What’s Next For Wearables?

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Revision **Final**

Release Date **June 2015**

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What next for wearables?

Wearable devices give us unprecedented ways to improve various aspects of our lives such as our productivity, health or general lifestyle. They can track and give us access to information about ourselves and our surroundings that can help motivate us or encourage us to make better choices. What's more, they enable personal connectivity – the ability to connect this "digital self" to the internet. This allows us to share our own information with friends or distant experts, for fun, advice or even on-the- spot medical diagnoses.

Hence it is not surprising that the wearables market is growing fast. According to analyst CCS Insight, in 2013, 9.7 million units were shipped, That figure almost trebled in 2014 to 29 million and is predicted to jump another 158% to 75 million units in 2015, reaching 172 million units per year by 2018.

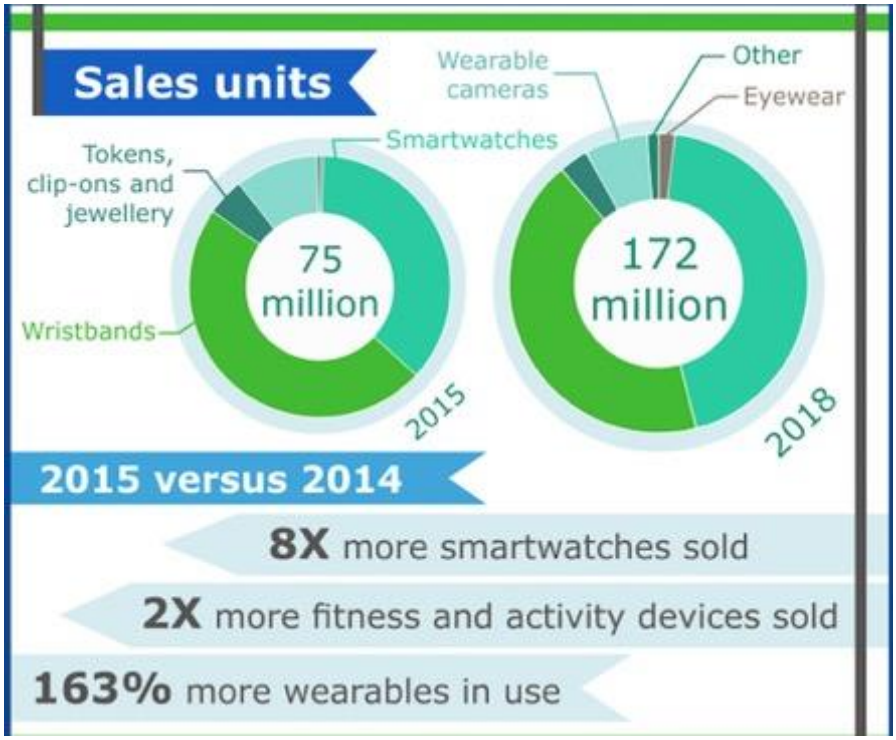

Figure 1: Wearables are the fastest growing segment of the Internet-of-Things (Source: CCS Insight)

Yet, despite this impressive early growth, the overall market is still relatively small – particularly compared to the billion-unit smartphone market. To really drive this fast-moving market to reach its full potential, we need exciting new second- and third-generation wearable devices.

These devices will integrate more sensors to deliver more useful information to users, and be context aware to ensure that information is delivered in relevant ways. They will open up new use cases, for example blurring the boundaries between the consumer and medical

domains to help people work with healthcare professionals to manage their own health. These new use cases will make data security and user privacy more important than ever.

Wearable devices are only helpful if people wear them. The longer the better. Hence these next-generation devices need to deliver long battery lifetimes or periods between recharges, and they need to come in form factors that are unobtrusive and comfortable to wear.

Data integration and context awareness

The first wearables were simple step counters based on three-dimensional accelerometers. More sophisticated devices soon followed, incorporating things like pressure sensors and gyroscopes. These allowed devices to identify the kind of activity the wearer was participating in – walking, running, climbing hills, etc. – and track their sleep cycles. At the same time, temperature and humidity sensors made it possible to more accurately measure quantities such as the number of calories the wearer had burnt while exercising.

