Internet of Things

Automotive as a Microcosm of IoT

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Application Developers Alliance

by The Application Developers Alliance Emerging Technology Working Group

"When Henry Ford made cheap, reliable cars people said, 'Nah, what's wrong with a horse?' That was a huge bet he made, and it worked."
~ Elon Musk, inventor, entrepreneur and CEO of Tesla Motors

EXECUTIVE SUMMARY

Since Henry Ford helped automate their manufacture, cars have become central to our lives. This makes the automobile a central hub for not only transportation, but as a communications center: The ideal ecosystem for the Internet of Things (IoT).

The connected vehicle is truly a microcosm of IoT. Not only can a networked car, truck or bus include internal sensors that determine such things as speed, location and temperature of the vehicle, but it also may interact with surrounding roads, buildings and other vehicles to provide up-to-the-minute information to improve safety and avoid traffic.

"Consumer expectations have really been changed by the prevalence of smartphones and tablets. People want uninterrupted connectivity and intelligent personalization, and this experience is now moving into a new medium - the car", says Alec Saunders, Vice President of Cloud at QNX Software Systems. Increasingly, connected cars (and particularly luxury cars) are taking advantage of the rise of smartphones, and apps are available to interact with a car's various systems. Users can unlock their cars, check the status of their batteries, find where they parked, or remotely activate the climate control system. Additionally, the transportation sector is expected to see many benefits from automation and control using IoT and associated technologies including opportunities to reduce distracted driving.

The market for automobiles enhanced with IoT is staggering. A 2013 forecast by GSMA, a global association of wireless carriers, found every car will have some type of connection by 2025. The market for technology to connect cars and the Internet was an estimated $18 billion in 2012 and is expected to increase three times that number in the next four years.

"Not only that, but this remarkable technology can seamlessly sync a wireless smartphone or tablet to a vehicle's audio and display system for communication with pedestrians, other vehicles and even road infrastructure," according to Rajiv Kapur of Broadcom India.

In 2014, the Application Developers Alliance and its Emerging Technology Working Group began identifying five areas influenced by IoT so that developers have insight into creating a robust IoT ecosystem. This whitepaper serves as an exploration of IoT by looking at its current state in automotive; best practices for creating apps; and new opportunities to explore. Other investigations will cover Home, Retail, Manufacturing and Wearables.

INTRODUCTION

In 1982, television audiences were introduced and entertained by the Knight Industries Two Thousand -- or K.I.T.T. -- a heavily modified Pontiac Firebird Trans Am that interacted via voice and other ways with its driver and designer Michael Knight (played by David Hasselhoff).

The famous talking car is often used as an example of how advanced automobiles can be when it comes to connecting the driver with different systems and advanced networking capabilities. Knowing that his car was connected to a greater network, Michael would typically instruct K.I.T.T. to keep his "scanners peeled" and assess the danger.

In the show, K.I.T.T.'s capabilities included many sensors and networked services. There was a comlink and a homing device as well as other sensor abilities. K.I.T.T. could "smell" via an atmospheric sampling device mounted in his front bumper, for example. K.I.T.T. could detect people and vehicles and track their movements and discern proximity. K.I.T.T. could gather structural schematics of buildings, vehicles, or other devices and help Michael avoid potential danger when he was snooping. K.I.T.T. could also monitor radio transmissions and telephone communications within a location and trace those calls. Flash forward to 2014 and K.I.T.T's novelties are mostly realities. The connected cars of today enable an average of 60 different sensors and electronic control units (ECU) to determine yaw, speed and dynamic traction control, among other things.

As John Ellis, Global Technologist at Ford Motor Company and Head of the Ford Developer Program explains it, the concept of connected cars is quickly surpassing K.I.T.T.- like capabilities and each new app and sensor design is expected to improve those capabilities year after year.

"What we're talking about is a network of devices and sensors that interact with each other and leverage the richness and the resource of the service," Ellis said. "These devices are connected and identify themselves as saying, 'Hi, I'm now a part of this network and here's what I can do.' As developers, we know already how to do what we can to build these systems. The challenge is to adopt that into the automobile context."

