INFORMATIONAL BRIEF

# Interview With Brian McCarson

## Interview with Brian McCarson on the evolution of IoT and ecosystem enabling

Brian McCarson is CTO of IoT Strategy and a Senior Principal Engineer at Intel Corporation. He leads the Technology and Standards Team within Intel's Internet of Things Group Strategy and Solutions Enabling Division.

We asked McCarson to share Intel's vision and his own views of the current status and future possibilities of the IoT, and Intel's role in enabling a robust IoT ecosystem

### Q: What is Intel's interest in the IoT landscape, and where does Intel fit within the landscape?

A: The Internet of Things is bringing the power of compute, connectivity and storage capabilities to the things that surround us in our daily lives. Because of Moore's Law, the sophistication of these capabilities is growing and costs are dropping at a tremendous rate. As a result, we can now put data center-level compute, connectivity and storage in places we never would have imagined possible.

Intel is a compute, connectivity and storage company. We excel at delivering high-performance computing capabilities for very complex applications. And today there's an enormous need in the marketplace for supporting connected things and complex IoT applications. That includes everything from smart door locks and lightbulbs to highly automated cars and commercial aircraft that take off and land by themselves.

### Q: How does Intel envision the major developmental phases of the IoT?

A: We see the IoT advancing in three phases. The first phase focuses on connecting the unconnected. This phase is about taking legacy infrastructure or existing assets, whether that's an air conditioning unit in a high rise apartment building or an 18-wheeler delivering inventory, and connecting them to a centralized infrastructure—the Internet or cloud infrastructure—so that we can gather data from them to give us more insight.

The second phase is about building smart and connected things. In this phase, connectivity and intelligence capabilities are designed directly into products. When a product ships to the customer, it comes equipped with the ability to connect to the internet because it was designed with the compute and connectivity built in. And it can do more than just send raw data to the cloud; it may be capable of performing basic intelligence tasks, or programmable to carry out those tasks. For instance, a smart vending machine would trigger an order for more inventory when it's getting low on products. Or a wearable health-care monitoring device would send an alert when a person's biometric data moves outside a doctor's recommended limits.

The third phase of the IoT is what we call the software-defined autonomous world. A good application example is autonomous vehicles. If you've flown in a commercial airline in the last 15 years, you've already gotten a taste of this phase. Almost all newer commercial aircraft virtually fly on their own; they can take off, land and navigate by themselves. We may feel safer knowing that pilots are in the cockpit, but their main job today is to take over in cases where multiple redundant systems fail. The reason why commercial flying is so safe is because we are so advanced in software-defined autonomous capabilities in phase three of IoT in the airline industry.

## Q: What's the current status of these IoT phases? How far have we progressed?

A: The answer varies by market segment. If you look at the smart home space, we are in the middle of phase one, connecting the unconnected. But we're starting to transition to phase two, with smart and connected devices like Amazon's Echo and Google Home, and a whole suite of new home assets that are coming on the market. Some of these devices have advanced compute capabilities, like natural language processing capabilities. I think we'll see significant ease-of-use improvements in the smart home space in the next few years, because consumers don't want to spend an hour on the phone with an IT department trying to figure out how to make their device they just bought work. They want to plug it in and have it work.

In the industrial sector, we see everything from phase one operations—retrofitting existing infrastructure to connect it to the Internet—to phase three operations such as smart manufacturing, where raw materials come in and finished goods come out without any human hands touching them. Intel's semiconductor factories are well into phase three. Much of the automotive sector has moved toward phase three, with sophisticated manufacturing capabilities, like high precision robots doing laser welding, and automatic monitoring and adjusting of paint quality. Autonomous vehicles, as I mentioned earlier, are another example of phase three.

Most commercial buildings are still in phase one. There's a huge number of older buildings around the world, so we will be connecting the unconnected for many years to come. New residential and commercial construction is in phase two. We're seeing smart and connected things like advanced elevators and escalators, and A/C units that can dynamically adjust to time of day and building load, and even collaborate with the energy grid to try to make better use of renewables where possible.