This trend to incorporate more sensors into wearable devices will accelerate in coming years. In particular, we will see more and more motion and environmental sensors being integrated as well as the emerging use of biological sensors. Biosensors are already deployed in standalone wearable medical monitors and we have seen the first consumer devices that include heart rate measurements. But in the next few years, a much wider range of biosensors will be integrated into consumer devices, such as spectroscopic sensors to measure blood oxygen, pressure and glucose levels and galvanic skin response sensor to determine sweat levels and pH values.

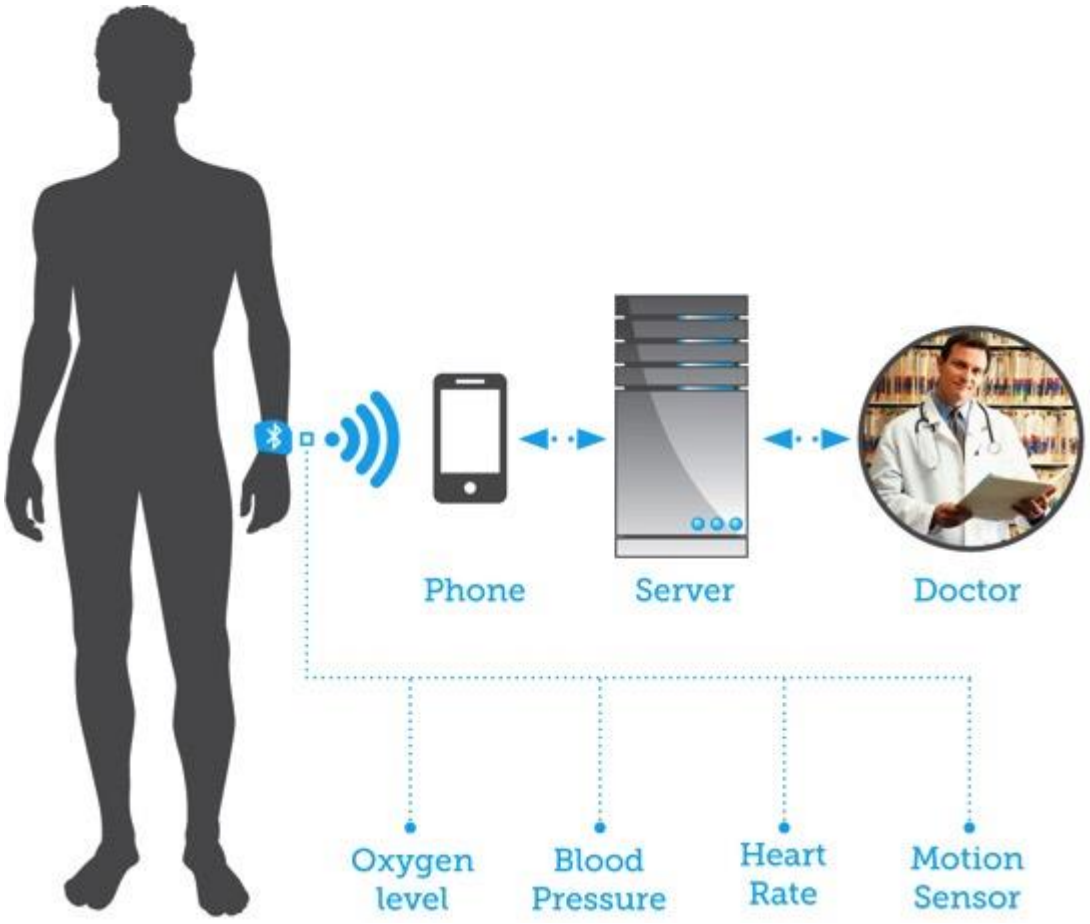

Figure 2: We're about to see a growing range of biosensors integrated into wearables.

Integrating more sensors has many advantages. Most obviously, it increases the functionality of the device – allowing it to measure more things. It can also improve the accuracy of the data collected. For example using information from other sensors to determine the type of activity being carried out can help inform the choice of algorithm used to process input from the accelerometers, making activity tracking more accurate. Furthermore, combining data from multiple sensors allows devices to extract more information that can be useful to the user – for instance, using heart rate, accelerometer data and the galvanic skin response to estimate a person's stress levels.

