Internet of Things

The Internet of Me: How Wearable Tech is Changing IoT

by The Application Developers Alliance Emerging Technology Working Group

EXECUTIVE SUMMARY

Imagine jogging along your favorite trail when suddenly you feel a shortness of breath and a painful squeeze in your chest. You stop… and with a flick of a finger, you instantly notify emergency responders of your situation and your location. At the same time, the notification alerts your doctor of the incident and sends your vital statistics. What enables all of this information to be gathered and transported to the right place is the combination of sensors and connectivity provided by the devices that make up the wearable Internet of Things.

This scenario may not seem far-fetched considering the explosive growth of Internet-enabled devices worn on the body. Whether strapped to your wrist, attached to your eyewear, or embedded under your clothes, developers are building applications that monitor body systems through sensors and pull notifications, and alert users to important changes through push notifications.

The popularity of smartphones certainly fueled the growth of wearable devices. The iconic iPhone and various Android devices provide a constant connection to the Internet that mobile developers know how to tether or synchronize with associated wearables.

Unlike Internet developments in homes and businesses, wearables represent such a fundamental change to our lives that Sandro Olivieri, a Senior Manager at AT&T's Foundry, calls developing for the wearable marketplace the “Internet of Me.”

“[Our research has found] that users don't really care that their identity lives beyond their own device and more than likely that it lives in the cloud,” says Olivieri. “If there is a center of the Internet - whether this is in a car, at the office or at home - they are comfortable using their primary device and interacting with the network.” Most people currently consider their smartphone the primary device, but it remains to be seen what the “main access point” to the "Internet of Me" will be given all these new points of connection.

Internet-enabled wearable gear was high on many people's holiday gift list this past year, with an estimated 35 million wearables in use by the end of 2014, according to researchers at CCS Insight. This represents a 180 percent increase in wearable IoT device shipments in only three years. And many of the new designs can run independently of a smartphone.

The wearable device market can be segmented into seven sections, according to ABI Research’s latest report: wearable cameras, smart clothing, smart glasses, healthcare, sports and activity trackers, wearable 3D motion trackers, and smartphone-compatible watches.

The opportunity for developers is to take what they know about mobile technology and apply it to emerging wearable products for a public that has already started to see the future and benefits of wearable applications.

“Anybody involved in the early days of mobile remembers that you had to do it yourself,” says Matt Powers, Chief Technology Officer with Applico. “None of the applications or connector protocols were built for you. Now there are tools that make it easier. Developers are well equipped for IoT work that is more at the application level and what is great is that the same mobile development principles apply to IoT.”

Powers suggests that developers look for ways to minimize the amount of button clicks and maximize the use of glance-able displays. If you make an app or hardware design too difficult, users will quickly move on from your design to another one that is less confusing, he notes.

In 2014, the Application Developers Alliance and its Emerging Technologies Working Group began identifying five areas influenced by IoT to give developers insight into creating a robust ecosystem. This whitepaper serves as an exploration of IoT by looking at its current state in wearable devices, best practices for creating apps, and new opportunities to explore. Other

investigations cover automotive, manufacturing, home and retail.

INTRODUCTION

From Dick Tracy's wrist radio to the current wave of Android watches, the idea of connected wearable technology has fascinated developers for generations.

Real wearable technology has been around since the early 60s, from the early days of MIT math professor's “Beat the Dealer” device to Keith Taft's "George" blackjack beater shoe technology. Modern interfaces include the Fitbit health monitor, Pebble smartwatch, and Google Glass. These innovations inspire new ways of thinking about IoT for the body.

Developers have numerous resources at their fingertips to learn the ins and outs of wearable technology. Artyom Astafurov, Managing Partner and head of the IoT practice at software development firm DataArt, notes that his company, like many others, supplies APIs, tutorials, videos, and physical meetups to help developers with design.

“Barriers to entry for wearable developers are still pretty high,” says Astafurov. “Putting together a prototype, testing that prototype and moving it into production involves quite a bit of discipline. It also includes embedded development, firmware and electric wiring – however, combining all of these disciplines can be difficult at times. In some cases, a proxy API can be provided though that allows developers to test the system without the worry of overloading their own systems.”

Others disagree and feel that entry into wearable technology is exploding due to increased funding and available tools. Matthew Wong, a Research and Data Analyst at CB insights stated, “Venture capitalists want to have Quantified Self in their portfolios. We're seeing significant investment.”