WHO'S BEHIND THE WHEEL?

Perhaps the ultimate expression of an IoT automobile is the notion of the driverless car. Vehicles ranging from Google's Self Driving Car; to AutoNOMOS from the Artificial Intelligence Group of the Freie Universität in Berlin; to Junior, a modified Volkswagen Passat designed by Stanford University students are all examples.

"A car that drives itself is 90% software and 10% hardware," says Liz Kerton, the Executive Director of the Autotech Council, a Silicon Valley group that aims to connect auto companies with entrepreneurs, venture capitalists and suppliers. "It is totally connected to everything around it. It is connected from vehicle to vehicle… from vehicle to infrastructure… and from vehicle to cloud. We're about 70% software now, so you could say there are many opportunities still out there."

While Silicon Valley hosts the majority of the projects, Kerton says half of the organizations are not from California at all. Israel, Germany and the Nordic countries are all coming up with new ideas for connecting cars to the Internet without requiring a driver to be overly involved.

Unlike most IoT strategies, the cycle for making cars is much longer than for nearly any other deployment of IoT around, according to Stephanie Boyle, the Innovation Lead at AT&T Foundry, an innovation center in Silicon Valley.

A car design from concept to show floor takes about 3 years. That's extremely difficult for electronics manufacturers who can speed new designs to market every year. Software developers have even shorter turnaround times with products taking just a few months or even weeks to ship.

So why are driverless automobiles the ultimate expression of IoT for developers and providers?

"I hate driving, so the idea of a car that navigates by itself automatically during my commute would be the best contribution that IoT technologies could provide," Boyle says. "Without having to worry about keeping their

eyes on the road all the time, people could get some of their time back in their day."
The transformation has already happened in certain makes and models. Several luxury carmakers have already installed vehicle-to-vehicle awareness sensors as well as smart devices.

The Audi Connect system, found in the latest A-series models, serves as a sensor system built around 4G LTE connectivity, GPS location and other vehicle sensors. The carmaker's ambitions to best equip drivers with information also include touchscreen dashboard, voice commands and gesture controls.

Additionally, smart cars should be equipped with virtual personal assistants like Apple's Siri or Microsoft's Cortana to help reduce driver distractions.

HOW WILL IoT WORK FOR A CONNECTED VEHICLE?

There are five ways to develop apps for vehicles, as explained by Peter Rogers, a Principal Architect for Mobility at Cognizant:

1. Run apps in the in-vehicle entertainment systems (Blackberry QNX CAR, Windows Embedded Automotive, Automotive Grade Linux and Android)
2. Use a link to a smartphone (Airbiquity, OpenCar, CloudCar, SmartDeviceLink / AppLink, MirrorLink, Apple CarPlay, Google Open Automotive Alliance and Windows in the Car)
3. Remote access to the vehicle through an API (OnStar, General Motors API, Ford Remote API, Airbiquity, reverse engineering of vehicle protocols)
4. Access to data through the On Board Diagnostics port called OBD-II (Dash Labs, Mojio, Carvoyant, MetroMile and smartdrive.io)
5. New and emerging initiatives (W3C Automotive and Web Platform Business Group and OpenXC)

"The biggest news in the connected car world is GM's announcement of its intention to rely solely on apps made available through Apple's CarPlay and Google's Android Auto. For sure this will give motoring consumers an interface they like. There is still choice but for developers the environment is manageable, a win-win all round." -- John G O'Brien, Practice Lead, Logistics at DataArt and former IT Executive at Ford Motor Company

The SDKs and APIs typically run into a few categories: back end, onboard user interface, onboard infrastructure and the world outside the car.

Backend systems are the easiest entry point for developers to engage with IoT. Developers can utilize well-traveled web services based on public, private and enterprise clouds to monitor and analyze IoT data from vehicles.

The next layer of developer engagement covers operations and the user interface. This layer includes management software bundled with policy enforcement and deep packet inspection. The process would be similar to the processes required for command and controls of Internet-enabled video and voice. This is also the layer where the vehicle's entertainment systems synchronize content with smartphones or cloud-based delivery systems such as Pandora or GM's Intellink.

