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Role of Internet of Things in Smart Passenger Cars

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Abstract: The rapid development of the Internet of Things (IoT) and Smart Things provides an opportunity for the informationization for the automotive industry. Smart Things is another paradigm shift in IT world. Smart Things are the things that are having embedding smartness or intelligence, identification, automation, monitoring and controlling calibre. Smart Things are assisting human life a lot, nowadays without their applications life is becoming cumbersome. The introduction of the concept of the Internet of things in the automotive industry will carry on the unified tracking, monitoring and managing and processing the entire automobile car operation, and has become a new trend. This paper presents the role of Internet of things and the new technologies in making the passenger car smarter. This paper exhibits systematically on Internet, Things, and then explores on Internet of Things and finally Smart Things from researchers', and corporate perspective. Moreover, this article focuses on the state of Smart Things and its applications. This in turn would help the new researchers, who want to do research in this IoT domain

Keywords: Internet of Things, Communication, Vehicles, Monitoring, Databases, Sensor Technology

1. Introduction

Internet of Things is defined as "An open and comprehensive network of intelligent objects that have the capacity to auto–organize, share information, data and resources, reacting and acting in face situations and changes in the environment". Internet of Things is one of the last advances in Information and Communication Technologies, providing global connectivity and management of sensors, devices, users and information. Imagining the Internet of Things (IoT) being used to track objects like a can of cola or a box of cereal from sites of production to sites of consumption is perhaps not too difficult to imagine. However, there is a movement under way to add almost every imaginable physical object into the Internet of Things [1-2].

In New Zealand, for example, all cows might had IP addresses embedded in RFID chips implanted into their heads by 2011 [3]. Furthermore, objects are increasingly able to not just be characterized by a unique identifier, but also to transmit location, automate the things, monitor and context-sensitive datum. The Internet of Things refers to the coding and networking of everyday objects and the things to render them individually machine readable and traceable on the Internet [4]. Much existing content in the Internet of Things has been created through coded RFID tags and IP addresses linked into an Electronic Product Code network. Currently, there are 9 billion interconnected devices and it is expected to reach 24 billion devices by 2020. US National Intelligence Counsel foresees that "by 2025 Internet nodes may reside in everyday things-food packages, furniture, paper documents and more" [5]. Internet of Things (IoT) describes a world where just about anything can be connected and communicates in an intelligent fashion that ever before.

Cars are no longer just a means of safe and convenient transportation. With the emergence of the Internet of Things (IoT), automobiles have the potential to become more than just means of transport They seamlessly link to our smart-phones, register real-time traffic alerts, stream our music playlists, and offer emergency roadside assistance at the touch of a button. Indeed, automakers began linking vehicles to information streams back in the early days of the Internet. When it comes to connecting drivers and technology, the auto industry has a longer and richer track record than any other sector [6-8].

The Internet of Things (IoT) has recently emerged as enabling technology for the smart gird, smart health, smart transportation, and smart environment as well as for smart cities. The major smart grid devices are smart home appliances, distributed renewable energy resources [9-17] and power substations. IoT is used in power electronic applications [18-27], renewable energy, power systems and different algorithms with different applications [28-40].

In fact, by 2020, it is estimated that more than 250 million vehicles will be connected and packed with sensor technologies. These 'smart-phones on wheels' will heighten passenger experience and transform the way we buy, drive and service our cars.

2. Evolution of Connected Cars

The connected car has evolved in distinct stages, or phases, over the last few decades that show advances in both technology and the ecosystem in which that technology functions. At each stage, not only are new features and services added to the growing connected car product portfolio, but also new ecosystem players as well as, in many cases, new business models and supporting technologies. That's why the best way to fully perceive the complexity of the playing field is to use the past as prologue, tracking the evolution of the connected car from its earliest stages to where it is today and where it's going. Figure 1 outlines these phases of evolution.

3. Dare to DAIR: The R&D Era

Since as far back as the mid-1960s, automakers have looked for ways to enhance the driving experience with information. General Motors' Driver Aid, Information and Routing (DAIR) initiative sought to provide everything from directions to current road conditions and accident reports. Far ahead of its time, DAIR never got out of the R&D stage, mostly because the technology of the day simply wasn't up to the task. Punch cards provided information for turn-by-turn directions; radio relay stations and magnetic sensors buried in roads communicated additional data. For such a system to be useful, it would have required ubiquitous availability-in other words, deployment on roads across the country or, at least, a substantial geographical scale-at the time, cost-prohibitive and commercially unworkable, which is why we classify DAIR as Phase 0, a connected car before connections truly existed.

