Following the herd

Cellular keeps track of the Sami’s most valuable asset across the vast subarctic.
Ear tag tracks location and health of herding animals

A tracking device that can be attached to an ear of herding animals and autonomously measure a location and health has been introduced by Finnish startup, Anicare. The Anicare Healtag employs Nordic Semiconductor’s multimode cellular IoT module to send data to the Cloud so that in the event a roaming animal becomes injured, it can be quickly identified for treatment. Existing herding animal trackers are so large they have to be hung from the animal’s neck, and they consume so much power that their batteries have to be replaced every year. In contrast, by employing the compact nRF9160 SiP, the Healtag is small and light enough (at 25g) to be attached to an animal’s ear like a traditional livestock ear tag, and offers a battery lifetime of up to five years.

The device integrates an accelerometer and thermal sensor to measure the herding animal’s activity and temperature once an event a roaming animal becomes injured, it can be quickly identified for treatment. Existing herding animal trackers are so large they have to be hung from the animal’s neck, and they consume so much power that their batteries have to be replaced every year. In contrast, by employing the compact nRF9160 SiP, the Healtag is small and light enough (at 25g) to be attached to an animal’s ear like a traditional livestock ear tag, and offers a battery lifetime of up to five years.

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Swedish startup, Minut, is employing LTE-M cellular technology to provide the wireless connectivity for its motion, temperature, sound, humidity, and air pressure detection smart home alarm.

The device, dubbed the Point, employs Nordic’s nRF9160 SiP cellular IoT module in place of the previous Wi-Fi/Bleuetooth LE solution, and enables owners to receive remote notifications in the event of activation. The unit measures 85 by 46mm and eliminates the need for multiple alarms. Privacy is safeguarded via local data processing.

The Point employs a patented sound-recognition technology that analyzes ambient noise in the home. This enables the device to immediately recognize out-of-the-ordinary sounds such as smashed glass or other alarms going off nearby. It can even alert neighbors, friends, and family of an intruder detection. “With the Point you can relax safe in the knowledge that...you’ll automatically get sent a notification alert,” says Niels Mattisson, CEO of Co-Founders Mollusk Technology. Unlike traditional intruder alarms that are hard-wired into the mains, low power cellular IoT supports battery-powered operation which is a bit of game changer. I suspect many previously Wi-Fi products will add or even switch to cellular.”

“Cellular IoT is a significant complement to existing wireless products and particularly relevant to security applications where it has often been used as the ‘wireless technology of last resort’ in traditional intruder alarms,” says Ove Langeland, Nordic’s Director of Sales. “Unlike traditional intruder alarms that are hard-wired into the mains, low power cellular IoT supports battery-powered operation which is a bit of game changer. I suspect many previously Wi-Fi products will add or even switch to cellular.”

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**Wireless tech helps track and conserve green sea turtles**

U.K.-based technology consultancy, Icotex, in collaboration with open-source conservation technology group, Ara Bada Initiative, has developed a solution to track and collect data on the movement and behaviour of green sea turtles using Bluetooth LE wireless tech. Collecting GPS data is critical for informing governments, directing conservation policy to designate marine protected areas, and combating turtle threats.

At the core of the solution is a platform called Horizon, incorporating a tag attached to the turtle’s shell during the “arribada”, the unique mass turtle nesting phenomenon where thousands of female turtles come together on the same beach approximately every two years. The tag features an active channel motion sensor, temperature and pressure sensors, a Bluetooth LE module, a sensors, a satellite receiver, and an Insight SiP 19P1807 module, based on Nordic’s nRF51823 Bluetooth LE SoC. When the turtles return to the beach the logged data is downloaded to a PC using Bluetooth LE connectivity.

Depending on the turtle species and location, turtle return to the beach can vary from weeks to months, demanding the solution can store with ultra-low power consumption to conserve and extend battery life. When the battery reaches a critical state, the thermostat can be easily implemented in a robust and secure Zigbee smart home mesh network, where the device acts as the router to other connected Zigbee devices.

**Smart Home**

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**‘World first’ Zigbee certified thermostat for underfloor heating**

Sikom, a Norway-based developer of GSM IoT platforms, has released what it claims is the first Zigbee certified product for the direct control of smart home underfloor heating. The Sikom Z3 Thermostat EP has been developed for the smart home, O2M channel, and employs Nordic’s nRF52840 SoC to enable Zigbee wireless connectivity and mesh networking. The thermostat integrates actuator’s enabling the device to control floor heating cables directly, and a mains-powered, eliminating the need for battery replacement. Once installed, the thermostat can be controlled via a Zigbee, Home Automation Profile-enabled control device using Zigbee wireless connectivity.

**News Extra**

**Nordic cellular IoT powers retail sector innovations**

Freezing Point is using NB-IoT to support its plan to revitalize the North American frozen beverage market. How cellular IoT will enable new business models is becoming clear across technologies such as Nordic’s nRF9160 SMT-LTE-M/NB-IoT module reach commercialization. One example comes from Freezing Point, a Salt Lake City-based frozen beverage company and owner of the “Slushie” brand, Frazil.

Slushie’s a trade name for frozen beverages comprising chocolate and fruit flavors. The frozen beverage is dispensed by a machine that constantly stirs and refrigerates the mix to maintain a smooth consistency.

Retailers have identified a strong correlation between how well they manage their Frazil program and how well they manage other aspects of retail excellence.

“ ’We’ve been developing cellular IoT applications using traditional cellular modules for some time,’ explains the company’s CEO, Max Tangen. ’But when the Nordic nRF9160 SMT module came along we saw it had a host of advantages to benefit us.’

As the name suggests, NB-IoT is a narrowband technology standard with a bandwidth of 200 kHz, significantly boosting its range compared with LTE-M (the trade-off is modest throughput (60/10 kbps downlink/uplink) compared with LTE-M). The longer range of NB-IoT is an advantage in retail environments which often have a lot of RF (RF attenuation) metal on floors, walls and ceilings.