In addition to the motion, environmental and biological sensors mentioned above, wearables are also likely to make increased use of microphones. But here the goal isn't to provide the wearer with more information; it is to help the device be aware of the context in which it is being used so that it can decide what information is useful for the wearer and how best to communicate it. For example, if the device "hears" the roar of jet engines, it could deduce that the wearer is on a plane and monitor for how long. It could then adjust its sleep and exercise recommendations to combat fatigue, dehydration and jet lag more effectively.

New use cases

As wearables collect ever more data about us, and our surroundings, they will increasingly become our "digital self". This – in conjunction with the mash-up of wearables and context awareness – opens up a host of new use cases for wearables. The possibilities are almost endless. But it is easy to imagine a wearable device becoming an all-purpose access device, unlocking your home, office and car door, logging you in to systems at work. No more keys, passwords or access badges to forget.

In the realm of home automation, a smart entertainment system could detect who was at home from their wearables – and automatically select TV channels, music and volume levels that will appeal to them. Wearables could communicate with beacons around the house enabling presence detection that adjusts lighting and heating according to personal preferences as well as just switching them on and off – so you are always comfortable and save energy.

Big data: blurring consumer and medical

Perhaps the most exciting new use case is the role wearables could play in helping people manage their health. As the number of biosensors increases and the accuracy and reliability of the data they collect improves, we will see a merging of consumer and medical domains. Fitness and lifestyle devices will move from a consumer gimmick to delivering medical-grade data.

Hence the information you collect to track your fitness or activity levels could be shared with your doctors or automated healthcare monitoring systems to spot pre-symptomatic warning signs of ill health. This will allow people to seek treatment or make appropriate lifestyle

changes at a much earlier stage when they are often less drastic, easier to implement and more likely to be successful.

Wearables are a natural partner for the data-sharing cloud infrastructures for healthcare currently being developed by various companies. And this is where we could see the real power of so-called big data. As wearables become more common and more sophisticated, it will be possible to collate and analyze anonymous health, fitness and lifestyle information from millions of people gathered over years. In addition to revealing deep lying health trends, these enormous datasets could shed light on how disease starts – so-called "stage zero medicine". This could in term enable even early interventions to minimize the financial, social and personal impact of ill health.

User privacy and security

As wearables gather more and more sensitive information, and so more fully become the digital self, privacy and data security will become crucial. Particularly where medical data is involved, consumers will demand the highest levels of data protection – and this could become a key factor in purchasing decisions as consumers become more informed.

Data will need to be secured in both storage and transmission. First-generation connected wearables tended to rely on the security protocols inherent in their chosen connectivity technology – typically Bluetooth® Smart. This may have been sufficient when tracking how far people walk in a day, but more robust measures will be required if consumers are to trust wearables with their medical information.

The latest version of Bluetooth (Bluetooth 4.2) offers improved security. But with the huge amount of Bluetooth devices in the field, there is always a risk that the security algorithms will be hacked – leaving transmissions unprotected.

Hence wearables manufacturers must consider independent data encryption measures such as those implemented in Dialog's solutions for wearables. Even if the Bluetooth security protocols are cracked, the transmitted data is still encrypted. In this way, manufacturers will be able to offer consumers end-to-end security independent of Bluetooth. So the personal information on their wearable devices has the same level of protection as their financial records in the banking industry.

Battery lifetimes

In integrating more sensors and supporting new use cases, wearables manufacturers face a big challenge to stay within the limited power budgets available through coin cell or rechargeable batteries. Time and again, studies by IDC and GMI have shown that battery lifetimes are the number one purchase driver for consumers buying battery-powered portable products.

Typically, today's wearable devices offer battery lifetimes / recharge periods of around 7-14 days. Consumers will expect this figure to be at the very least maintained – and preferably extended – as devices become more sophisticated. What's more, many use cases for wearables depend on extended periods of continuous monitoring, and having to remove the device to recharge it or replace the battery will counteract the benefit of the application –

making them less attractive to consumers. For example, if you have to charge a device overnight, you can't track sleeps patterns and you risk missing the palpitation that could be a warning sign of a serious heart condition.

A typical rechargeable lithium-polymer battery has a capacity of just 40 mAh. Powering a multi-sensor wearable for several days from this budget means reducing the power consumption of all parts of the system: the sensors, the system and communications hardware and the software. Sensor technology is continually moving forward and reducing power requirements. Meanwhile Dialog is making constant strides forward in overall system power consumption through Bluetooth® Smart SoCs that combine application and communication hardware – such as the new SmartBond DA14680. Thanks to innovative power management and RF technology, it consumes around 1 mA for typical Bluetooth events.