“The barriers to entry are very low for developers, with free or low cost tools and developer kits generally available. The greatest challenge is to go beyond creating something that simply looks neat or cool, but that also that adds genuine value. For example, bringing Evernote checklists to your wrist, and being able to check items off on both Android Wear and the Pebble is simple but incredibly useful when you are out and about," says Damian Mehers, Senior Software Engineer at Evernote.

Google's Android has captured early success with its Wear series of APIs. Apple is also looking to dominate with its HomeKit protocols. The much anticipated Apple Watch, projected to debut in 2015, is expected to propel the company into more mainstream IoT-enabled markets.

Samsung's plans for IoT wearables are reaching further than the Android operating system. The company announced in 2013 its own Linux-based operating system for smaller devices called Tizen. From powering smart cameras to smartwatches and eventually smartphones, the OS includes, among other things, a telephony stack, Smack - an HTML5 sandbox for apps, ConnMann as its network manager, and Zypp package manager.

“There are hundreds of ways to do the same thing – so we're in a bit of a primordial soup to build something meaningful,” Astafurov says.

TRENDY AND TOPICAL

Wearable fitness devices are expected to generate the most mass consumer adoption in 2015, with 22 percent of consumers already owning or planning to make a purchase next year, according to a survey of more than 2,000 North American consumers by Acquity Group, part of Accenture Interactive.

The study surveyed future purchasing trends and attitudes about the digital connection of physical, identifiable devices to the Internet where the data and devices communicate in an intelligent fashion. Some 59 percent of Generation X consumers (ages 26-35) said they plan to adopt wearable fitness technology in the next five years, compared to 47 percent of Millennials (ages 18-25).

Of the men surveyed, 53 percent said they plan to purchase wearable technology in the next five years, compared to 45 percent of women. However, when it comes to wearable fitness devices, women are slightly more likely to have already adopted them than men (8 percent compared to 7 percent).

Smart clothing and heads-up displays are expected to see the least overall adoption, with only 3 percent projected to be adopted in the next year, and 14 and 16 percent in the next five years.

“IoT is a convergence of trends, security, and user experiences,” says Artyom Astafurov of DataArt. “I believe there will be faster adoption for non-critical applications, mostly for consumer use.”

HOW WILL IoT WORK ON THE BODY?

Similar to other IoT interfaces, wearables are based on three key layers. First are the electronics placed closest to the body that monitor elements such as temperature, movement, and pulse. Battery life tends to be an issue in this layer, as these interfaces need to be as small as possible.

The second is the connectivity and control layer. Smartphones have initially played this role but the strength of watches and inclusion of wireless radios may shift the center of the mobile hub from your smartphone to your wrist.

“Wearable devices are a lot about capturing and displaying information. But the way to interact with those devices will make the real acceptance and differences,” says Denis Manceau, Director of Global Product Management at MyScript. “In that respect, as much natural and gesture-centric interface as possible should be designed. It is all about digitalizing real work so people are expecting to interact with devices naturally. The learning curve should be set to its minimum.”

For instance, Manceau notes that text input or search is difficult on a wearable due to the size or form factor of the device since a keyboard cannot be present. With handwriting recognition based on superimposed characters, users can enter text, a command or a search query on limited surface, such as a watch, with minimal attention.

“The watch can even be used for pushing command to your eyeglasses,” Manceau says. “The user experience will be similar to the one in the car already equipped with handwriting recognition. Your main attention is still on what happens in your field of view and not on the input device." (Watch an interview with MyScript’s CEO Paddy Padmanabhan for more insights on IoT integration).

The Bluetooth low energy protocol has become the most popular way to connect a wearable device to a smartphone or home router with network access. This enables devices to operate for months or years on a single button cell, something that other wireless standards (802.11, LTE) cannot currently offer. Additionally BLE has become the de-facto standard for low power higher bandwidth communications with a phone.

Chris Surowiec, Head of Business Development for Global Partners at Microsoft and a startup mentor, notes that this is why Microsoft built the latest BTLE stack into Windows Phone 8 and why partners like Fitbit are able to work easily with the platform.