We also see different levels of progress across the market segments, depending on the price point of the goods being produced. As Moore's law continues to drive down the cost of compute, connectivity and storage, we will start to see phase two or three capabilities in lower-cost products.

## Q: How do standards help to enable the vision of the IoT's future shared by Intel and other industry stakeholders?

A: There are many reasons, but one critical reason is that standards enable interoperability. Here's an example: Whether you have a brand new laptop or one that's ten years old, you can still go to Starbucks or any other coffee shop in Jakarta, Tokyo, London or San Francisco and connect to the Internet using standardized Wi-Fi technology. That's possible because of the standards work that Intel and our partners did in the '90s transitioning from desktop computing to mobile laptops.

We knew that if there were different radio wireless technologies for every city you lived in, your laptop would only connect in some cities and coffee shops and not others. Imagine how frustrating that would be. The same thing is true in the cellular space, with improvements that we've made in 3G, 4G, LTE, and the next generation 5G universe that's on the horizon.

In the IoT space, standards will be critical to enable devices to be connected to each other and to the Internet in order to communicate and interoperate securely.

## Q: What standards areas are most important when it comes to the IoT? Which are most important, relevant and impactful for industry?

A: The first, and probably most pressing area right now, is security standards. How do you enable devices to come online and communicate only with the devices they're supposed to communicate with, and do only what they're supposed to be doing, in a safe way that doesn't jeopardize anybody's health, privacy or security? For that you need security standards.

When configuring your new smart home devices for the first time, it would be nice if, when a device gets powered on, it wakes up and communicates—as an example, it says hello, I am a smart door lock, and I was just purchased by Andrea, and I'm able to talk only to another device that's been confirmed to be owned by Andrea, and I need this encrypted passcode to be registered or I'm not going to permit speaking to anyone else.

Another important area is metadata and data interoperability standards. These focus on how a device communicates what it is, what data it's sending, and understands data sent from other devices. These kinds of standards are critical to advancing the IoT, because devices speak a lot of different languages, just as humans do. If you get off a plane in Vietnam or Thailand or Kenya, you're going to have a difficult time communicating if you don't speak the local language.

## Q: There are many IoT standards in the marketplace already. Are there too many? Is there a need for some consolidation?

A: In Intel's view, there should be some competition in the standards space, because each standard represents a different idea. But it's best if there's some consolidation, so that the market doesn't become too fragmented. That's especially true of consumer products, such as smart home devices and consumer appliances, which you want to be interoperable. To achieve interoperability, it's better to reduce the number of standards, so that every consumer product you buy either runs on the same standard or one of a handful of standards that can interoperate with each other.

In the industrial segment, there's also a need for consolidation. Last time I counted, there were well over 100 different communication standards alone; that's 100 different languages that devices are speaking. Someone's got to do the translation, if these devices are going to interoperate. I think we'll see some consolidation in the industrial segment, but it will be slower. Some industries, such as manufacturing, aerospace and banking, have been more vertically developed; they've invested a lot in proprietary or customized technology or application-specific standards. So they don't have as much of a horizontal interoperability view as we see in the consumer and IT space. But as the IoT advances, these industries are starting to talk about the need for horizontal standards.

One of the focus areas for horizontal standardization is smart cities, which needs standards for transportation, energy, security and public safety. Smart manufacturing is another area.

We think that a lot of industries will probably develop hybrid solutions, with companies using some of their own proprietary technologies and also leveraging industry standards. For instance, you could see some industries adopting open standards for connectivity, communications and maybe even data interoperability.

## Q: Where is Intel focusing its investments in the standards space?

A: The largest investment that Intel is making right now in standards is clearly in 5G, which is critical to communications in an IoT world.

We've also made some very big investments in standards organizations that are driving the IoT forward. But 5G, is the most prominent area of investment.

We knew that if there were different radio wireless technologies for every city you lived in, your laptop would only connect in some cities and coffee shops and not others. Imagine how frustrating that would be. The same thing is true in the cellular space, with improvements that we've made in 3G, 4G, LTE, and the next generation 5G universe that's on the horizon.

In the IoT space, standards will be critical to enable devices to be connected to each other and to the Internet in order to communicate and interoperate securely.

