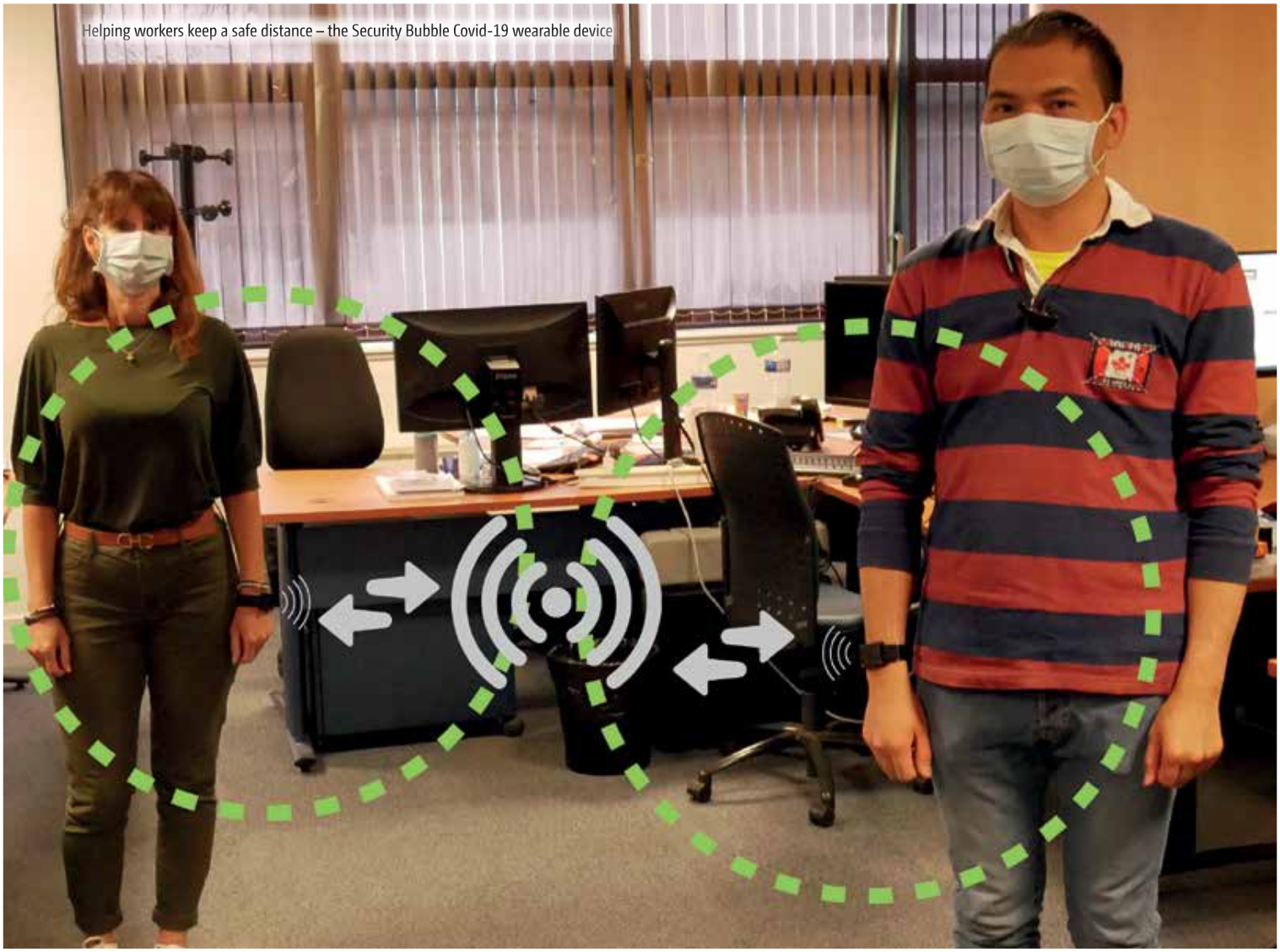
What will they be we

A decade of growth has seen wearable devices mature from basic health trackers to devices for complex functions that are easy t



Helping workers keep a safe distance – the Security Bubble Covid-19 wearable device

The market for wearable electronic devices has undergone dramatic growth over the past decade, from a small starting point in 2010 to become a major segment of the electronics industry. Precise figures vary, but a CAGR in excess of 20% seems common to most reports, with an overall market size of multiple billions of dollars under a broad definition of the sector.

> The technology is moving fast, and what was once only worn by geeks is becoming unremarkable

First generation wearables

The first generation of wearables fell into two main categories, either simple devices, such as basic fitness trackers, or highly complex ones including advanced smart watches.

As the market has developed, the high-end segment has consolidated around a few major brands, the obvious ones being Samsung and Apple. The investment behind these devices is significant, requiring custom system in package (SiP) designs, and in some cases unique semiconductors; only possible for those companies with deep pockets.

At the other extreme, the initial wave of wearables was quite straightforward, often consisting of little more than a Bluetooth Low Energy (BLE) device with an integrated microprocessor and a few sensors.

aring next?

o use, say Nick Wood and Chris Barratt

Initial wearables were health trackers and smart watches

Wearable expansion

BLE was the crucial foundation technology for the sharp rise in the wearables market. Classic Bluetooth, while functionally capable, was simply too power hungry to make devices that met the consumers' ease of use requirements.

Few people were interested in something that needed daily charging. Other low power radio technologies were available but needed some other device to connect to. BLE solved these issues, allowing wearables with a time between recharge measured in weeks rather than days and which could easily connect to any phone on the market and send data to the cloud if required.