Finally there is the cloud layer, where the device supplies and reads data specific to the use case. Developers should always consider how wearables can make this data actionable. It's great that things like Fitbit record data about someone, but wearables will truly empower consumers when they deliver outputs that will improve the user’s quality of life. So far the applications and platforms in the market have not made this connection, which is possibly why after six months, more than 75 percent of people have stopped using their wearable device.

BETTER KNOW YOUR NoSQL

One aspect of the Internet of Things that is becoming apparent in the development community is the structure of programming surrounding it. Whereas cloud-based software offloads a large percentage of data crunching, wearables must also lean on network computing capabilities to take advantage of non-sequential computing.

That's why a study by Machina Research recommends that developers use NoSQL databases (MongoDB, Couchbase, NeDB, Cloudera, Hadoop, Cassandra) to help process the data produced by millions of devices that are connected to each other. NoSQL databases allow for highly flexible data modeling, not to mention, "dramatically better scalability than even the most hefty of relational database management systems (RDBMSes)."

"There are an increasing number of tools out there (like the Wunderbar) that are directed at enabling developers to build and learn at a much more rapid pace," says Jackson Bond, Co-founder and Chief Product Officer at relayr. "If you haven't started yet, you better do it quickly because it's simple to start prototyping."

WATCHING THE WATCHMEN

To quote Dr. Manhattan from the movie *The Watchmen*, "My father was a watch maker. He abandoned it when Einstein discovered time is relative."

Time might be relative, but in today's world watches can do so much more. Apple, Samsung, Google, Pebble and Intel are all looking to establish their products among the smartwatch elite.

The motivation to enter the connected watch fray is certainly fueled by high expectations. Strategy Analytics reported that in Q1 2014, global smartwatch shipments grew more than 250% YoY. Growth is expected to continue with over 373 million smartwatches projected to be shipped by 2020, according to NextMarket Insights.

Pebble was first to mass market its smartwatch and continues to build a steady following. The watch's FreeRTOS kernel has had several updates, making it a stable environment. The apps themselves can be as simple as a display of an RSS or JASON feed or as complex as turn-by-turn directions when paired with a smartphone or tablet.

Pebble continues to innovate to a broader audience including adopting Unix-based operating systems to write their apps (Mac OS 10.7 or Ubuntu 12.04 box). The company set up its SDK for C programmers and includes ARM compiler tools. Native apps run on the smartwatch's 144 x 168 black-and-white screen.

Google, with its Android Wear platform and Android 5.0 Lollipop operating system, is already making headway in the wearable space. Google's greatest advantage in the market is that they have already enabled open source standards for software development on Android phones, which can now be used to easily adapt existing apps for wearable devices. As a result, Motorola, Samsung, LG, Asus, and Sony have already released nearly half a dozen Android-Wear compatible devices in the market.

Outside of its relationship with Google, Samsung also has a separate smartwatch strategy. The company's operating system for mobile, Tizen, has open source roots with development tools based on the JavaScript libraries jQuery and jQuery Mobile. Most of Samsung's smart wearables are currently Tizen-based, so the company is betting on its own wearable platform that does not rely on Google's Android Wear.

An offshoot of its smartphone and wearables developments, Samsung is looking at immersive eyewear to pique interest. Specifically, the company announced at its recent developer conference the advent of virtual reality glasses that would synchronize with your Samsung-brand smartphone, television, tablet and watch.

Apple may be late to the smartwatch party, but is expected to make a huge splash with the consumer market. Given its alignment with

fashion designers and industry influencers, Apple is hoping to capture the same excitement with its wearable technology as it did with the iPhone. Some developers have already had access to Apple's WatchKit.

There are also other candidates for the ultimate smartwatch including Intel, which announced its MICA (my intelligent communications accessory). The bracelet includes built-in GPS and wireless notifications via AT&T wireless without the need for a smartphone nearby.

Expect to see a whole slew of new smartwatch models at all consumer electronics shows in 2015.

SMALLER PLAYERS, LARGER IMPACT

While larger companies like Apple, Google, LG and Samsung are well known to consumers for building products with Internet-enabled technology capabilities, the bigger force in the market may be the nearly endless string of smaller companies and start-ups whose aim is to connect all things.

"There is a larger community and a long-tail community working together with smaller companies on open source projects and they will be able to get traction with each other where the larger players cannot," says relayr's Bond.

Over the last two years, more than 11,000 open APIs have been published for developers to take advantage of and use to build their next big thing. Bond notes this strong trend toward openness can only help expand IoT's influence in wearables.