Conceptually, however, we can think about this effort in terms of how the information creates value and therefore assess DAIR in those terms. The Information Value Loop describes the stages through which information must pass to create value, the technologies required to push information around the loop, and the characteristics of the data that drive value.
By connecting the vehicle with in-road sensors, DAIR created and communicated information, analyzing it to provide an augmented response-action-in the form of navigation and traffic information. In closed test environments, the value was visible as information completed the trip around the value loop. At commercial scale, however, the cost of putting the expensive sensor technology in place across large stretches of road created too tight a bottleneck for DAIR to be feasible. It did not help that, for a single-company initiative, there was no larger ecosystem in place to spread the costs around. Even for the GM of the 1960s, DAIR was too great a dare.

4. The Information Value Loop

The suite of technologies that enables the Internet of Things promises to turn most any object into a source of information about that object. This creates both a new way to differentiate products and services and a new source of value that can be managed in its own right. Realizing the IoT's full potential motivates a framework that captures the series and sequence of activities by which organizations create value from information: the information value loop is shown in Figure 2.
For information to complete the loop and create value, it passes through the loop's stages, each enabled by specific technologies. An act is monitored by a sensor that creates information, that information passes through a network so that it can be communicated and standards-be they technical, legal, regulatory, or social-allows that information to be aggregated across time and space.

Augmented intelligence is a generic term meant to capture all manner of analytical support, collectively used to analyze information. The loop is completed via augmented behavior technologies that either enable automated autonomous action or shape human decisions in a manner leading to improved action. Getting information around the Value Loop allows an organization to create value; how much value is created is a function of the value drivers, which capture the characteristics of the information that makes its way around the value loop. The drivers of information value can be captured and sorted into the three categories: magnitude, risk, and time.

Figure 1 Outlines Phases of Evolution.

5. ONSTAR and its Constellation: The Embedded Era

When GPS technologies were opened up to civilian use in 1996, GM announced On Star in collaboration with EDS and Hughes Electronics. As originally introduced, every connected car would have a digital communication module (DCM), essentially a phone embedded in the vehicle, responsible for communicating information wirelessly to a telematics service provider (TSP) or the automaker itself. In a breakthrough we categorize as Phase 1, this connected the car to information and services from the outside world to enable a safer and easier driving experience.

Communication-based technologies often require an expanded ecosystem to function effectively and affordably, appeal to customers, and offer opportunities to generate value. But while enlarging an ecosystem enables a given value loop to create more value, it poses additional challenges for the players involved when it comes to capturing that value. The continued evolution of the connected car has played out according to these same rules.

6. On-The-Go: The Infotainment Era

By the mid-2000s, the near-ubiquity of mobile phones and the rapid rise of smart-phones prompted the introduction of “infotainment” applications within the vehicle. These applications were built on a driver’s “brought-in” phone (using a phone’s cellular connection to stream data to the vehicle via Bluetooth) rather than embedded hardware (as with DAIR or On Star). The connected capabilities within the car aimed to duplicate entertainment and features a driver could get elsewhere (at home or on their phone) rather than providing a wholly new stream of features and new kinds of value. Even so, this signaled a new phase: a shift from creating value through technology to creating value through information, and expansion of connectivity to better integrate with the customer’s out-of-vehicle life.

On the whole, the infotainment era renewed interest and adoption in the connected car. However, monetization of services continued to be an issue as customers grew accustomed to accessing music and other entertainment on demand, often for free, they resisted paying extra for those services in their cars.

7. The ONRAMP to Tomorrow: The V2X Era

For several years, players debated whether to create systems around embedded or brought-in technology and services, and that debate drove the scope of the connected-car ecosystem and the struggles over value capture. The last couple of years, however, have seen the development of a “hybrid model” that combines the two and opens the door to the introduction of a host of applications and opportunities for value capture.

High-tech innovation from outside the automotive world is bleeding into it, making the current period one of intense activity and excitement, with many new entrants, startups, VC investments, and M&A movements. It is no surprise, though, that this is further muddying the ecosystem’s waters. At the heart of these hybrid solutions are multiple sensors embedded not only in the vehicle itself but in all manner of smart devices across the IoT landscape from wearable’s and Dedicated Short-Range Communications devices to smart-home gadgets to infrastructure that can communicate with and share data with the vehicle through what is being called V2X integration.