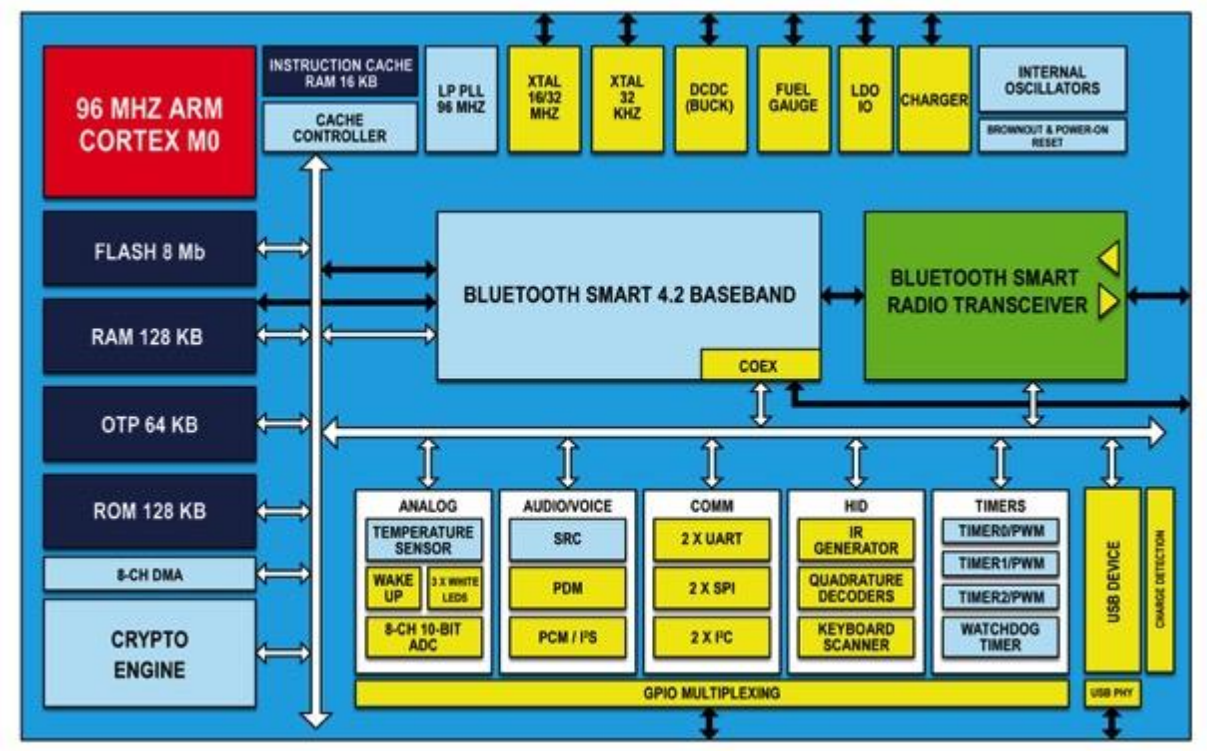

Figure 3: Dialog's SmartBond DA14680 is a "wearable-on-chip" SoC which, with the addition of sensors, a power source and a few external components, can be used to create wearable computing devices quickly and reliably

The Holy Grail: a wearable you never take off

The ultimate goal for wearables would be to enable continuous monitoring. That means finding a way to power the device without ever having to take it off for recharging or to change the battery. The two obvious options to enable this are energy harvesting and wireless charging.

For energy harvesting, the most likely candidates are photovoltaics and harvesting stray RF signals. Vibrational harvesting and thermoelectric generation are also possible but the frequency of human motion and limited temperature differentials around the body mean

they have very limited potential. Some manufacturers have already started exploring the role of energy harvesting in wearables – such as the collaboration between Misfit and Swarovski, which has produced solar-powered fitness tracking jewelry. However, given the increasing demands we are placing on wearables, it seems unlikely that harvesting could ever be the sole power source for an always-on device. Rather, harvesting could become a secondary power source, helping to extend the lifetime of a primary battery.

Wireless charging offers more potential as a primary power source. Given the need to keep the wearable on the body, the most promising option is loosely coupled wireless charging where RF signals deliver power to a number of separate devices within an extended area – similar to the way Wi-Fi systems wirelessly connect multiple devices to the internet. Dialog and Energous recently demonstrated a first proof-of-concept for such a system with a charging radius of up to 10 meters.