"Larger companies are creating these wearable devices, but they are acting alone and not allowing the devices to talk with other connected devices," Bond says. "With no open APIs, you couldn't connect a wearable device to a Philips Hue light bulb or a weather station. It's very much like 30 years ago during the PC era when you had different computer manufacturers [IBM, Wang, Microsoft, Apple] wrestling to take control of the networking protocols. Building wearable apps that live in a cloud configuration helps these different devices connect with each other. And if you look at open software and open hardware, developers see they can leverage a platform like Kickstarter where they are exposing their designs and their code."

The growth of IoT-enabled wearables will certainly impact many company revenues, according to market researcher Juniper Research's new report, *Smart Wearable Devices: Fitness, Glasses, Watches, Multimedia, Clothing, Jewelry, Healthcare & Enterprise 2014-2019*. The firm estimates global retail revenue to triple in volume by 2016 before eventually reaching $53.2 billion in sales by 2019.

Currently some of the well-known VC-funded private wearable companies include:

1. Jawbone, San Francisco, $470.8 million.
2. Fitbit, San Francisco, $66 million.
3. mc10, Cambridge, Mass., $63 million.
4. mCube, San Jose, $37 million.
5. Withings, France, $34 million.
6. Ineda Systems, Santa Clara and India, $26 million.
7. Misfit Wearables, Redwood City, $23 million.
8. Zepp Labs, Los Gatos, $20 million.
9. Quanttus, Cambridge, Mass., $19 million.
10. Recon Instruments, Vancouver, British Columbia, $17 million.

(List according to Silicon Valley Business Journal, September 2014)

WEARABLE IoT BEYOND WRISTS AND EYES

In addition to the surge in wearables for the wrist and eyewear, smart clothing initiatives are also on the rise. NanoSonic, Textronics (which makes NuMetrex), Weartech (GOW Trainer) and Sensoria are leading the pack of those developing IoT in textiles.

Certain items like shirts can directly measure a person's temperature and heartbeat whereas socks can provide impact measurement.

WEARABLES FOR MORE THAN FITNESS

While fitness applications have dominated wearable apps for the past few years, health care firms are looking to tap into wearables for patients and providers alike. As sensors become smaller and more sophisticated, and analytics software improves, developers have more information to work with to determine how best to serve the specific needs of a patient or caregiver.

"I see connected sensors on the skin as a precursor to ones embedded under the skin, it just depends on the use case," says Wearable World's Snodgrass. "There are fake teeth that can detect before you have a stroke or a heart attack. Eventually, you will be able to put a wearable on every part of your body. The people who win this are going to be the ones who can make this fun and convenient for end users and align it with what works best on multiple platforms."

If consumers are driving wearable IoT on the outside of the body, then healthcare is pushing the technology onto and even under the skin, according to Chris Surowiec, Head of Business Development for Global Partners at Microsoft and a startup mentor.

Several companies are experimenting with temporarily embeddable sensors that are flexible on the skin and measure heart rate, temperature, hydration and other body metrics in a more granular way.

"The next step to wearing sensors on the skin is embedding them in the body. We're moving into an era of computing that will provide continuous monitoring, allowing people to trust the data more," says Surowiec. "This will transform how people manage their health. Cloud services learning algorithms will bring about far greater self-awareness that will change how people treat themselves."

Combining data from different places is a great opportunity for development.

"Socks, pants, underpants, pecks, kneecaps… it's up to our imagination where we want to put it," says Redg Snodgrass, Founder of Wearable World. "The wrist is the most common place for most IoT wearable products because the FCC and other regulators do not require extensive descriptions on what you are trying to accomplish."

The advantage of smart garments is that they can create new data sets that have never been collected before, says Sensoria Co-founder, Davide Vigano. This is beneficial for both specialized applications of wearables as well as for the general public.

