well before Sphero RVR made its market, the unique software architecture of Nordic’s nRF52 Series helped Sphero add key capabilities to the robot such as enabling users to easily code RVR from the Sphero Edu app hosted on a smartphone or tablet. The nRF52832 SoC at the heart of Sphero’s RVR Soft Device, a proven Bluetooth LE solution leveraging the Thread protocol and LE applications, Nordic’s unique software architecture maintains a clear separation between the stack and the customer’s application code, ensuring it can’t be corrupted during firmware updates. This arrangement significantly simplifies the system integration process. Bringing code to life requires that the RVR be able to communicate with the system through the robot itself. More than any computer program, robots bring code to life and can help solve problems and develop solutions that are currently being taught in the classroom.

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Nordic’s semiconductor company has launched the nRF21540 RF Front End Module (FEM), the company’s first power amplifier/low noise amplifier (PA/LNA) product developed to complement its nRF52 and nRF53 Series multiprotocol SoCs. The RF FEM’s PA offers a highly adjustable output power boost up to +21 dBm, with the LNA providing +13 dB RX gain. The LNA’s low noise figure (NF) of only 2.5 dB also ensures increased RX sensitivity for Nordic’s Bluetooth 5/Bluetooth LE, Thread, Zigbee and 2.4 GHz RF low power wireless solutions. When combined with an nRF2840 SoC, running Bluetooth LE at 1 Mbps, for example, the nRF21540 improves the RX sensitivity by 5 dBm. Coupled with the increased output power, the connection link budget is raised by 18 dBm. For other devices with less than +8 dBm TX power on-chip, the improvement remains significant. The resulting increase in connection link budget offers significantly longer range and helps lower the number of retransmissions due to corrupt packages. The nRF21540 is a valuable addition for all applications that may require increased range or robust coverage. Some example applications are safer tracking, audio, smart home or industrial use cases. The nRF21540 is a ‘plug and play’ complementary device when used with Nordic’s short-range wireless SoCs. The nRF21540 connects to the SoC’s antenna output and features two additional antenna ports to enable antenna diversity features. The device’s gain control, antenna switching and power modes are controlled via GPIO or SPI or a combination of both. While the device can be used with other radios, the ease of use with Nordic SoCs is further enhanced as developer support will be rolled out as part of future releases of Nordic’s nRF5 SDK, nRF5 SDK for Thread and Zigbee, and the nRF Connect SDK.

Programming language could eliminate IoT device vulnerabilities

Nordic Semiconductor’s nRF5080 SLP cellular IoT solution has been used by U.K.-based consultancy, 42 Technology, to highlight how the ‘device is the company claims is the world’s first Rust programming language application for a single-chip technology. “Our aim is to help eliminate the security vulnerabilities that too many people have seen, for example, with low cast home security cameras, smart hubs and medical equipment such as insulin pumps,” says 42 Technology Senior Consultant, Jonathan Pallant. “The ability to change the Rust in IoT applications could accelerate the development of much more robust and secure low cost, low power cellular IoT products and systems,” continues Pallant. “And the technology could play a critical role in unlocking significant new markets for smart industrial and consumer products where security remains a major concern.”

Tech Perspective

What’s new in Bluetooth 5.2

Bluetooth 5.2 enhances the short range wireless standard by introducing LE Isochronous Channels to support LE Audio. But that’s only the start.

LE Isochronous Channels

LE Isochronous Channels’ functionality is important for LE Audio because it allows the communication of time-bound data to one or more devices for time-synchronized processing. The technology extends audio applications because it can be used across connections or broadcast to multiple devices in a connectionless topology.

The existing Bluetooth audio protocol, Advanced Audio Distribution Profile (A2DP), designed for Bluetooth headsets, can be used for high quality audio applications, such as streaming music from a smartphone to a set of Bluetooth headphones. However, A2DP does not support the delay, which is critical for LE Audio. With Bluetooth 5.2, the LE Isochronous Channels can support LE audio by allowing developers to create and control delay- and latency-sensitive LE audio applications. This allows for greater flexibility in terms of where and how LE Audio can be used.

Enhanced Attribute Protocol

Bluetooth 5.2 introduces EATT (along with some associated changes to the Generic Attribute Profile (GATT)) that will allow the Bluetooth controller to control the protocol stack temporarily blocks another. The improvement is achieved through reducing instances where one application’s use of the Bluetooth controller is blocked by another application’s use of the controller. This is achieved by interleaving Logical Link Control & Adaptation Protocol (L2CAP) packets to support LE Audio. But that’s only the start.

Bluetooth LE Audio has become a popular feature for smart devices, from headphones to smartwatches. Bluetooth 5.2 introduces LE Audio, which allows for more robust and secure low power wireless communications. The new features in Bluetooth 5.2, such as LE Isochronous Channels and Enhanced Attribute Protocol, are designed to improve the performance and reliability of LE Audio applications. These enhancements make Bluetooth 5.2 an ideal choice for applications that require low latency and high quality audio, such as in-ear monitoring and virtual reality.

In support of EATT, the revised Core Specification defines a new LE Audio protocol. This protocol is designed to provide improved audio experiences while also ensuring that Bluetooth devices can coexist with other devices on the same network. The new protocol includes features such as LE Audio Encryption and LE Audio capabilities that allow for greater control over the audio data sent between devices.

Bluetooth 5.2 also includes updates to the LE Power Control profile, which is now more robust and secure. The new updates include changes to the LE Power Control profile’s Energy Manager (EM) and LE Power Manager (LMP) protocols. These changes allow for more efficient power management, which is critical for devices that are battery powered.