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Frazil’s machines low on Slushie content weren’t used anywhere in the store but were instead waiting for a period of a few hours, it will notify Freezing Point.

**Tech check**

*7Sense’s credit card-sized cellular NB-IoT central board is based on Nordic’s nRF9160C1401 series. The nRF9160 is a low power SiP with integrated LTE-M/NB-IoT modem and GPS, designed for worldwide operation in bands from 700 MHz to 2.2 GHz. The SiP incorporates an Arm Cortex-M3 processor, 1 MB flash, and 48 MB RAM.*
The public safety and law enforcement landscape is changing as wireless technology enables the instant, automatic deployment of innovative personal protection methods and incident monitoring platforms. It’s an important evolution for both those in danger and those in the line of duty.

According to data from the FBI’s annual Uniform Crime Report, law enforcement agencies killed or assaulted 60,211 officers in 2017, compared to 64,579 in 2016. Those were the fewest line-of-duty deaths since the FBI began tracking them in 1966. Although the number of deaths fell, the percentage of unarmed officers killed rose, from 44 percent in 2016 to 56 percent in 2017. Clearly, the global market for more effective self-defense technologies and connected law enforcement platforms is substantial.

Building safety networks

How can short range wireless technologies like Bluetooth LE contribute to the development of advanced solutions for handling, such serious incidents? By creating secure wireless networks of people, self protection devices with multifunctional built-in sensors, and police incident reporting, smartphones apps or Cloud based alarm platforms. Such products not only cut down emergency response times, but automatically record incidents for handling such serious incidents. By creating secure wireless networks of people, self protection devices, with multifunctional built-in sensors, and police incident reporting, smartphones apps, or Cloud based alarm platforms, such products not only cut down emergency response times, but automatically record incidents for handling such serious incidents.

Many of these networks are designed to help law enforcement agencies act faster and more efficiently. The TASER Pulse+, for example, when paired to an AID panel detects any piercing event to the wearer’s front or back, at which point the vest automatically connects to a paired smartphone using Bluetooth LE connectivity. The smartphone then sends an emergency alert to nominated first responders or backup units via SMS, or directly to a dispatcher’s console.

Future of law enforcement

Emerging wireless technologies like cellular IoT are also likely to impact other crime response management and law enforcement as we know it. Within an IoT powered smart city, for example, street lights could use gunshot detection equipment to evaluate the location and distance of the shooter. IoT based Law enforcement agencies can use this data to develop a better understanding of where violent crime is likely to occur. According to a 2019 U.S. Police Foundation report, shootings in the Chicago district of Englewood, where an SDSC was deployed for the first time in 2017, fell by 67 percent that year compared to 2016.

In the Central West End District of St. Louis, MO, an initiative using Cellular Solutions North Platform has seen significant improvements in response times for assistance through a smartphone app, with local officers then able to aggregate data from alarm, IoT sensors, cameras, and communication systems to quickly develop an action plan.

Why the smart home needs to get even smarter

Before the industry can grow, smart home device vendors need to learn to play nicely together. Smart home device shipments grew 55 percent in 2016 over 2015 to total 252 million units with more than 70 million homes worldwide now having some sort of a smart home system. According to ABI Research, with such impressive market penetration you could forgive for thinking that the smart home is doing everything right. But I don’t think it is. Rather I think vendors’ outdated business models and product complexity are compromising growth. Traditionally, if a consumer wanted to install an alarm system at home, they’d turn to a professional security company. In return, the consumer not only paid for equipment installation and remote monitoring — but also a hefty, cost-considering monthly fee. If the consumer wanted to add, for example, CCTV to their system, the security company would have to pair the Bluetooth-based camera with the same vendor and pay them to install and configure an additional set of Bluetooth LE base stations. And the equipment monthly fee would get even higher.

Today’s consumers are sending a clear message (through their investment in DIY home security systems) that they don’t like being locked in to a single vendor and technology. It’s a smart message that in the long-run is good for consumers as it helps to keep costs down.

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Today’s consumers are sending a clear message (through their investment in DIY home security systems) that they don’t like being locked in to a single vendor and technology. It’s a smart message that in the long-run is good for consumers as it helps to keep costs down. Throughout the industry, vendors have to pair the Bluetooth-based cameras. As a result, they’re paying a hardware and software fee every month, which adds up to a lot of money over the years. But now, we see the smart home market becoming a lot more competitive. We see an increased need for technology that makes law enforcement officers safer, more efficient, and more effective in their roles.
W Following the Herd
In the harsh subarctic, cellular IoT monitoring of valuable livestock can mean the difference between boom and bust for Sami reindeer owners

Reindeer benefit from an enviable public image. When most people think of the animals they picture a snowy scene with a cute, healthy animal (typically with a red nose) tethered to a shiny sleigh laden with children’s presents. There are even some who believe reindeer are from the world of fantasy: a fragment of a Christmas card designer’s imagination inhabiting the same place as unicorns, mermaids, and dragons. Hardly. Direct ancestors of the reindeer have been around for some 680,000 years and far from being cuddly, reindeer are extremely powerful and robust animals. They have to be to survive the challenges of the alpine tundra landscapes and subarctic forests in which they live, the harsh winter conditions comprising ice, deep snow, high winds and extreme temperatures. Migrations across hundreds of kilometers between seasons to find food, avoid predators and reproduce bring further dangers.

The reindeer’s resilience is derived from its evolutionary adaptations which include a compact body morphology and thick pelt to minimize heat loss; a high population of fiber-digesting bacteria in the gut flora to maximize the nutritional value of poor-quality vegetation; and unusually large deposits of subcutaneous fat laid down in late summer and fall that sustain the animals during winter limits the food supply. When not migrating or running from danger, reindeer conserve energy by walking at a leisurely pace and lying down for almost half the day. But such long periods of resting should not be confused with an easy life. While reindeer are very social animals, gathering in herds that can number up to several thousand individuals, populations exhibit large fluctuations. Extreme weather events, lack of food, predators, hunters, road and rail accidents, insect borne diseases, competition between species, and human encroachment on grazing areas all serve to erode their numbers.