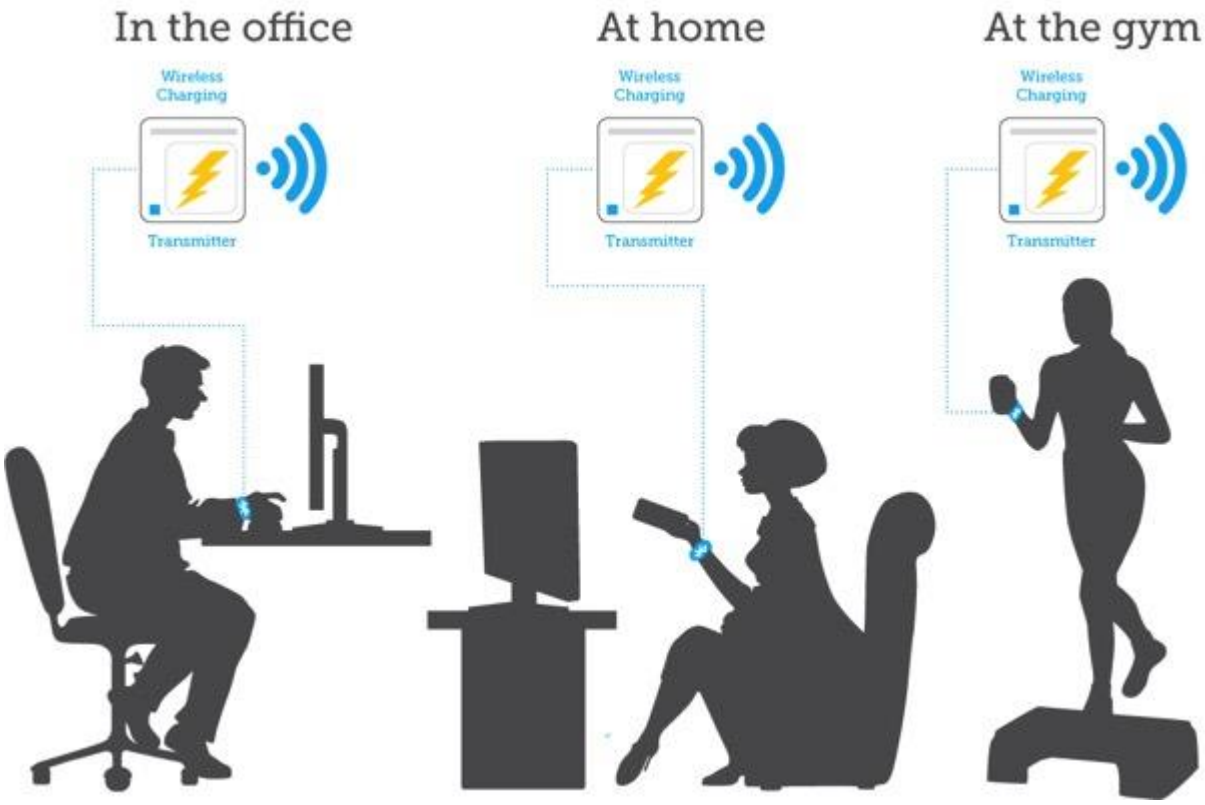

Figure 4: Loosely coupled wireless charging could support the development of wearables you need never take off

If wireless charging truly is to become a primary power source for always-on wearables, there needs to be major investment in charging infrastructure. Wi-Fi could be the model here; charging systems could be installed at home and in workplaces, while coffee shops, airports, hotels, etc. could differentiate themselves from competitors by creating extended "charging hotspots" for customers.

Form factor

A further challenge for wearables manufacturers is to squeeze all this functionality into devices that people will choose to wear for many days at a time. Different people will want

to wear wearables differently. Some will want to make clear fashion statement, while others will prefer something more discreet.

Currently, the most common wearable form factors are wristbands and smart watches. Initial market research by Forrester suggests that these will remain among the most popular form factors, with 28%[1] of people happy to wear interesting and trusted sensor devices on their wrist. Other popular choices for wearable devices are shown in Figure 5.