Entertainment seems to be the hottest IoT development space, Rogers said because that's where more software and hardware companies are intersecting. For example, automobiles with IoT technology could be streaming music and commercials based on location and then offer the driver the opportunity to purchase said music using only voice commands.

Not all designs will be totally hands-free. Handwriting software pioneer, MyScript promotes its APIs for auto manufacturers who want to take advantage of human-machine interface features for dashboards. Pierre Laporte, Executive Vice President of Engineering says these features are exciting to work with now because they often are the differentiators for manufacturers.

"Chances are that for the next car you purchase you will not need to look under the hood," Laporte said. "What will be valuable to you is the screen size of the console or the ease of connection to your devices or the interface in which you can power these devices in your car." He adds that carmakers like Audi are focused on handwriting which, like voice, is a natural input method. Studies suggest handwriting is even far safer than voice, that is, less disruptive for the driver who needs to concentrate on the road. Additionally, International PROOF Systems developed computerized license plates known as PROOF Smart Tags. These tags use wireless communication and embedded micro-electromechanical systems to validate auto insurance, vehicle registration and response time during an emergency in real time.

Next come the infrastructure layers, which typically include interfacing with a vehicle's on-board diagnostics II (OBD II) communication port.

Finally, there is everything that talks to the car that is not in the car itself. Beyond the end points, the vehicles (cars, trains, etc.) use vehicle-to-vehicle communications. This also includes vehicle to streets or vehicle to buildings communications via IEEE 802.11p wireless standards.

For example, imagine finding a parking space and paying your meter fare based on your car's proximity to the site. Laurens Eckelboom, the Executive Vice President of Business Development at mobile app developer Parkmobile is touting just such a scenario. The company works in and around IoT standards to develop mobile parking payments for connected cars.

"What's exciting about working in the development of IoT software is communicating with devices that provide a plethora of data," Eckelboom says. "These apps are no more difficult than what people are already doing for smartphones or tablets, just on a broader scale. As emerging technologies mature, they'll be added into the fabric of IoT. I see predictive behavior as a huge opportunity for developers in the near future."

These hardware-software relationships may rely on mobile Wi-Fi offload capabilities and include the potential for creating mobile Wi-Fi hotspots using IEEE standards 802.11u (which seek out pre-authorized Wi-Fi networks) as well as 3G and 4G cellular interactions. There is also dedicated short-range communications (DSRC) infrastructure that includes 802.11p (or V21) as its standard. Then there are femtocells (small, low-powered, cellular base stations) and other communications should the vehicle be electric based and stop at a charging station.

"Cars have antennas that can act as a transmitter and receiver, so it makes sense for cars to be able to share connectivity among telecom providers," AT&T Foundry's Boyle says, noting that current E-911 services are often shared between rival wireless providers because they see the value of providing baseline services for the greater benefit of user adoption." As more data flows into and out from cars, we're going to need these types of relationships. I could even see microcells in streetlights to help handle the increased data being produced."

FOUR ON THE FLOOR SECURITY

While security should always predicate every conversation about developing an effective IoT application or standard, threats to automotive IoT should be handled with extreme care considering the number of safety requirements for a moving vehicle. Media outlets are providing no shortage of stories about hacks designed to break into or even take control of automobiles. Two DARPA-funded security researchers recently showed how they were able to take control of braking and steering systems easily with a hack that cost $150 in parts. Other more common hacks include commandeering keyless entry fobs or siphoning communications between a smart phone and a smart car using a Bluetooth network.

"No one wants their car or house being hacked or allow hackers to find ways to turn on and off their services," says Roger Ordman, Director of Product Marketing at Red Bend software. "It's not enough that your car can connect to the internet but that you want it to be encrypted enough that you don't have to worry. Nothing is inherently secure. Security is very local on one hand - yet having the ability to provide updates and apply patches helps if vulnerabilities are found. At least you can have the management capability there."