Climate change is adding to the burden. Increased warming is changing migration routes and patterns of vegetation, but these aren’t the major threats; rather it’s the rain. Traditional winters above the Arctic Circle are very cold but also very dry. Warmer winter temperatures are encouraging bolder snowfall and more wet weather. Reindeer are perfectly adapted to snow; they can sniff out vegetation with a highly sensitive nose and dig through the layers with their hooves to reach the food underneath. But when rain falls and then freezes, edible flora is locked beneath an undrivable ice layer and starvation quickly follows.

A report by New Scientist, a U.K. magazine, described the impact of two major rain events on the Yamal Peninsula in Russia which caused mass starvation on reindeer in November 2006 and 2013. After the 2013 rainfall, over 20 percent of a herd numbering 275,000 animals died. The rain froze into a thick ice sheet for months, preventing the animals reaching vegetation underneath. “Reindeer are used to sporadic ice cover, and adult males can normally smash through ice around 2 centimeters thick,” Bruce Forbes at the University of Lapland in Rovaniemi, Finland, told New Scientist. “But in 2006 and 2013, the ice was several tens of centimeters thick.” Despite the suffering, the life and death of reindeer would be little more than an academic curiosity if the animals weren’t worth billions of dollars. Decimation of a herd due to disease or starvation is only DANGER EVERYWHERE
Decimation of a herd due to disease or starvation is only one concern for the owners. Although reindeer prefer to stick together, struggles often become separated. That makes them easy pickings for predators, particularly wolverines, which since 1995 have been protected by...
Finnish hunting regulations. According to The Economist, a family of wolves can get through 90 reindeer a year. Because the forests are vast and remote, if an isolated animal is attacked by predators, starves or falls ill and dies in the dark frozen trees, it is often never found. And even if it is located the carcass is typically mutilated by scavengers. In as little as a day, the scavengers can do so much damage that not only can the cause of death be impossible to determine but also that proof of ownership can be erased. Untimely dead animals are not only distressing but also, in Lapland in particular, costly because if the herder is unable to prove the reindeer was killed by a predator, they miss out on a compensatory payment from the Finnish government. (4,126 such payments were made in 2014.)

One such unfortunate beast led to the 2012 foundation of Anicare, a company whose mission is to help herders look after their animals. The company’s CEO, Aki Marttila, chanced upon the dead reindeer in the forest and set him thinking, “I want reindeer to last.” He says, “And I wondered if there might be a device for tracking the animals from which all herders could benefit.”

It’s not a completely original idea; some reindeer have been equipped with satellite tracking devices for over a decade. But they’re expensive, costing hundreds of dollars, heavy (mainly because of the large batteries which still only last about year) and bulky. The heft of the tracking devices dictated that they are attached via a collar. This is far from ideal, partly for the reasons that the animals cannot be relocated and the low power consumption offers a battery life of up to five years.

The narrowband tech lends itself to long range (tens of kilometers) while throughput is limited to tens of kilobits per second. That matches the requirement of the reindeer application where the animals roam over long distances and the volume of data is small, amounting to hourly updates of location, movement and body temperature.

**PROTECTED SPECIES**

Dubbed the Healtag, the Anicare product integrates Nordic Semiconductor’s nRF51822 for NB-IoT standards, GPS, an accelerometer and a temperature sensor into a device small and light enough to attach to a reindeer’s ear like a traditional livestock tag. The Healtag’s low power consumption offers a battery life of up to five years.

The component integration and small-size of Nordic’s solution—the module is the smallest NB-IoT solution on the market with GPS—mean we could fit the product into a package measuring just over 3 by 2 by 2 centimeters and weighing only 25 grams,” says Marttila. “And because the Nordic product is certified for global cellular networks, we didn’t have to worry about ranging any regulatory approvals.” [See this issue p.13]

As the reindeer moves across theundra, its location is monitored and transmitted by the NB-IoT device to the Cloud. Herders can use a browser dashboard to check each animal’s unique position, as well as where and how far it’s moved since the last update. An app supports a smartphone version of the dashboard. Over time, positional data can help build up grazing patterns to help herders better manage the reindeer.

Key to the product’s success is an alert function that triggers a notification if a problem is detected with a particular animal. The accelerometer and temperature sensor monitor movement and body heat, and the alert is sent immediately (rather than waiting for the next periodic transmission). If the algorithm calculates something is amiss. For example, if the animal is lethargic and its temperature rises, it could be an indication it has an infection. Or if the reindeer is lying down and its temperature drops it could be that it is injured or dead. “A rapid alert enables the herder to reach the reindeer as soon as possible and hopefully take it to a vet or at least end the animal’s suffering. And in the worst case it can ease the identification of the cause of death,” says Marttila. "If it’s due to predation, the herder can initiate a claim, but if it’s due to, for instance, starvation or disease, the herder can take measures to protect the remainder of the herd.”

**WHAT’S NEXT?**

Healtag is still under development and an updated version of the device is due for release soon. The tech has been tested across Lapland for over 12 months and the unit’s fixed to reindeer last winter is still working well. More herds will be added in other geographical areas around Finland to continue to test, among other things, that cellular coverage is adequate to cover the reindeer’s wandering range. Marttila expects the technology to be commercially available by year end when the solution will be available to herders for the cost of a software license fee.

“While the product is designed for reindeer, we consider it to be a demonstration of how cellular Iot can be used for animal farming in general,” explains Marttila. “Versions for sheep and cows are next on our list.” Marttila’s ambition extends beyond domesticated animals; he also suggests a version for the very wolves that attack the reindeer. “If we keep the technology open, we can at least limit the number of reindeer they take,” he says.