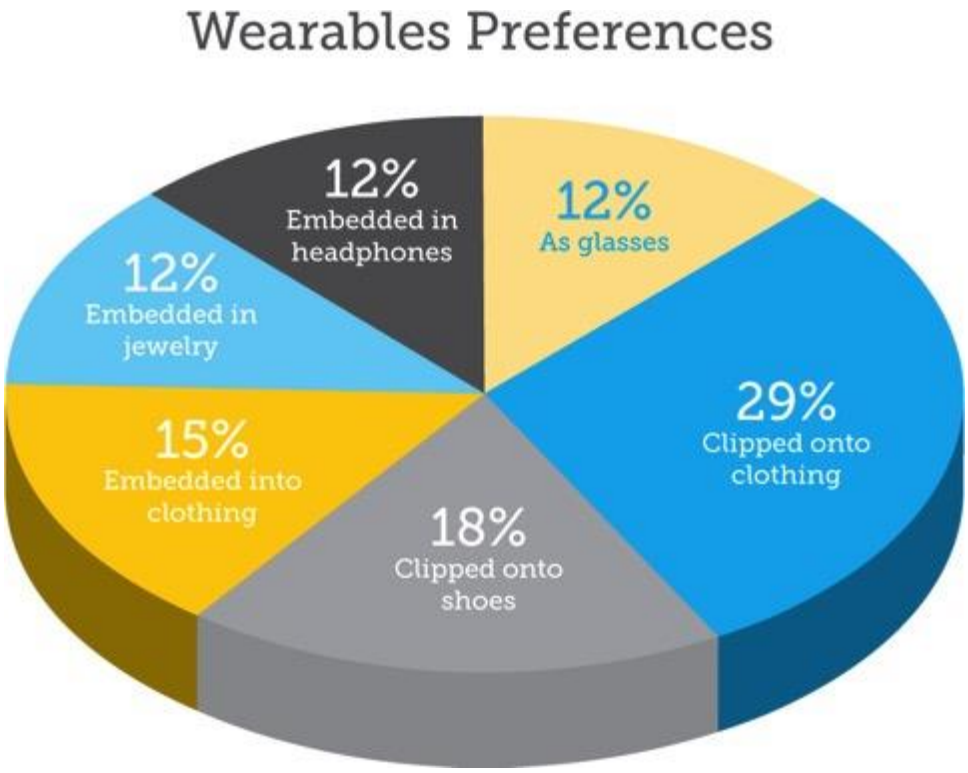

Figure 5: Wearables are likely to develop in a variety of shapes and sizes - not just wrist bands and watches

This suggests that we will see a multitude of different device types. But they will all have one thing in common – extremely space-limited form factors.

To deliver such small devices, manufacturers will need access to more integrated hardware solutions; SoC solutions that deliver all the application, system, security and personal connectivity functionality in one package. Today, the smallest solutions – incorporating an SoC and all necessary passives in a single module – measure around 3.5 x 3.5 mm. To meet future form factor requirements, such solutions will need to shrink even further.

IC companies that supply wearables manufacturers can help drive this shrink by increasing the functionality integrated into their IC solutions. For example, Dialog's SmartBond DA14680 includes communication, application processing, sensor hub and power management functionality in one. This does away with the need for an external battery charger, fuel gauge, DC/DC converters, etc., enabling significant board space savings.

Ready for the future

Comfortable and highly functional multi-sensor wearable devices have the potential to help people improve their lives in many ways. But to truly harness that potential, wearables manufacturers need to couple their devices with services that are interesting and relevant to consumers. The possibilities for such services are almost endless – from remote medical check-ups and helping people make healthy dietary choices to home automation and beyond. It is these services that will encourage people to buy and use wearables, propelling this young market forward to continue the impressive growth of its early years as it matures.

To enable these devices and services, wearables manufactures need access to silicon solutions that allow them to expand functionality while meeting the unique size and power consumption restrictions these devices impose. Dialog Semiconductor is committed to delivering those solutions through its SmartBond family – with an innovation roadmap designed to keep pace with the industry's evolving needs. The SmartBond DA14680 is the first step on this roadmap. As the first single-chip solution for wearables, it combines excellent performance with high levels of integration and low power consumption. It is the only integrated solution that lets designers create complete, context-aware multi-sensor wearables with user-friendly periods between battery recharges. As such, it enables the creation of next-generation Bluetooth® Smart wearables that will help this emerging market reach its full potential.