"I'll give you two examples at opposite extremes: one is a fitness enthusiast and the other is an elderly patient recovering from hip surgery," Vigano says. "You want to measure fitness levels – activity for one and lack of activity for the other. So the challenge for the developer is that you did not have enough data sets for the fitness enthusiast or the surgery patient. A traditional wrist worn fitness band would not provide enough actionable data for the fitness enthusiast and absolutely no data for a person who takes very slow and careful steps. Now a garment such as a smart sock with embedded pressure sensors would detect not just activity, but also cadence and foot landing technique in both scenarios. Doctors refer to this data set as 'GAIT' and they refer to it as the sixth vital sign. All these new data sets that IoP-Internet of People enabled garments can provide will enable the developer community to create new apps for a broader audience. That's providing a post-surgery patient or fitness and sports enthusiast with more accurate, actionable and meaningful data by simply wearing their favorite piece of clothing vs. a piece of plastic."

In one prominent example, OMsignal signed a deal with Ralph Lauren to embed biometric sensors in shirts used during the U.S. Open tennis event this past summer. The data was

WEARABLES TO PROTECT, TO SERVE AND TO SAVE

In a more industrial setting, developers can build apps for wearables that increase worker efficiency and ensure safety.

Many police departments in North America are using body-mounted cameras connected to the Internet to record interactions with the public. The deployments serve as a protection against accusations of questionable police tactics and as evidence in the case of an arrest.

The Washington D.C. police department recently rolled out its six-month pilot program that put the IoT-enabled cameras on the shoulders of many local police officers. Officials expect the program to reduce the number of complaints filed against officers by as much as 80 percent. The program wasn't cheap: it cost $1 million to buy and store the necessary volume of cameras.

To increase adoption nationwide, President Obama recently announced $263 million in federal spending, which is expected to fund 50,000 cameras. Other departments and developers that decide to take the same leap will have federal matching funds to soften the blow.

Additionally, wearables can be used to help workers be more productive. Several manufacturing and logistics firms are testing out connected eyewear (like Google Glass) to improve worker safety, reduce mistakes and cut costs. As Pete Wassell, Co-founder and CEO of Augmate puts it, companies are eager to use smart eyewear as a competitive advantage since they already know the costs of their workers and the processes involved. Augmate creates software for smart eyewear for businesses as well as consults with companies who are testing and implementing these smart glasses.

“Many companies are now storing data on chips attached to factory equipment that can be retrieved using Bluetooth,” Wassell says. “This is not just information about the function or location but the entire manual can be stored on the equipment. Now someone with the right type of eyewear can simply walk up to the equipment and operate this information because it is pumped right to their safety goggles, for example.”

Patrick Henshaw, Co-founder and COO of Strap says, “We’re seeing trends in the manufacturing and healthcare spaces where glasses can be very powerful. For example, glasses for a surgeon who is operating on someone and needs seamless access to their vital signs, or a mechanic who is operating on machinery without time to physically flip through pages of a manual.”

Wassell notes that his company's typical 8-10 week pilot study includes assessing sound and lighting levels where the eyewear would be used, identifying the use case and the baseline for the worker using the eyewear, and shadowing that person to determine how well the application is working.

“After that 8-week period, the discussion is mostly about modifying the navigation or what can be seen on the screen," he says. "We also talk about scaling the software from five or 20 people to the larger group as a whole or in batches.”

measured and used to provide insight into player performance. For videos further exploring insights on wearables beyond the watch and glass, click here.

USER-FOCUSED IoT DEVELOPMENT

Since wearables are close to the body, developers are reminded to always keep the end-user in mind in both design and functionality. As one Internet poster pointed

out: *Wearable interfaces are like a comedian's joke; if you have to explain it, it's not effective.* "I would urge app developers to understand and identify an exact use case they want to solve. Make it simple and make it integrated into the end user's daily life. Don't make something so difficult to use that it takes users outside of their norm," says Patrick Henshaw, Co-founder and COO of Strap.

"It's important to think about designing wearables on two planes: one on the plane of connectivity and the other from the plane of data," says Euro Beinat, Vice President of Platform Technologies at Zebra Technologies. "To help our developers understand the difference, we borrowed the term 'avatar' from the gaming industry. Data is still collected from a wearable device and we transfer these items into the cloud, but we structure these elements in a consistent way across diverse devices by building device avatars, so that every object shares a similar data representation. This significantly reduces the burden to develop applications that use device data and also provides a mental model to think about devices in the cloud."

Simplicity also means not over-complicating real life. Applico's Powers is critical of apps that try to re-write human behaviors for the sake of technology.