Life in the subarctic is never going to be easy. Winters have always been harsh and global warming is changing weather patterns in a way that adds to the already tough challenge of feeding for the north’s reindeer herds. And an increase in the number of hungry wolves, not to mention Scandinavian cars and trams, is killing more animals. But three things provide hope for the future; the reindeer demonstrate a tremendous capacity to adapt, the herders are clever and resourceful people, and cellular Iot technology can help them better protect and nurture their animals.

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**By the Numbers**

In Lapland, 1,200 reindeer roam across an area of 98,984 km². Source: Antavaraisten Seuran raportti 2019

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**Tech Check**

Measuring just 19 by 15 by 17 mm, the Healtag includes everything a cellular connection and all application needs beyond an external battery, SIM and antenna. The nRF51822 is capable of delivering class-leading output power (<2 dBm) and sensitivity, all within LTE’s support.
Power Mad

Every year consumers pay power bills for energy they never use, but smart wireless technology is helping turn the tide on waste.

When the Deepwater Horizon drilling rig started spewing crude oil into the Gulf of Mexico following a catastrophic explosion at the BP-operated platform in April 2010, the world looked on in horror as an appalling environmental disaster unfolded. By the time the leak was finally contained 87 days later, the U.S. government estimated more than 4.9 million barrels—or 795 million liters—of oil had been spilled into the sea.

The environmental cost remains incalculable, but the energy cost of the spill, according to U.S. utility service provider EnergySavvy, was, in relative terms, a drop in the ocean. To put it in context, the company said the energy consumed in a single year by the oil spill is roughly equivalent to the energy that just 75,000 American homes—or 0.005 percent of the estimated 127 million households in the country—waste in a single year. Echoing this finding, the U.S. Energy Administration, in 2014, the latest year for which data is available, reported that roughly a third of all energy consumed in the U.S. homes was wasted.

The data generated by Smart Home devices is helping to curb this waste but consumers need to be convinced of their merits. The Environmental Protection Agency, in 2018, reported that roughly 15 percent of American homes are smart homes. And while the EPA’s definition of a smart home is vague, it’s generally agreed that it’s one that’s equipped with easily accessible sensors and devices that can be remotely controlled through a smartphone or other mobile device.

Every year in the US, $260bn is spent on electricity and 530bn of it is wasted.

By the Numbers

Each year in the US,

"The true potential for energy savings in the smart home lies in reducing energy consumption through better management." King said the ACEEE report. “And better management lies in optimizing our home’s energy-consuming systems. We can align their operation to our preferences and reduce unnecessary energy use. Smart technologies can yield higher overall efficiency through better controls, communication, and response... In short, smart technologies that target major end uses can change the picture of household energy consumption.” However, smart homes are less about individual devices than about their interaction with one another: “The key to the smart home is connectivity,” King said “Wireless protocols—Wi-Fi, Bluetooth, Zigbee, Z-Wave, Thread, and others—allow smart devices to share their status and data with one another.”

The Power of Connectivity

Wi-Fi is popular because it’s already widely available in almost every home in the developed world, offers good data throughput and reasonable range, but it is “power hungry.” Bluetooth is attractive because of its presence in smart phones as well as its ultra low power consumption. While range was Bluetooth LE’s Achilles heel, the arrival of Bluetooth 5 and the extended range that came with it has gone some way to addressing the issue. Zigbee is well established and useful for particular for mesh applications, but requires a gateway and offers limited throughput. Thread has been developed specifically for the smart home and is simple to install, secure, and scalable, but like Zigbee it is not present in smartphones. Cellular solutions meanwhile offer range aplenty, but come with a higher price tag and a relatively higher power requirement.

“What is the perfect connectivity option? The answer is simple— it depends,” says Erik Midttun, Technical Product Manager at Nordic Semiconductor. “The ideal choice would consume low power, have long range capability, and high bandwidth capability. Unfortunately that doesn’t exist in one solution. It’s unlikely one low power wireless protocol will win out.” And other than to chipmakers and developers, it hardly matters: the issue of wasted energy in the home is protocol-agnostic. But connectivity of some form is key. Smart thermostats, smart lighting, smart meters, and any other smart power-saving devices for the home rely on wireless connectivity to not only communicate with one another, but also to proactively communicate with the consumer. If it’s a case then of seeing is believing, then smart energy device manufacturers will need to tap into the drivers of consumer demand for this technology. Fostering a product that consumers trust and feel the true potential for energy savings in the smart home lies in reducing energy consumption through better management. To prove the point, the company said of those who had invested in smart energy-saving devices, 70 percent believed the technology had helped them reduce energy consumption. It’s a view backed by recent research from analyst Parks Associates. “Roughly 46 percent of U.S. broadband households currently have no intention to purchase any smart home devices,” says Patricia Samuels, Senior Analyst, Parks Associates. “Delivering on the promise of saving money is among the key factors that will drive purchase intentions among these consumers.” To prove the point, the company said of those who had invested in smart energy-saving devices, 70 percent believed the technology had helped them reduce energy consumption.

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The Environmental Cost remains incalculable, but the energy cost of the spill, according to U.S. utility service provider EnergySavvy, was, in relative terms, a drop in the ocean. To put it in context, the company said the energy consumed in a single year by the oil spill is roughly equivalent to the energy that just 75,000 American homes—or 0.005 percent of the estimated 127 million households in the country—waste in a single year. Echoing this finding, the U.S. Energy Administration, in 2014, the latest year for which data is available, reported that roughly a third of all energy consumed in U.S. homes was wasted.

The data generated by Smart Home devices is helping to curb this waste but consumers need to be convinced of their merits. The Environmental Protection Agency, in 2018, reported that roughly 15 percent of American homes are smart homes. And while the EPA’s definition of a smart home is vague, it’s generally agreed that it’s one that’s equipped with easily accessible sensors and devices that can be remotely controlled through a smartphone or other mobile device.

Every year in the US, $260bn is spent on electricity and 530bn of it is wasted.