Driver interaction with an IoT-enabled vehicle is just as important as protecting its security systems. Many innovations in automobiles are meant to reduce driver distractions. In 2012, 3,328 people were killed and 421,000 were

Sensitive Cars

The average American automobile includes around 60 sensors covering aspects from driving to braking to climate control systems. For example, there are two types of speed sensors on some vehicles. One is a VSS (vehicle speed sensor), which provides input to the PCM (powertrain control module) for speedometer, transmission, cruise control, EGR (exhaust gas recirculation) strategy, etc.
The other is WSS (wheel speed sensor) and these inputs are used solely for the EBCM (electronic brake control module) for operation of the ABS (anti-lock brake system). Most if not all of a car's driving systems are accessible from its on-board diagnostics II (OBD II) port.

Here are just a few other well-known systems that have the potential for connecting via IoT:

- Road Condition Sensor
- Magnetic Sensor
- Vehicle Distance Sensor
- Forward Obstacle Sensor
- Blind Spot Monitoring Camera
- Drive Recorder
- Side Obstacle Sensor
- Air Pressure Sensor
- Airbag
- Road-To-Vehicle/Vehicle-to-Vehicle Communication System
- Rear View Camera
- Water Repelling Wind Shield
- Seatbelt Pretensioner
- Driver Monitoring Sensor
- Headup Display
- Steering Angle Sensor
- Electronic Control Throttle
- Electronic Control Brake
- Fire Detector Sensor
- Vehicle Speed, Acceleration Sensor
- Collision Detection Sensor
- Pedestrian Collision Injury Reduction Structure
- Electronic Control Steering
- Message Display System
- Hands-Free System
- Inside Door Lock/Unlock
- Rear Obstacle Sensor
- GPS Sensor

injured in distraction-affected crashes, according to research out of the Virginia Tech Transportation Institute. Engaging in visual-manual tasks such as reaching for a phone, dialing and texting increases the risk of getting into a crash by three times, according to national traffic statistics. As vehicles become more connected, standardizing interfaces and reducing the amount of time needed to take a driver's eyes off the road becomes important.

Companies such as Famigo and General Motors are putting more focus on ways to reduce driver distraction. Rob Myers, Senior Product Manager of Infotainment/Connected Car Applications for General Motors, and his team are encouraging developers to simplify user experiences in the in-vehicle apps they build for the radio or phone so drivers can focus on their number one priority, driving. “One of our goals is to have our customers put down their phones, utilize an app designed for the vehicle instead and focus on the windshield as their primary screen.” Additionally, Mobile platform Famigo developed a program to reduce distracted driving by providing back seat entertainment for children in select models of GM’s Connected Car. Q Beck, Famigo CEO and Founder explains, “The IoT has allowed consumers to be connected anywhere and providing backseat entertainment to kids can alleviate some of that distraction for parents so they can concentrate on driving.”

While the United States has spearheaded efforts in educating about driver distractions, developers should keep driver safety in mind before worldwide governments impose regulations.

Needless to say, ensuring developers enable security measures at all levels of an IoT design is imperative. Failure to do so would only stifle innovation and potentially set consumer adoption of smart cars back a decade.

FOG AND CLOUDS KEY IN CONNECTING SENSORS TO THE INTERNET

Among the key elements in connecting vehicles is the notion of collaborative ad-hoc networks (aka persistent systems) such as the one being used by the State of Connecticut where multiple mobile vehicle nodes with 4G backhaul help the governor's office and the Emergency Operations Center director the most up-to-date information.

Deterministic Networking (a TCP/IP-based network environment to augment controls) also plays a strong role in shaping IoT in automobiles. Commonly used by Internet providers, network ingress filtering and network

What is Fog computing?

Unlike Cloud computing where resources and services are scattered across different nodes, Fog computing is likened to Edge computing where an endpoint like a car sensor passes through and is blanketed with secure, highly virtualized computing and storage. Some call it just another name for Edge computing, but the "Fog" uses and supports the same technology infrastructure as cloud computing (virtualization, multid tenancy, IaaS, PaaS, SaaS, automation).