"There are companies that make smart power strips that have apps that can control individual power outlets," Powers says. "Now while this sounds good for reducing your energy bill, it made it more complex than ever." Powers bought the smart power strip and downloaded the app. However, when he went to use the power strip, he found it frustrating that he could not quickly turn on or off a lamp without the app even though it was within his arm's reach. "I just wanted to go over to the lamp and turn the switch," he says "But instead, I have to pull out my phone, wait for the app to load and then I have to identify the individual switch when all I want to do is reach over and turn it on."

TOUCHDOWN FOR WEARABLES

One of the more innovative adoptions of Internet of Things for wearables comes from the National Football League's (NFL) collaboration with Zebra Technologies on a real-time location system (RTLS) for players.

Receivers installed throughout the stadium communicate with two radio-frequency identification (RFID) transmitters placed inside the shoulder pads of each player to capture precise location measurements, up to sub 6 inches. Zebra's technology will collect data such as position, speed, and distance that will be registered and compiled into a database. This data can then be reviewed by coaches to help them make changes during the game.

Because it is basic data, the NFL says the easy integration with graphic systems lets them use Zebra's RTLS for both live broadcast and replay. The wearable technology could be used for building training applications to visualize player data, making practice more efficient.

The RTLS is being used in all NFL Thursday Night Football games this year: Atlanta, Baltimore, Carolina, Chicago, Cincinnati, Denver, Green Bay, Houston, Jacksonville, Miami, New England, Oakland, San Francisco, St. Louis, Washington as well as Detroit and New Orleans.

Euro Beinat, Vice President of Platform Technologies at Zebra Technologies, says fans of the sport will also be able to benefit from the data for a deeper fan experience.

"Imagine if we could use this data for the fan in the stands so that they could wear some type of immersive device and actually see the game from the perspective of the player?" Beinat says. "With the amount of information that locates every player many times per second, that data could be used to overlay the game image and make this an augmented reality."

The idea of a good interface includes "micro-interactions," which, according to Google Glass advocate Timothy Jordan, is the idea that "every interaction should be as unobtrusive as possible. Designers and developers are encouraged to connect people and focus on the user."

And while ABI research has identified seven categories for connected wearables, Augmate's Pete Wassell suggests the sky is the limit for body sensors and awareness.

"Don't get hung up on the form factor," Wassell says. "Nobody thinks twice about people walking down the street with glasses on unless there is a camera attached. Certainly there is a backlash from a style standpoint. But in a few years you should be able to go to your optometrist and order a digital display option. Each generation of these devices gets better because they improve on the processor or the camera or the apps. And that will drive adoption."

For developers who want to start building for wearables, Strap's Henshaw suggests that they attend hackathons, participate in forums, and engage with the development community to leverage all available resrouces. "I urge developers to think outside of fitness. What is the next big thing? If developers jump on board and get in there early, they'll be ahead of the framework and what's to come. Get out there. Get your hands dirty. Get into some code and figure out what the next killer app is ging to be," Henshaw says.

SECURITY AND PRIVACY CHALLENGES

As developers continue to build dynamic apps and hardware for the wearable space, a few items should be kept in mind: most importantly, security and privacy.

Privacy and security are always at the forefront of design. Most importantly, after the "year of the breach," developers of both wearable hardware and software should prioritize protecting user data. Identity theft has been the top consumer complaint at the Federal Trade Commission for 14 straight years, and the ubiquitous collection from smart watches, sensor-enabled clothing, and other wearables could introduce new threat vectors that require baking in data security protection by design.

Damien Patton, CEO of Banjo advises, "Design your applications and architecture around protecting data. Have a way of not only deleting user data easily, but verifying that it's deleted. You also have to consider how you're collecting data and make sure that you can scale and make quick changes based on user feedback."

Developers should also build in privacy by design as well. For starters, developers should be mindful of the privacy regulations that apply to them. Of course, it is important to know the location of the end-user as different jurisdictions can have dramatically different privacy and data collection laws.

"These differences can be especially pronounced when one is collecting data from end-users in the EU and other international jurisdictions where device fingerprints and cookie information trigger special end-user protections," says Steven Roosa, Partner in Holland & Knight's New York office and Co-chair of the Data Privacy and Security Team.

In addition, the type of data matters as well. In the U.S., laws specific to certain data, such as the Video Privacy Protection Act ("VPPA"), the Health Insurance Portability and Accountability Act ("HIPAA"), and the Children's Online Privacy Protection Act ("COPPA"), take an expansive view of what information qualifies as "personal" or "protected."