By the Numbers

Each year in the US,
“Devices with analytical capability generate copious amounts of data that can provide insight into a home’s activities,” said Krueger. “These data create new opportunities and mechanisms for identifying equipment inefficiencies and energy waste behaviors. Third-party solution providers have entered the smart home space to make sense of the data and engage residents in their energy use.”

The data holds value to utility providers who can use the information to engage in demand response programs, in effect, a technology enabled economic rationing system for electric power supply where consumers are incentivized for allowing the utility company to automatically reduce their energy use during peak times of the day. For example, for consumers that have opted-in, in a particularly hot summer’s day, during peak load, the utility could remotely turn off a customer’s AC unit, or raise the temperature setting on their smart thermostat.

POWER TO THE PEOPLE
An example of a third party solution provider. In the smart home space is Currant, a California based company, which last year released its Wi-Fi Smart Outlet. The device is a Bluetooth LE and Wi-Fi connected product which employs AI to enable users to monitor and manage their power usage, reduce energy consumption, and cut electricity costs. Any household appliance can be plugged into the device and once paired with a smartphone or tablet the product enables the user to view their energy consumption by appliance, as well as create customized rules to manage their energy usage. The Nordic SoC-powered device uses AI to recognize patterns in energy usage and suggest changes to cut down consumption. Once the device has been in operation for a week it will learn the user’s schedule, the devices that are plugged in, and the associated energy usage. Using this information – and data gathered from thousands of other devices—the partner app will recommend a schedule for appliance use to minimize energy consumption. The user has ultimate control over the schedule, which in turn enables Currant’s proprietary algorithm to continue to learn and improve.

"Some smart outlets have rudimentary energy monitoring, but none use AI to suggest schedules based on energy usage," says Nasty Granbery, the CEO of Currant. "There are some basic handheld energy monitors that show real-time usage but don’t aggregate data over time, and there are whole house monitors that have trouble identifying specific devices, especially those that draw a small amount of idle power. This is the AI-powered smart outlet to help people control their homes, and their energy bills."

Another company working hard to curb power waste is Polish IoT startup, OneMeter, which recently released its OneMeter Beacon, a device that also allows users to monitor and manage their energy usage. While currently designed for use in industrial and commercial environments, the company is looking at the domestic market and integration via Amazon Alexa, Google Home, as well as Apple HomeKit. The OneMeter Beacon is plugged 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 1107 protocol. Once installed, the beacon is paired to a smartphone or tablet using Nordic Bluetooth LE wireless connectivity, and allows the user to view the data including active and reactive energy consumption parameters, as well as daily, weekly, and monthly energy usage charts. From the accompanying OneMeter Cloud platform a company cannot only monitor its metering data, but also receive accurate energy usage cost estimation, conduct effective energy audits, avoid penalties for exceeding contracted power by defining, power parameter alerts, as well as manage it’s photovoltaic infrastructure. Certified measurement data can be shared with energy vendors enabling invoices to be settled on an actual usage instead of forecasts.

The examples of wirelessly connected smart energy saving devices are numerous and varied, but the principle in every case remains the same – knowledge is power.
A new trend is rising, driven by the belief that it’s not just rapid food delivery that’s important, rather the entire customer experience.

**State of Play**

Top five QSRs by U.S. revenue

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Revenue (Billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>McDonald’s</td>
<td>$17.65bn</td>
</tr>
<tr>
<td>Del Taco</td>
<td>$9.79bn</td>
</tr>
<tr>
<td>Wendy’s</td>
<td>$9.65bn</td>
</tr>
<tr>
<td>Burger King</td>
<td>$7.08bn</td>
</tr>
<tr>
<td>Subway</td>
<td>$5.94bn</td>
</tr>
</tbody>
</table>

The fast food business was worth $199 billion in the U.S. alone in 2018 and is set to exceed $223 billion next year. In 2016, there were 186,977 QSRs in the U.S., up by 28,000 from a decade ago. 20 percent of Americans dine at a QSR once per week and 7 percent have visited a McDonald’s in the last year.

**CUSTOMER ENGAGEMENT**

Typically the new breed of companies bringing such technology to the QSR sector is Radius Networks. The company builds a platform that uses machine learning to help companies conduct location-based transactions with their customers, including table service and curbside pickup. The wireless location platform allows a customer to place a food order via a mobile app or in-store, and relays their exact location to the restaurant for delivery.

Introducing robust, flexible and scalable wireless networks into a crowded restaurant is no mean feat as it must compete with a barrage of interference from Wi-Fi and smartphone Bluetooth transmissions. However, Radius Networks turned to low power wireless system integrator Rigado to solve the engineering challenges. The company specializes in commercial Bluetooth LE solutions built on Nordic Semiconductor’s nRF52 Series.

“Using a standard protocol such as Bluetooth makes things less complex, which makes it easier to install and run apps,” Kevin Tate, Chief Revenue Officer with Rigado told ascom.

“We’re trying to make it so that customers only have to worry about the data and what to do with it, and we’ll take care of getting that data to them.”

To meet the specific needs of the Radius Networks project, Rigado used its Bluetooth gateways—which support multiple IoT applications and are capable of over-the-air updates as new use cases arise—typically four to five per retail location, to deliver wireless sensor and device data to the Radius Networks location engine and platform. Customer location and order details, and other incoming data, trigger real-time notifications for restaurant staff. Staff in turn use a tablet running the Radius Networks dashboard to identify customer location for order delivery. Other data integration introduces capabilities in areas such as in-store and curbside pickup, asset tracking, and pay-at-table functionality.

Early results after installing the systems are impressive, with a significant decrease of 50 percent in customer problems, complaints and incorrect orders. Meanwhile, overall customer satisfaction—the name of the game—has increased by 20 percent, the amount spent on each order has grown by up to 15 percent, while overall guest count has risen by 4 percent.

