IoT for the Consumer

The Internet of Things has inundated almost every area of consumer electronics. Check out some of the latest innovations.

The Internet of Things (IoT) covers a lot of ground, and much of it is in the consumer space. There has been a flood of products and the numbers continue to rise. Many have a limited market, but the number has risen into the billions: Gartner estimates 6.4 billion in 2016.

Though IoT devices vary greatly, most have a number of common attributes. These include wired or wireless connectivity, movement of data to the cloud, and an application to configure and monitor the IoT device. The app typically runs on an Android or Apple platform, with Windows and macOS running second. At this point, many consumer IoT devices only interact with the app and the cloud. Still, more are starting to integrate with other devices, often using frameworks like those associated with Google Nest and Apple HomeKit.

1. COMMUNICATION: IOT'S TOWER OF BABEL

Interaction with other devices can be complicated by the plethora of communication mechanisms, as well as by an

1. The Samsung Gear 3 runs Tizen Linux. An LTE version is available.

overcrowded wireless space. Ethernet dominates wired connectivity, although other wired connections exist, such as power-line networking. Bluetooth and Wi-Fi are most common, but even these have compatibility issues. Bluetooth 4.0 supports Bluetooth Low Energy (BLE), also known as Bluetooth Smart, and classic Bluetooth.

Other low-rate wireless personal area networks (LR-WPAN) include 802.15.4, ZigBee, and Z-Wave. There are proprietary wireless protocols, but these aren't the only alternatives for developers and consumers. Wireless standards like LoRa and ULE, that uses the cordless phone DECT protocol, are in play as well.

Near-field communication (NFC) is often used for synchronization or authentication. It has a short range, and is often utilized for financial transactions (though it isn't limited to that application).

Most devices use a single interface, but some may provide support for two. Typically, gateways will be the only devices that have more than a couple interfaces. Many consumer IoT

2. The Hexiwear module (left) runs a NXP Kinetis K64x Cortex-M4. It can be customized using a built-in header (center).

microphone.

Building a smartphone is no easy task and, given the competition, it's not something that most developers will want to tackle. There are other mobile IoT device applications, however. This is where platforms like Hexiwear *(see "Module Targets Rapid IoT Development" on electronicdesign.com)* come into play. It's based on an NXP Kinetis K64x Cortex-M4 chip. Hexiwear supports Bluetooth LE and 802.15.4. It has a 3D accelerometer, 3D gyro, pressure sensor, light sensor, humidity sensor, and HRM. The platform has a capacitive-touch interface and an OLED displayn *(Fig. 2)*.

Unlike the Gear 3, Hexiwear is designed to come apart. It can also be inserted in a wristband and has an expansion port. The Micro USB socket is for charging and development.

But watch wear isn't the only wearable technology being developed; smart clothes and shoes are also becoming available. For example, ReTiSense's Stridalyzer *(Fig. 3)* is an intelligent insole. It tracks foot pressure using a pair of sensors, allowing the system to calculate stress and movement—not just the number of steps typical of a fitness tracker. It uses Bluetooth LE to communicate with a smartphone or the Stridalyzer Pod. The Pod can double for the app in a smartphone and record information, which is useful in the event that you don't want to run around with a smartphone.

Sleep tracking is often supported by smartwatches and fitness bands, but they need to be worn overnight to be effective. An alternative is a smart bed or, in the case of the Luna Indiegogo project, a mattress cover. The cover includes a range of sensors to track information like the bed temperature and ambient humidity. It also has a light sensor and microphones.

The mattress cover is

devices are designed for mobile use, so minimizing power requirements often means limiting wireless support.

2. WEARABLE AND MEDICAL IOT

Wearable consumer IoT devices like smartwatches, pulse oximeters, and heart-rate monitors (HRMs) are readily available. Hundreds of smartwatches are now on the market, along with even more fitness bands, including the Samsung Gear 3 *(Fig. 1)*. The Gear 3 hosts a dual-core, 1-GHz Exynos processor with 768 MB of RAM and 4 GB of flash memory that runs the Linux-based Tizen operating system.