For the long term, however, both developers and policymakers will have to assess not only how wearables must approach privacy, but also how privacy laws and principles will operate as wearables disrupt how users approach existing technologies. "The problem of the 'vanishing screen' or that there are many surfaces becoming interfaces for computing is that brands will need to focus on unifying their experience in an ever growing variety of

contexts. People may look at the next great smartphone as a wearable device," says Microsoft's Surowiec.

As a result, the “vanishing screen” and other unique attributes of wearable devices will pose challenges to developers and policymakers alike who have relied on traditional privacy principles. For example, devices that have tiny or even lack screens are not able to provide notices about data practices in the same way as those provided by traditional online companies. As the Future of Privacy Foundation has noted, “attempting to provide meaningful ‘notice’ … is not feasible when many devices lack meaningful user interfaces or screens.”

For regulators, “the challenge then is to allow practices that will support progress, while providing appropriate controls over those practices that should be forestalled or constrained by appropriate consent.” Thus, while the developers of wearable technology should work to bake in security and privacy to protect users now, policymakers should also be working to assess how privacy principles can be flexibly applied to both protect consumer privacy and innovation at the same time.

Wearable IoT will also be susceptible to latent listening, from both the perspective of an audio input and device awareness. A smartwatch or other wearable device could potentially tell where you are, who you are with and how you’re feeling from passive listening. “The smart watch you see today is always on your wrist and ready to listen,” Surowiec says. “We will gradually shift from that to always listening which will create new opportunities as well as legal and ethical dilemmas.”

Artyom Astafurov of DataArt also notes that with privacy, everyone with a smart phone is already sharing their user information in some way. This issue was there before IoT and needs to be addressed on a daily basis.

“The good news is that the overall privacy trends are much larger than the IoT community,” he says. “The development community can learn from previous missteps, and we can reuse standards and policies in our designs.”

CONCLUSION

On a daily basis, developers are building experiences bolstered by the Internet of Things. Data from multiple sources is instantly transformed into information and knowledge about what’s happening. If it's something important, these experiences can create an actionable insight and modify our behaviors.

Whether it is a text alert or a notification to the display screen, wearables are the most personal interaction of IoT. That multidimensional data opportunity is just starting to emerge.

We don't know what is going to be acceptable 10 years from now any more than what we expect will be acceptable next month. So people like Julien Blin, an evangelist, strategist, and President of Smart World Alliance, suggests the most graceful of interactions between machine and human.

Blin explains that eventually, all garments will be enabled to some extent but they will only be adopted if the price comes down. “[People] will see the value of it, especially if the price point is not too far away from what it would normally cost people.” Blin adds that textile wearables could really take off in the footwear category like shoes and socks because, “not everybody wears a watch or glasses. However, I'm not sure if all of these devices will combine into one interface. People may not want to link their $10 socks with their $400 watch.”

No one wants to be left behind in the Internet of Things space. This is why developers are asked to look at their existing processes, the way these processes interact with their customers, and to see what would make a natural fit. Wearable World’s Snodgrass says, “If you can find a simple use case that improves people’s lives, that’s where you build, that’s where you develop and that’s where you acquire your initial revenue and understanding to bridge out further into the space.”

Overall, our experts advise that the wearable Internet of Things must be a natural extension of existing processes that fit seamlessly into a sensor actuator world.

For additional insights, click here for videos that explore opportunities and what developers need to know.

ONE IN A SERIES

This whitepaper is one of a series of documents designed to help developers understand the many facets of the Internet of Things that are connecting to the Internet. The series begins with an introduction and each of the papers focuses on a vertical marketplace such as automotive, manufacturing, wearables, home, and retail. The papers include a review of available standards, opportunities for exploration and individual growth, as well as specific calls-to-action that developers can immediately use.

ABOUT THE APPLICATION DEVELOPERS ALLIANCE

The Application Developers Alliance is a non-profit global membership organization that supports developers as creators, innovators, and entrepreneurs. We promote the continued growth of the industry and advocate on behalf of our members on public policy and industry issues. The Apps Alliance serves a growing membership of tens of thousands of developers and hundreds of companies including: mobile app publishers, platforms, wireless carriers, hardware manufacturers, ad networks, enterprise tools and service providers.