More than seven decades since the McDonald brothers first came up with their formula for fast food, the same basic principles still apply. Combining those principles with modern commerce technologies has allowed the QSR sector to become almost ubiquitous across most of the globe, and it looks set to become a trillion-dollar industry in the not-too-distant future. And now wireless connectivity is poised to supercharge fast food restaurant efficiency while at the same time bringing greater convenience, comfort and choice to hungry consumers.
The ATMOS Mission One dive watch employs Nordic's nRF52840 Bluetooth 5/Bluetooth LE advanced multiprotocol SoC to act as the main control chip, as well as provide the device with Bluetooth LE connectivity. The SoC's powerful 64MHz, 32-bit Arm Cortex M4F processor provides ample computational power to run the watch's complex sensor algorithms.

The world record for the deepest ever SCUBA dive was set by Egyptian Army special forces officer Ahmed Gabr in 2014. Gabr descended 332 meters in the Red Sea off the coast of Egypt. The pressure at that depth is 32 times that on the surface, so while it took 42 minutes for Gabr to reach maximum depth, it required nearly 15 hours for him to return to sea level safe from decompression.

The worldwide market for wearables grew more than 31 percent during the fourth quarter of 2018, reaching a new high of 59.3 million units according to analyst International Data Corporation (IDC). Wrist worn devices, including those for sports and fitness activities, accounted for more than 64 percent of total shipments.

ATMOS Mission One Dive Watch

This Bluetooth LE diving watch records detailed dive information and wirelessly transmits sensor data to a user's smartphone app to enhance the underwater swim experience.

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Smart ski boot ‘digital coach’ improves skiing technique

Through Bluetooth LE connectivity and Atomic’s Hawx Connected ski boot platform, skiers can track their own performance metrics and make improvements on the slopes.

As inevitable as an avid skier hitting the slopes, the moment conditions become favorable, so too has a market emerged for connected ski gear and skiing performance analysis platforms built on low-power wireless technology. Runners wirelessly monitor their performance metrics, cyclists do likewise, so why shouldn’t skiers do the same?

Among the innovative companies leading the race to develop the most advanced solutions for the global winter sports enthusiast community is Atomic, an Austrian ski equipment manufacturer that’s been at the forefront of the industry for over six decades. With a goal to revolutionize skiers’ ability to track and review their own skills and techniques, Atomic—in conjunction with biomechanics experts from Salzburg University and Salzburg Research—has developed Hawx Connected, a Bluetooth LE ski boot. The boot is complemented by an iOS or Android compatible smartphone app designed to deliver direct, on-slope sensory feedback to enhance the skier’s overall skiing experience. The platform effectively acts as a skier’s ‘digital coach’ and training log, not only providing real-time analysis of individual ski runs but also archiving results from a full season of skiing and setting targets for improvement.

Hawx Connected is based on sister company Suunto’s ‘Movesense’ platform, an open environment for developers of wireless motion sensing solutions incorporating a nine-axis Inertial Measurement Unit (IMU). The smart ski boot features eight embedded force sensors that measure pressure at key contact points inside the boot liner, while the IMU’s built-in accelerometer and gyroscope simultaneously detect turns and ski edge angles through the orientation of the boot. Immediately following either a single run or full session on the mountain, the skier can use their smartphone to access the Atomic CTD app, which via Bluetooth LE connectivity retrieves the performance metrics gathered by the ski boot’s various force and motion sensors. The metrics allow the user to instantly view comprehensive information about their skiing performance across a range of indicators including balance and edging, turn count, run count, average speed, top speed, slope angle, total distance, total vertical distance, G-force, and more.

Using the on-demand notifications and readily available performance reviews help the user improve their overall technique for “smarter, safer, and stronger skiing” claim the developers. In addition, the app makes it easy for skiers to set personal goals, challenge fellow skiers from the same ski resort and right around the world and even compare their own performance data against professional athletes.

The Hawx Connected platform allows the skier to know precisely how to adjust their skiing technique for higher performance by refining their balance, pressure control, and edging skills.

Through Bluetooth LE connectivity and Atomic’s Hawx Connected ski boot platform, skiers can track their own performance metrics and make improvements on the slopes.

**Tech Check**

**Nordic’s RFS2832**

**WLCSP: SoC measures 3.5 by 3.5 mm while offering all the features of the conventionally packaged chip, including the 28-pin SMD-pitch 9V/10V CMOS and a fully-automated power management system that reduces power consumption by up to 50 percent compared with Nordic’s FS1 Series SoCs.

**Profile**

**Name:** Karl Helmer Torvmark
**Job Title:** Technical Product Manager
**Joined Nordic:** August, 2018
**Based:** Oslo, Norway

**Interests:** Family, homebrewing beer, playing classic videogames, performing as synthesizers and the guitar

**Old-school gamer helps develop modern products**

Hi, I’m Karl Helmer Torvmark and I’m a Technical Product Manager based in Oslo, Norway. Before joining Nordic in 2018, I had worked in the electronics industry for almost 19 years. For the majority of that time I worked with wireless ICs in various roles including Field Applications Engineer.

My main responsibility at Nordic is to ensure we develop products that I talk to customers to understand their needs, analyze the information together, and then together with the R&D team turn it into specifications for future products. Unfortunately, I can’t say too much about the project I’m currently working on but I can say there are some really exciting things in progress at Nordic.

The best parts of my job are working with some very smart people, being exposed to new ideas and technology, and seeing what our customers are able to do with the tools we provide. I’ve really come to love the Nordic company culture—very professional, very customer-centric, and a culture where they just don’t fix mistakes, they take risks. A flat company structure, colleagues being passionate, engaged with each other and their views. Decision making seems to be quick and efficient at Nordic. I think these are all key elements to the company’s success.

Outside of work, I like to spend time with my family, my wife, two sons, a dog, and a cat. As a family, we enjoy playing board games, watching movies, or just hanging out together.