Unlike most IoT technologies, the automobile really moves in and out of Clouds and Fog so they need that true seamless user experience to maintain success. Developers will need to keep in mind that IoT in vehicles must be 99.99% reliable from a connection standpoint, which is why wireless standard 802.11p has been employed. Developers should also consider application aware and flow-based connectivity. There should be a seamless handover between next-generation cellular standards and Wi-Fi (roaming or not).

synchronization help establish machine-to-machine communications. Wireless radios such as IEEE 802.15.4 or "ZigBee" could be used for low power and low rate (4Hz) while a 5G Wi-Fi connection (802.11ac) could be used to deliver packet data over a higher rate.

The technologies considered for auto IoT include LISP (Location Identifier Separation Protocol with IP-in-IP), PRF architectures, mobile IPv6, Network Mobility (NEMO) and single-IP reachability.

However, Ford's Ellis says even the simple Universal Plug and Play (UPnP) that was set up several years ago can stand as the basis for developers to get cracking on IoT for their muscle cars.

"Combine that with SOA [service oriented architecture] and the contract and the entity and extend it so a third-party developer can to leverage is not so hamstrung," he said.

DRIVING INNOVATION IN ENTERPRISE

Beyond passenger cars, the transportation sector is expected to reap many benefits from automation and control, as the back end of the information and analysis application. Take United Parcel Service (UPS) as an example. The courier company tracks more than 200 pieces of information on every single truck that's deployed, using the mass of data to save fuel, check on drivers, fix vehicles when there are signs of trouble, and more. Likewise, municipalities can also get in on the action by using sensors in traffic lights that track traffic patterns, and using the data to improve the safety of those intersections.

Like retail consumer tracking, fleet tracking also had a pre-Internet iteration, using satellites to track vehicle locations. As Balazs Szabo, the CEO of Smartdrive.io, a connected car startup says, "Connected car services could help companies to increase vehicle efficiency by measuring driving habits of employees and help their improvement with gamification techniques. There will be a significant transition from monitoring to rewarding by the help of enabling technologies and changing the mindset of the companies from penalizing employees to reward and motivate for further improvement." Now, companies can use sensors to measure a multitude of variables, and real-time analytics

Testing out IoT designs

Prospect Silicon Valley (also known as ProspectSV) is a nond profit organization in California that was established to support the growth of smart cities: ones that promote emerging technologies as well as learn and respond to emerging business models for infrastructure, energy, transportation, building management and other aspects.

Participating technology companies have access to a wide range of resources including access to a $12 million, 23,000 sq. ft. Technology Demonstration Center with working space, lab facilities, specialized equipment, meeting rooms and a working test track in north San Jose, Calif. Companies can test out their IoT designs in a test-bed corridor with live traffic including access to fleet vehicles, data feeds, buildings and other programs.

The goal of most tests is to demonstrate in commercial- and municipal-scale settings, with access to public infrastructure for field trials to lower risk, prove market viability, and prepare for scale. Executive Director, Doug Davenport notes that cities and companies are very alike in their quest to use IoT technologies to save energy costs, reduce energy use and cut emissions.

"What works well with our startups are projects with a high level of sustainability as well as a high level of usability while really serving those communities that bring all of these technologies closer for the benefit of all smarter cities," said Davenport.

help to optimize maintenance and route planning, among other things.

To date, vehicle insurance has been based on a variety of circumstantial criteria, such as age, gender, and county or city of residence. But insurance companies are offering a new basis for premiums: They'll install sensors on your car if you'll let them monitor your driving habits. So rather than pricing your policy because you're a 25-year-old male in a city with multiple reported accidents, they'll price based on how well you drive and where.

IoT DEVELOPERS START YOUR ENGINES

As always, developers want to be on the cutting edge of technology trends, so auto manufacturers and their partners are eager to oblige.

Most major automobile companies and their partners offer their own software development kits (SDK), application protocol interfaces (API), and developer programs so that developers can quickly understand the architecture and how to interface their designs or functions with the inner workings of the automobile. "At this stage, cozying up to the manufacturers and their developer programs / app recruitment programs is the best way to get noticed, discovered, and distributed." says Terry Hughes, Managing Director of AppCarousel. "It's just like mobile was 10 years ago…a decade ago the only way to get an app distributed was to cozy up to the mobile operators and get featured on their WAP decks. Fast forward 10 years and it's all changed, but automotive is where mobile was 10 years ago."