## Q: One emerging area for standards development is fog computing. What is fog computing, and what is its role in the IoT?

A: By one estimate we'll have about 50 billion connected devices in the world by 2020. If the cloud needs to process and analyze all the data that these devices are sending in real time, networks will be overwhelmed, which could lead to major latency issues.

The idea behind fog computing is to bring the power of the data center much closer to the "things" in the IoT world; the cloud comes down to the ground level. Now you have real-time computing and communications capabilities that don't exist in a cloud computing environment. That's because even at the speed of light, which is how a lot of devices communicate with each other, you can only be so far away from your computing source and still be able to make a decision in less than a millisecond.

Making those split-second decisions is critical in some situations. For instance, you want your autonomous vehicle to decide in less than a millisecond if there's something dangerous ahead. Or in an emergency, you want your smart factory to be able to control the safety of workers in microseconds.

## Q: Tell us about the key consortia that Intel supports for IoT interoperability and ecosystem development.

A: There are a few which are pretty important. I think the Open Connectivity Foundation is going to lead the way in compute, connectivity and interoperability standards for the smart home and consumer products. The OCF consolidates some of the leading industry efforts focused on home networking and smart homes over the past few years. It was formed in 2016 and merges the work from the Open Interconnect Consortium, which Intel co-founded; the AllSeen Alliance; and the UPnP Forum. To me, having these organizations join forces is a huge step in the right direction that benefits consumers everywhere. That's the kind of collaborative industry effort that we at Intel like to see in the marketplace.

The OCF also oversees IoTivity, which is an open source project under The Linux Foundation that's supporting the development of specifications for interoperability developed by OCF. The two organizations work well with one another, and their efforts are complementary in helping to move the ecosystem and market forward.

The OpenFog Consortium and the Edge Computing Consortium are two other important organizations. Intel is a co-founder of these two consortia and serves on the board of both of them. OpenFog Consortium is a global organization that's developing reference architecture frameworks technical guidelines, and market models for how companies can come together to solve problems such as reducing latency, lowering the cost of computing, and enhancing the privacy and reliability of IoT solutions. The Edge Computing Consortium is based in China and Intel is engaged to support development of the edge computing market in China and beyond.

The Industrial Internet Consortium is looking toward advancing the industrial IoT, as we move from phase one, connecting the unconnected, to phase two, smart and connected things. Intel was one of five companies to launch the organization. IIC has developed frameworks for reference architecture and security and now they're focused on coordinating with other consortia and global standards organizations efforts.

## Q: How does Intel work with standards organizations and industry consortia?

A: If you go through the list, Intel is either an active participant or a leader of some of the most important standards and consortia efforts for IoT globally. And as I noted, we helped to launch some of the key organizations.

Intel is considered a trusted ally and a neutral party for a lot of players in the market, because we have a long history of working for the benefit of the broad market in the standards and consortium world.

So you will continue to see Intel involved in these organizations, serving in a leadership role, contributing code and specifications, and helping to build bridges between competitors in the marketplace, for the betterment of the entire market.

## Q: One of the most important emerging areas of IoT that you described earlier is autonomous applications. Tell us more about the role that IoT standards play in these applications.

A: A good example is autonomous cars. Think about driving on a highway. If a vehicle can't communicate to the vehicles around it—this is my path, trajectory and speed, this is where I'm going, and this is what I'm seeing in front of me—it puts those other vehicles at risk.

Standards can enable vehicles to communicate with each other, which will improve safety and allow things like platooning. When your vehicle gets on the highway, imagine if it could communicate with the vehicles around it and form a platoon, with 10, 20, or even 30 vehicles that can all travel at 65, 75, or 80 miles an hour on the freeway, safely, even though they're just a few inches apart from one another. You could have up to ten times the number of vehicles on a roadway if everyone were able to platoon, without having to build any new city infrastructure, so the savings to taxpayers would be significant. It would also be much more time-efficient to commute to work.

Platooning is only possible if you have vehicle-to-vehicle [V2V] standards that allow different brands and models of vehicles to communicate with each other, and in a safe way so that someone can't take control of another person's vehicle. That requires communication, data format and notification as well as security standards.