Niche applications

Despite their relative simplicity, a wide variety of devices could be conceived based on a BLE radio/microprocessor connected to some sensors. Simple fitness trackers were among the first entrants to this market, but many of the more interesting solutions were focused on niche applications with their value based on smart data analysis more than advanced electronics.

Products under the wide-ranging health and wellness heading vary from somewhat gimmicky products, (connected toothbrush, anyone?) to medically certified devices aimed at assisting people with serious health conditions, such as continuous glucose monitoring devices.

There are companies with billion-dollar businesses based almost exclusively on electronic glucose monitoring wearables. Between those extremes, there are devices to assist people with fertility, improve sleep, monitor heart function or even control mood.

Technology never stands still, however. The simple fitness tracker has been made almost redundant through the integration of most of the features into phones. Meanwhile the Bluetooth devices that triggered the market have become increasingly sophisticated, enabling new possibilities.

The latest, high-end BLE devices have dual-core processors, floating point processing, a much expanded I/O capability, and run real-time operating systems. The BLE standard itself has evolved, offering higher data rates, longer range, better locating capabilities and low power audio.

Nor is BLE the only radio technology available. LoRa (long range) offers low powered wide area network capability and UWB (ultra-wide band) is used in high-end smartphones to enable high precision location functions.

This means designers are much less constrained by calculating power, connectivity limitations or the number of sensors or other peripherals they can connect to a still relatively low-cost central unit.

Security challenges

A less welcome challenge is posed by malevolent actors for whom any electronic device is just another challenge to hack. Spying on one's step count might be harmless but interfering with a glucose reading or heart monitoring device could cause serious harm.

To counter this kind of threat, the latest generation devices has enhanced security features which were not available on the older generation of devices.

Arm Trustzone blocks are now available on high-end BLE devices, which permit secure key storage and advanced end to end encryption and authentication. Embedded secure elements like those in SIM or bank cards represent a further level of hardware security.

There will be increased focus on such capabilities as wearable device design advances in the medical domain, where it will be used to protect sensitive data as well as active interference in the operation of a device. Wearables may also integrate financial capabilities in the future, meaning the wearer needs to be protected from fiscal as well as physical harm.

The location generation

Location services are another new frontier in wearable capability. Crude indoor location was already availably with BLE and used for "find me" tags but had limited accuracy.

The Bluetooth 5.1 standard enhanced locating capability by adding angle-of-arrival capability, whereby a locating antenna anchor array can track enabled BLE devices more closely. This can be used to locate people or physical assets in a building, for example.

LoRa offers a different set of options for wearable devices. With a range of up to 10km and the capability to set up a relatively simply network, it can be used for monitoring across wide distances. Some applications involve animals, rather than humans, wearing the devices. Farms cover wide areas and a LoRa wearable can monitor animal health and provide position information if linked to a GPS. Agriculture and farming may seem like a traditionally operated industry but it is increasingly also smart too.

UWB-driven positioning has been available for some time but has been hampered by a lack of standards or widespread adoption, meaning only complex and closed proprietary systems can really take advantage.

First generation devices using UWB were also rather power-hungry, limiting their appeal. New situations, however, are leading to innovative applications. For example, InSight has developed Security Bubble Covid-19, an electronic device which helps to ensure awareness of social distancing in crowded environments, including workplaces.

All these factors are now being addressed with standards driven by industry-wide bodies, a newer and higher performing generation of chips and – most important of all – the appearance of UWB on high-end phones, notably from Apple and Samsung.

Should this technology follow the same path as BLE, in terms of becoming a widespread feature of phones, then a whole range of location and authentication-based wearable devices can be envisaged.

For example, a UWB-based device could remove the need to use a card to pass a gate in public transport systems, or to access to a building. It could also

be used to track people in dangerous places – for example on a building site, or firefighters attending an incident – suppling real-time information on everyone's location.

Audible additions

The most immediate impact of BLE Audio will be simply to provide more power-efficient music devices – headphones and earbuds – that can last longer between charges. It also offers additional high-end features such as multi-casting, where multiple parties can receive synchronised audio through their own connected devices.

In the longer term, the ability to stream data may find other creative applications in devices where the power-hungry nature of classic Bluetooth meant it was not well suited.

Audio is not the only application for streaming capability – humans can, in many situations, be remarkably sensitive to latency in response, and such a capability could also have applications in haptic response devices such as game controllers. The science-fiction vision of controlling computers by swiping in the air is not so far away.

Future generations

Wearables have come a long way from the simple step counter, and there is no sign the growth trend is slowing down. The technology is moving fast, and user acceptance is growing, so what was something once only worn by geeks is becoming conventional and unremarkable.

Smart glasses, for example, got off to a bad start with adverse publicity, but are returning in more sombre and focused forms and will undoubtedly become widespread in a variety of professional and personal settings.

The challenges in wearable design will remain: packing as much technical capability as possible into a small space and making creative and intelligent use of data to offer real value to users.

There are technical issues involved in handling radio transmission close to the body as well, but a new generation of core components is nonetheless spurring on an exciting wave of innovation in the field. ❑

Oh deer, where's the herd?

The Rudolf reindeer monitoring wearable uses narrow band IoT (NB-IoT) technology

Photo by Anicare Oy

Anicare is a Finnish company which develops equipment for animal health monitoring. Its device, called the Rudolf, has been designed specifically for use with reindeer, including newborn calves. The waterproof device operates at temperatures from -40 to +60°C. It uses NB-IoT technology to let reindeer herders locate injured, stray or dead animals so that they can respond quickly.

The Rudolf device weighs just 23g and measures 22x36x23mm.

It is attached in the same way as a conventional animal ear tag for a reliable attachment through all the seasons and is small and light enough not to disturb the animal. It can be used with the majority of reindeer (excluding newborn calves).

About the author

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