The watch supports Bluetooth 4.2, 802.11b/g/n, and Magnetic Secure Transmission (MST), as well as NFC. Sensors include a 3D accelerometer, 3D gyro, barometer, HRM, and ambient light. The system has GPS, too. There's even an LTE version that can make calls using the built-in speaker and

4. Home voice-activated control systems like Amazon's Echo (left) and Google's Home (right) can control other IoT devices.

5. AwoX's StriimLIGHT WiFi bulb surrounds a speaker with controllable LEDs.

6. Smart locks like Kwikset's Kevo can be controlled through a variety of means.

designed to track people's breathing and heart rate, and is linked to the cloud via Wi-Fi. It even functions as a collaborative IoT device that works with Nest-compatible products. This would let the system adjust the house temperature once you're comfortably asleep. The cover is machine-washable and can be tumble-dried.

2. HOME AUTOMATION

Home automation is ripe for IoT, but it hasn't been cheap. Most of these devices still come at a premium price, but they are more common. Command-and-control systems like Amazon's Echo *(Fig. 4 left),* with its Alexa-enabled voice-control system, competes with platforms like Google Home *(Fig. 4 right).* These systems provide voice control of other IoT devices like smart lighting, security systems, smart thermostats, and smart HDTVs that are part of the smart home. Wireless connectivity is big change compared to the wired smart homes of the past.

These control systems can double as wireless speakers, but they're also always listening to users. They do not have cameras, yet. Of course, smart cameras are already available for security applications. Still, it's possible to order items to be delivered using Alexa.

Smart lighting has seen everything from multicolored mood lighting to a wireless, DLP projector in a light-bulb form factor. Speaker-based light bulbs include Sengled's Bluetooth speaker bulb and AwoX's StriimLIGHT WiFi smart bulb *(Fig. 5).* Smartphones can stream audio to the bulbs that can be used in almost any receptacle that's already occupied by a lightbulb.

Smart locks like Kwikset's Kevo *(Fig. 6)* can be controlled using a key fob, a real key, a smartphone with Bluetooth 4, or via the internet. Other systems employ communication alternatives like NFC. These devices can provide selective control such as one time access, as well as tracking status and usage.

Tracking status and usage of all sorts of things are part of the IoT mix. For example, plant-tracking devices measure ground water and ambient humidity. And systems like Fishbit monitor pH, salinity, and temperature in an aquarium.

Cats, dogs, and other pets can now have wearable GPS tracking systems, but so can children and adults. For dementia patients, they can be very helpful to caregivers by warning them if a patient leaves a known area.

3. AUTOMOTIVE IOT

The car is another space where IoT is cropping up. Smart cars have the ability to link devices into their telematics system. The minimum these days is Bluetooth connectivity for tying a smartphone into the audio system, allowing hands-free calling. More advanced systems provide two-way linkages between applications. Streaming audio is a common application.

Some cars now have options to act as a mobile Wi-Fi hotspot. For example, most new GM cars (like the Chevy Bolt) have an option to support OnStar 4G LTE, providing Wi-Fi hotspot capabilities to passengers *(Fig. 7).* This capability is just the start of more advanced communication and cooperation with other devices. For example, the Bolt can be recharged at home or at charging stations where communication with the vehicle can provide additional services.

There will likely be a never-ending flow of new consumer IoT devices. New application areas are opening up as more sensors are brought into the mix. Smart-metering systems for electricity, oil, and gas cross over from industrial IoT to the consumer space, potentially providing users with more information about their consumption.

There remain a host of issues to resolve, ranging from security and personal privacy to ever-more-crowded communication environments. This will be a challenge given the exploding number of devices.

7. Chevrolet's electric Bolt can act as an LTE/Wi-Fi hot spot.