Ford Motor Company and General Motors support their own training centers with laboratories and test tracks. Toyota has tapped IBM to build a development platform for IoT and other advanced services. Tesla Motors Inc. (TSLA) and others are making their patents and platforms "open source" to expand the adoption of electric cars.

Audi, GM, Hyundai and Honda are all part of the Open Automotive Alliance. The consortium seeks to create a standard for Android devices and software to work with in-car systems. In typical fashion, Apple established its own partnerships with Honda and Hyundai to get its car-friendly iOS 7 operating system into their models. Microsoft similarly has its own "Windows for the Car" moment with its Windows Embedded Automotive 7 platforms.

Always one to get in on the ground floor of standards, on January 6, 2014, Google announced the formation of the Open Automotive Alliance (OAA) a global alliance of technology and auto industry leaders committed to bringing the Android platform to cars starting in 2014.

The OAA includes Audi, GM, Google, Honda, Hyundai and NVIDIA. Two months later, Apple announced a new system to connect the iPhone to car infotainment units using iOS 7 to cars via a lightning connector, called CarPlay.

Most if not all of the automotive players and software companies engaging with IoT are staging meetups, hackathons and other public developer events to see what kinds of innovative apps developers can come up with. Alex Donn, Developer Evangelist at AT&T advises, "Go to meetups. Find people that are interested in the same thing and want to build IoT applications, or more importantly, have already built apps in the space." A handful of companies are also approaching universities and colleges to get design and engineering students to develop the next big IoT app for the car. Rachel Hankerson, CEO and Founder of International PROOF Systems seconds, "Stay connected to trendy innovative networking groups and involve yourself with groups such as Open Mobile Alliance and AutoTech Council."

Intel Partners with Auto Manufacturers

Intel Corporation is partnered with leading car manufacturers to develop products and solutions for connected cars and autonomous driving:

- **BMW**: Intel technology is used in BMW's Navigation System Professional, part of BMW ConnectedDrive, to provide the processing performance needed to deliver a compelling experience to the driver and passengers, including a rich display screen interface and quicker response times when interacting with the applications.
- **Hyundai Motor Company**: The Driver Information System in the all-new 2015 Hyundai Genesis powered by Intel technology offers Best In Class in-vehicle high definition screen and improved response times whens interacting with the system.
- **Infiniti**: Infiniti selected Intel technology to power the company's Infiniti InTouch in-vehicle infotainment system to deliver a rich experience to the driver and passengers, such as high-end graphics on the touch-screen displays.
- **Kia Motors Corp**: Kia Motors Corporation's K9 luxury sedan will be powered by the Intel® Atom™ processor to feature dual-independent displays so that drivers and passengers can enjoy desired content anywhere in the car.
- **Ford**: Mobile Interior Imaging explores how interior-facing cameras could be integrated with sensor technology and data already generated within and around the vehicle to create a more personalized and seamless interaction between driver and vehicle.
- **Jaguar Land Rover**: Jaguar Land Rover will enhance its research and product development on future vehicle infotainment technologies through a new collaboration with Intel to explore and develop next-generation digital vehicle prototypes with in-vehicle experiences that connect car, device and cloud.
- **Toyota**: Intel and Toyota will focus research on developing a user interaction methodology including touch, gesture and voice technologies as well as information management for the driver.

To reduce development costs and speed time to market, Intel has developed three application-ready products to help system developers and automakers create compelling in-vehicle technologies: 1) purpose-built, in-vehicle infotainment (IVI) computing modules, 2) automotive middleware software and 3) a development kit.

There is also no shortage of organizations looking to standardize IoT for vehicles -- AllSeen Alliance, Genivi Alliance, Open Automotive Alliance, OpenXC and the Connected Car Project are all pole positioning for market dominance.