Overall, Bluetooth 5.2 is a significant enhancement to the Bluetooth 5.0 standard. The new features and enhancements in Bluetooth 5.2 make it an ideal choice for a wide range of applications, from smart devices to industrial and consumer products. With its robust and secure low power wireless communications, LE Audio, and improved power management, Bluetooth 5.2 is poised to continue its growth and widespread adoption.
Cellular technology promises a solution for connecting IoT sensors directly to the Cloud. It is also an option for connecting local networks powered by short range wireless tech such as Bluetooth LE, Thread or Zigbee, to the Cloud through a gateway.

Key advantages of the cellular IoT technologies LTE-M and NB-IoT are that they are supported by an open standard, operate in a licensed portion of the RF spectrum, leverage existing infrastructure and have coexistence mechanisms that enable scaling to high-node counts per base station.

Nordic Semiconductor's nRF9160, a low power SiP with integrated LTE-M/NB-IoT modem and GPS, has been engineered for energy-efficiency and security whilst simultaneously bringing advanced applications to the IoT. The nRF9160 has been in volume production for almost a year having successfully passed major certifications, deliverables and testing.

The nRF9160 LTE modem integrates RFFE, radio and baseband. The modem offers 700- to 2200 MHz LTE band support and 25 dBm output. LTE-M throughput is UL DL 100/579 kbps while NB-IoT throughput is 50/60 kbps. RX sensitivity is -108 dBm for LTE-M and -114 dBm for NB-IoT. The modem supports half-duplex FDD operation.

The SiP architecture

The nRF9160 comprises a dedicated application processor and memory, multimode LTE-M/NB-IoT modem with integrated RFFE and BB, GPS power and memory management in a compact 10 x 16 x 2 mm package. Through high integration and precertification for global operation, the SiP solves the complex wireless design challenges arising when employing cellular technology requiring just an external battery, SIM, antenna and sensors. The nRF9160 supports global operation with a single variant thanks to the combination of Nordic’s multimode LTE-M/NB-IoT modem, SAW-less transceiver, and RFFE. The SiP is the first cellular IoT solution to incorporate a 64 MHz Arm Cortex-M33 CPU core supported by 1MB of Flash and 256KB of RAM onboard memory. The module incorporates Arm TrustZone (see WO 2016/017032 and Arm CryptoCell (see WO 2016/017032) for secure Internet-level encryption and application protection.

LTE-M/NB-IoT modem

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Development tools

Nordic’s strategy for cellular IoT mirrors that for its short range wireless products and that is to make its solutions easily accessible, easy-to-use and well supported. Cellular is one of the most intricate wireless technologies, but Nordic’s development tools shield the designer from its complexity and allow them to focus on the application.

Software development for the nRF9160 SiP starts with the nRF Connect SDK, a software development kit which includes everything needed for a designer to get started on a cellular IoT prototype project. TheSDK also includes tools for more advanced design including the Zigbee RTOS, application layer protocols such as CoAP, MQTT and LWM2M, and application examples covering a wide range of use cases.

The SDK also includes software for secure boot, and secure firmware over-the-air (OTA) device updates for both application and cellular modem firmware. The nRF9160 SiP’s tool suite is completed with an affordable, pre-certified single board development kit, the nRF9160DK, easing development with LTE-M, NB-IoT and GPS. The DK has a dedicated LTE-M and NB-IoT antenna supporting a wide range of bands and global operation. The DK also includes an nRF52840 advanced multiprotocol SoC enabling the DK to form the basis of a design for a Bluetooth LE to cellular IoT gateway.

Development can be accelerated by designing with the Nordic Thingy:91 cellular IoT prototyping platform. The Thingy:91 is the ideal platform for rapidly developing a prototype for cellular IoT and comes with an eSIM card from iBasis, preloaded with 10 MB of data allowance.
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### Product Summary

**nRF52833**

- **Description:** The nRF52833 is a multiprotocol SoC with a Bluetooth Direction Finding capability, qualified for operation in an extended temperature range of -40 to 100°C. A generous memory allocation and dynamic multiprotocol support ensures the nRF52833 is an ideal device for commercial and industrial applications, including professional lighting and asset tracking. A ±8 dBm to ±1 dBm adjustable output power makes nRF52833 an ideal choice for wearables or smart home applications where robust coverage is important.

- **Hardware:**
  - The nRF52833 incorporates an 80 MHz 32-bit Arm Cortex-M4 processor with floating-point unit (FPU), 512 kB Flash and 256 kB RAM. The chip includes up to 8 dBm TX power (programmable from -20 dBm to +4 dBm steps) and 8 dBm sensitivity (Bluetooth LE at 1 Mbps) for a TX budget of >30 dBm. The radio is capable of all Bluetooth Direction Finding functionality and its large memory can support both receiver and innovative nodes for Angle-of-Arrival (AoA) and Angle-of-Departure (AoD) applications. The SoC has an analog input balun with single-ended output and includes advanced features such as Full-Speed USB and High-Speed SPI. The SoC includes up to 42 GPIOs with a range of analog and digital interfaces, NFC-A, ADC, UART, SPI, TWI, PWM, QSPI and UPD. It has a 1.8 to 3.6 V supply voltage range, a five-stage LCD regulator and ADC-DC converter. The SoC includes a 1.5 by 1.0 mm QFN73 with 42 GPIOs, a 3 by 5 mm QFN84 with 51 GPIOs and a 2.5 by 3.2 mm WL-CSP33 with 64 GPIOs.

- **Software:**
  - The nRF52833 is supported by Nordic’s open-source Long Range Software Stack (LRSS). The LRSS provides the examples, libraries and drivers needed to get started with Bluetooth LE, Bluetooth mesh, 2.4 GHz proprietary and Thread or Zigbee development. The LRSS is a versatile single board development kit with a Connector-IF (CIF) for a wide range of third-party devices.

### Tech Profile

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