I also love collecting and playing retro videogames and arcade games from my childhood in the 1980s. This hobby provides an opportunity to learn about old embedded electronics and brush up on troubleshooting skills. Although my sons play a lot of modern games, they also want to play some of the classics, which I appreciate a lot. A few years back, while working in Bluetooth SIG, I met one of the people who designed the chips for the Atari 2600 back in the late 1970s. It was really interesting to meet someone who was there when videogames (and indeed computers) were somewhat new. I’ve enjoyed playing around with synthesizers since got my first one at age 12, and I’ve always been interested in making our products to play electric guitar accusing of years ago. Making music is lots of fun, but I’m getting grumpy day just yet.

From a work perspective, my main focus is ensuring Nordic has exciting products coming up in the future, which our customers can then use to make some fantastic products for their own customers. It’s always very interesting to see how our products are being used, often in ways that we had never even thought of.
Tech Briefing
Why cellular IoT needs eSIMs

OS maintains robust link in challenging RF environments

Flexible IC offers Bluetooth LE in world’s thinnest form factor

Dongle delivers M2M IoT product

American Semiconductor has launched a flexible Bluetooth LE connectivity in the 6ghz to 6ghz-660mhz frequency range, enabling BLE connectivity in what the company claims is the world’s thinnest and smallest Chip Scale Package (CSP). The AS_NRF51 Flex-BLE is an ultra-thin version of Nordic’s nRF51822 SoC, enabling the American Semiconductor’s FlexSoP product line. The AS_NRF51 Flex-BLE employs Nordic’s Arm Cortex M4F processor and offers ample computational power to run Microchip’s microcontroller, allowing the IC to be used in small form factors. The package size is approximately 3mm x 3mm, and the thickness of a human hair. From and backplane solders from HD Microsystems provides mechanical strength to allow the IC to bend without breaking. The result is an IC that is robust, thin, and physically flexible form factor designed for solutions that demand ultra thinness, physical flexibility, and high reliability in applications ranging from wearables and logistics, to the IoT.

“We were looking for an advanced Bluetooth Low Energy solution that was rich in features and available in water format for conversion through our FlexSoP product,” says Richard Ellinger, VP of Sales and Marketing at American Semiconductor. “The nRF51822 SoC’s Arm microcontroller, large Flash memory low power consumption, and excellent 2.4GHz radio performance made it the ideal choice.”

The availability of an established suite of support software was also essential, as we want our end customers to be able to quickly deploy the products. This chip will allow entry into markets demanding an ultra thin, conformable, and flexible solutions.

Communication through LumenRadio’s MiraMesh networking stack and Nordic’s Bluetooth protocol stack.

“For low power applications, its critical RF spectrum is used efficiently, to ensure energy is not wasted on transmissions,” says Michael Karlsson, R&D Manager at LumenRadio. “Collaborating with Nordic has allowed us to take the benefits of cognitive coexistence to large wireless networks.”

Because it stores only a single set of operator credentials, a conventional SIM becomes impractical for a cellular IoT device that could be used anywhere in the world.

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Flexible IC offers Bluetooth LE in world’s thinnest form factor

Dongle delivers M2M IoT product

Taiwan-based Raytec Corporation has released a dongle that is only programmed with a developer’s application software, provides designers of M2M IoT applications with an preconfigured and complete multi-protocol connectivity solution, negating the need for design expertise and time consuming development work. The compact 43.1 by 18 by 9.3mm design enable the dongle to be used in small form factors. The dongle also allows us to bring the benefits of cognitive coexistence to large wireless networks.

A key advantage of cellular IoT is that the infrastructure to support global deployment is already in place. The installed cellular network encompasses a robust, proven network technology that covers most of the populated regions of the globe. Because cellular spectrum allocations are licensed and regulated, devices must be identified and authorized before accessing these networks. Most mobiles use a Subscriber Identity Module (SIM) for this purpose. SIMs were originally developed by the European Telecommunications Standards Institute (ETSI) for GSM networks. Today, SIMs are used by almost all mobile devices that connect to LTE, 5G, and WiFi. Future cellular IoT devices will also require identification and authorization, but alternative technology is required because the conventional physical SIM is not a practical solution for billions of remotely deployed devices.

SIMple connection

A SIMless connection is an International Mobile Subscriber Identity (IMSI) number, a 16-digit code uniquely identifying the card (and mobile on the operator’s network) and typically associated with a company that issued the card and that operator deals with the access request even if the user wants to use a different operator network. For example, another country. When network access is requested, the IMSI and a one-time-use 128-bit authentication key (Ki) are related to the network to prepare for the call, and the operator then authorizes the connection.

There are two major disadvantages of this system for cellular IoT deployment. The first occurs because conventional SIMs are discrete cards that plug into the mobile device that means they take up space. The mobile device needs a port (increasing costs and providing an ingress for dust and water), and a SIM upgrade is required if the port is not replaced. Another disadvantage is that its hardly practical for potentially millions of devices, many of which will be too inaccessible locations.

The second problem arises because of the SIM’s association with a single operator: While a SIM covered by roaming contract can theoretically provide global coverage by accessing local networks, the actual coverage depends on the number of roaming relationships the “home” operator has negotiated. It also means paying the high data charges incurred while roaming. Because it stores only a single set of operator credentials, a conventional SIM becomes impractical for a cellular IoT device that is required to operate anywhere in the world. For example, in some regions, a customer may be authorized by a remote operator is not allowed under local regulations. Limiting the cellular IoT device’s usefulness. An embedded SIM (eSIM) can solve these problems. The device is no longer a separate, relatively large external plug-in; rather, as the name suggests, it comes in the form of a chip (known as an embedded Universal Integrated Circuit Card (eUICC) that becomes part of the device’s electronic assembly. That means it can be made tiny—an important consideration for compact cellular IoT devices—and removes the cost and vulnerability of an external port. (An eSIM can also be supplied in conventional micro- or nano-SIM card formats allowing use in older devices that feature a port and don’t have a built-in eSIM.)