Automotive IoT has some unique standards (Bluetooth 4.0 and Wi-Fi 802.11p come to mind as well as standards set by the National Highway Transportation Safety Administration (NHTSA)) and most are pervasive enough that developers can get started now with minimal effort in the analysis of IoT data. Meanwhile, those hoping to interact with the sensors or devices themselves will be required to work with on-board diagnostic ports and the latest wireless standards.

Groups that do well typically combine open source hardware and software that lets you extend your vehicle with custom applications and pluggable modules.

TIME FOR ACTION

As with all new technology trends, developers are the ones who decide which tools are necessary to build the products that the rest of us will use for years to come. When IBM and Apple defined the personal computer era, for example, developers typically built consumer programs using BASIC, C++ and Java while SQL, COBOL and FORTRAN were used for business purposes. Tackling the business of building new applications and products that tap into the power of IoT opens up many opportunities. But it also means that there are nearly as many ways to build the future as there are devices connecting to the Internet. The current trends in development favor functional programming along with concurrent, distributed and object-oriented programing tools.

The tools of choice also depend highly on which platform a developer decides to target. In a simplified way, Apple's iOS favors knowledge of Objective-C and HTML5 versus Google's Android, which centers on Java and JavaScript. As car manufacturers team up with different platforms, it is likely that the attributes seen with phones and tablets will also occur with automobiles. “There is a need for end-to-end privacy, security, and reliability for connections, and building an IoT system to provide these capabilities to the automotive market is complex. It requires significant considerations in system design, from the client software to the application platform in the cloud,” says Alec Saunders.

As one industry leader noted in an interview with the Alliance, "It's like making a salad. Some people like a lot of dressing while others add tomatoes and onions."

Developers also need to choose where they want to engage with IoT. Cloud-based software for data gathering and analysis is an easy way to participate. Most if not all of the cloud standards also apply to deciphering sensor data. Likewise are the applications that tie into the closest communications with the sensors themselves. One only needs to coordinate efforts with the original equipment manufacturer (OEM) or platform supplier to begin designing products based on their specific Application Programing Interface (API). The most challenging area of IoT engagement seems to be the layer that interacts with the most complex variables of IoT -- human beings. This includes any interaction with the product or application that provides information, communication and entertainment.

CONCLUSION

The Application Developers Alliance conducted numerous interviews with industry leaders. Through these interviews, the Alliance set out to find the gateway for developers to enter automotive IoT. The areas listed above are the key areas in which developers can get involved. However, there is not a one-size fits all path for automotive IoT. Though various aspects have been around for years, automotive IoT is still in its infancy. Car manufacturers and platforms are actively recruiting involvement from developers. Terry Hughes states, “As automotive is so new, Ford and others will happily talk to developers. We are entering a phase of developer conferences and hackathons for car apps, which tells us we are at the early stage.” However, the system is undoubtedly going to be fragmented with manufacturers working with different platforms and operating systems but there are many options to get involved.

For the connected automobile, innovative apps and wireless devices are being made possible mostly thanks to wireless technology innovations like Wi-Fi, Bluetooth Smart, near field communications (NFC), and GPS. Combine that with breakthroughs in batteries that have allowed equipment to become smaller and less dependent on power supply, and IoT technology is hurdling forward at breakneck speed. Bluetooth Smart, in particular, allows devices to consume so little energy that one single coin-cell battery can keep them going for months or even years.

Developers also need to know that building the next big app using IoT is not a race to build the first big application and cannot be produced in the same way that you build for the standard Web. However, developers should not focus their efforts on automobiles in isolation. Instead, developers need to make sure that their apps can be used seamlessly across devices and platforms for users. John Ellis warns, “Developers need to slow down, understand the relevancy that they have to offer, and realize the opportunities as well as the challenges." As Ford's Ellis says, most applications take months if not years to develop. Developing for automotive IoT requires skill sets of all levels.

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. Each of the papers will focus on a vertical marketplace such as Home, Retail, Automotive, Manufacturing and Wearables. The papers will include a review of available standards, opportunities for exploration and individual growth, as well as specific calls-to-action that developers can immediately use.

Check out the Introduction,
for more perspective.

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.