Vehicle-to-infrastructure, or V2X, standards can also enable vehicle communication with infrastructure to improve safety and traffic flow. For instance, the infrastructure could communicate with vehicles approaching an intersection and optimize the timing of traffic lights around those vehicles. Eventually you might even be able to remove lights from intersections because vehicles would receive alerts and could adjust their speed as they approach an intersection. That would require a combination of V2X and V2V communication.

You could also use V2X communication to substantially reduce pedestrian accidents. A driver or automated vehicle may not be able to see that a pedestrian is just around the corner. But a streetlight or other infrastructure equipment could send a signal to every vehicle in the area that there's a pedestrian approaching the intersection, or there's a school zone here. You could also use V2X communication to reduce accidents in road construction areas.

## Q: What will the IoT landscape look like a year from today? Five years? Ten years and beyond? How will the IoT change the way we live?

A: I think we've already seen a glimpse of how the future will unfold. The fact that our planes are flying themselves is a great example. As we see the cost of the fundamental ingredients required for autonomy and machine learning and deep learning capabilities continue to drop, we'll see these advanced IoT capabilities gradually creep its way into more and more aspects of our life.

We many not even realize how quickly the IoT will evolve. One day we all woke up and realized we needed a smartphone, thanks to Apple's introduction of the iPhone. I think we'll see something similar with the IoT. All of a sudden there will be products available on the market that make us wonder how we lived without them. It will start with small innovations, like houses that cool down when we pull into the driveway during the summer, or heat up when we come home in winter, and refrigerators that track inventory and restock to our specifications as products start to expire, or recommend recipes based on what we already have in the fridge. These are the kind of things that I think will creep into our lives.

## Q: How do standards help to enable the vision of the IoT's future shared by Intel and other industry stakeholders?

A: There are many reasons, but one critical reason is that standards enable interoperability. Here's an example: Whether you have a brand new laptop or one that's ten years old, you can still go to Starbucks or any other coffee shop in Jakarta, Tokyo, London or San Francisco and connect to the Internet using standardized Wi-Fi technology. That's possible because of the standards work that Intel and our partners did in the '90s transitioning from desktop computing to mobile laptops.

We knew that if there were different radio wireless technologies for every city you lived in, your laptop would only connect in some cities and coffee shops and not others. Imagine how frustrating that would be. The same thing is true in the cellular space, with improvements that we've made in 3G, 4G, LTE, and the next generation 5G universe that's on the horizon.

In the IoT space, standards will be critical to enable devices to be connected to each other and to the Internet in order to communicate and interoperate securely.

## Q: How did you become so passionate about the IoT? Tell us a bit about your personal background and your career at Intel.

A: My educational background is materials science and EE, but I was a geek from a very early age. (laughs) It started with a passion for automobiles. I needed to work on my own vehicles, out of necessity, and I watched as fuel injection and other electronic control systems came into the market, and compute and connectivity were added. And I became fascinated by device physics and advanced process control systems. That led me into the manufacturing segment, which led me into working on the IoT. That's where my passion comes from.

Before I joined the IoT group, I was working at Intel's factories. I spent a lot of time focused on automated process control systems, and trying to make our machines smarter and better capable of making real-time decisions. I was thrilled when Intel formed the IoT group. Being able to see the IoT expand into so many other aspects of our lives is deeply fascinating to me.

I think Intel is uniquely positioned in the market to be able to provide the whole fleet of compute, connectivity and storage ingredients and building blocks for the Internet of Things economy. So I feel like I'm in the right place at the right time.

[1] Tas repro omniatintus ut fugitem poreicipsum quid es acerepe llorem venducitem fugias dolorem sitatia sinulpa prestor ianiti ipsam eum exerferatnditatis nihillecum.

[2] Ur arum, od et ipitibust imaio verum veles eium ullitaqui consere henditia imporiae nistiorum necae poratur.

* Feriorunt et etum quia doloressimet fuga. Ra doleserum faccusdae pore perferovitas dolum et lit am re non prehendae. Et aut aut magnam fuga.