An eSIM holds multiple local network operator credentials (in contrast to a conventional SIM card that can only hold one). An eSIM can also be “remotely provisioned” (e.g., programmed over the air). Such capabilities not only allow for future technology enhancements but also repeated updates with profiles suitable for the local network – eliminating the regulatory challenges that come from constant roaming and allowing the compact device to take advantage of local (typically cheaper) data charges.

Network benefits

There are advantages for the networks too. Remotely provisioned eSIMs enable mobile operators to seamlessly add cellular IoT devices and apply data charges that would otherwise be directed to the home operator. Cellular IoT solutions can only be used this way, as an eSIM is a way for a cellular IoT device to connect to the network. For example, if a remote operator is not available under local regulations. Limiting the cellular IoT device’s usefulness. An embedded SIM (eSIM) can solve this problem. The device is no longer a separate, relatively large external plug-in; rather, as the name suggests, it comes in the form of a chip (known as an embedded Universal Integrated Circuit Card (eUICC) that becomes part of the device’s electronic assembly. That means it can be made tiny—an important consideration for compact cellular IoT devices—and removes the cost and vulnerability of an external port. (An eSIM can also be supplied in conventional micro- or nano-SIM card formats allowing use in older devices that feature a port and don’t have a built-in eSIM.)

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Tech Check
Bluetooth 5.1 takes real time location systems to the next level

The latest update to the Bluetooth Core Specification provides access to RF phase data making it easier for developers to build accurate position location applications.

While Global Navigation Satellite Services (GNSS) works well outdoors, the loss of satellite signals makes the system unsuitable for indoor position location applications. Engineers are looking to other wireless technologies for an alternative. Bluetooth technology’s Received Signal Strength Indication (RSSI) can be used to estimate the distance of a transmitting device from a known fixed point such as a beacon. However, the technique is limited to proximity applications because variable signal attenuation and lack of information about the direction of the signal prevent an accurate position estimate. This lack of capability limits implementation in applications such as real time location systems (RTLS) and Indoor Positioning Systems (IPS).

The recent introduction of Bluetooth 5.1 Direction Finding (see WQ Spring 2018, p.25) offers a basis for commercial ‘positioning engines’ (for example, Qualcomm’s Intelligent Locating System) are available. And a new generation of these firmware products, adhering to the Bluetooth 5.1 specification, are already in the works. The Bluetooth SIG is also working on its own AoA and AoD direction-finding profiles for early release which could form the basis of future positioning engines.

The ambitious developer to code these algorithms but commercial ‘positioning engines’ (for example, Qualcomm’s Intelligent Locating System) are available. And a new generation of these firmware products, adhering to the Bluetooth 5.1 specification, are already in the works. The Bluetooth SIG is also working on its own AoA and AoD direction-finding profiles for early release which could form the basis of future positioning engines.

The other area requiring careful consideration from the developer is system hardware. First, the selected Bluetooth LE SoC must of course be Bluetooth 5.1-compliant and it will typically need a powerful on-board processor paired with ample Flash and RAM to handle the complex direction finding algorithms. Second, designing an antenna array for 360-degree coverage is not trivial and an inexperienced might prefer a commercial option. Third, Bluetooth LE SoCs typically don’t have multiple antenna ports so a peripheral device will be necessary to feed the signal from multiple antennas to the SoC’s single antenna port.

The AoA system is suited to asset tracking where the transmitter is a mobile and the receiver is a stationary fixed point. The AoD method reverses the roles, with the mobile receiver calculating the direction from which the signal comes and hence the direction of the transmitter. The situation is reversed for the AoD method. In this scenario, the device with the antenna array sends a signal via each of its antennas. As the signal from each antenna makes the receiver, the antenna that the signal arrives in turn at the receiver’s single antenna. It is phase-shifted from the previous antenna in the array arrives in turn at the receiver’s single antenna. This data can be used to compute the angle from which the signal comes and hence the direction of the transmitter.

Exposing IQ data
Bluetooth 5.1 Direction Finding is far from a complete suite of RTLS firmware, rather it simply makes the protocol’s IQ signal available for engineers to develop a Bluetooth LE SoC’s API.

Bluetooth IQ data is a fundamental requirement for performing direction finding. However, to realize a full RTLS implementation requires intensive processing using complex algorithms. It is possible for the ambitious developer to code these algorithms but commercial ‘positioning engines’ (for example, Qualcomm’s Intelligent Locating System) are available. And a new generation of these firmware products, adhering to the Bluetooth 5.1 specification, are already in the works. The Bluetooth SIG is also working on its own AoA and AoD direction-finding profiles for early release which could form the basis of future positioning engines.

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Bluetooth 5.1 Direction Finding offers a basis for centimeter precision positional estimates in two- or three-dimensions by using ‘Angle-of-Arrival’ (AoA) and ‘Angle-of-Departure’ (AoD) methods.

The AoA method forms the foundation of a system for tracking a transmitting Bluetooth LE device. The transceiver sends Bluetooth 5.1-compliant packets using a single antenna which are then received by an antenna array—equipped device locator. As the transmitted signal crosses the array, the receiving device monitors the phase difference at the wavefront caused by the difference in distance from each array antenna to the single transmitting antenna. This data can be used to compute the angle from which the signal comes and hence the direction of the transmitter. The situation is reversed for the AoD method. In this scenario, the device with the antenna array sends a signal via each of its antennas. As the signal from each antenna makes the receiver, the antenna that the signal arrives in turn at the receiver’s single antenna. It is phase-shifted from the previous antenna in the array arrives in turn at the receiver’s single antenna. This data can be used to compute the angle from which the signal comes and hence the direction of the transmitter.

The ambitious developer to code these algorithms but commercial ‘positioning engines’ (for example, Qualcomm’s Intelligent Locating System) are available. And a new generation of these firmware products, adhering to the Bluetooth 5.1 specification, are already in the works. The Bluetooth SIG is also working on its own AoA and AoD direction-finding profiles for early release which could form the basis of future positioning engines.

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