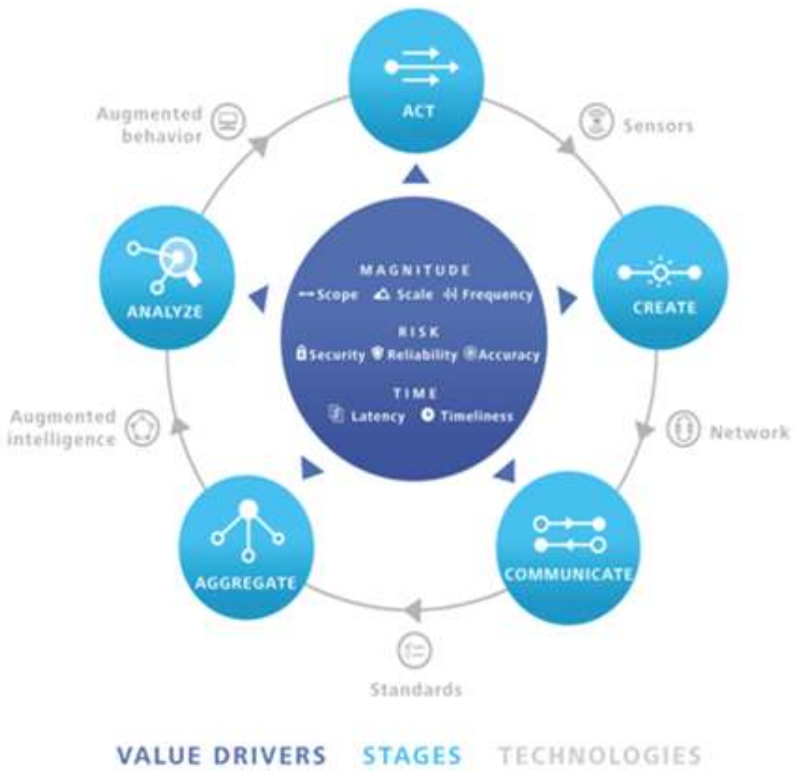

Figure 2 Information Value Loop

The breadth of devices and sensors available create a tremendous scale of data based on a wide scope of detected events, and that in itself is responsible for much of the value being seen in this phase. An IoT system can communicate the generated data to a common platform, where it may then be aggregated with data originating from other sources, including third-party content and social media, and analyzed, generating a response that is then delivered through the vehicle or other designated output device. This triangulation of data coming from these myriad devices is where the greatest value lies: firstly, in making sense of the data to paint a complete picture of both the customer's behavior and the surrounding context to generate insights, and secondly, to even enable this aggregation in the first place in a way that is interoperable across devices and provides a comprehensive and cohesive customer experience. A platform that can aggregate and analyze all this data represents a complex undertaking, as it involves cooperation and collaboration between multiple stakeholders from multiple industry sectors. The aggregate and analyze stages are the real bottlenecks for this phase of connectivity, and this is what positions software providers at the center of value creation in this ecosystem, since they, and they alone, hold the wherewithal to deliver such a platform.

The increasing scale and scope of data from the vehicle and connected devices represents a tremendous revenue opportunity for the players that own and control this information, but it raises the stakes for these same players in ensuring that the data remains secure. Car hacking has grown as a concern over the last few years, with several digital-security studies revealing the dangers of vehicle security breaches: Protected personal information could be stolen; hackers could potentially even seize remote control of a vehicle, with dangerous consequences. In light of such possibilities, the players that own and operate on the data expose themselves to significant legal liability, an additional consideration that they will have to take into account as they look to establish their positions in this space. The specific characteristics of Vehicular networks favour the development of attractive and challenging services and applications is shown in Figure 3.

8. Innovations in Automotive Industry with IoT

8.1 In the Driver's Seat

IoT is making vehicles more self-aware, contextual and potentially autonomous. This trend is driven by an amalgamation of trends such as the move towards digital lifestyles, as well as the rise of smart-phones and the mobile internet.

One of the primary drivers of the connected vehicle is its ability to collect and use information from the ecosystem- including the driver, the surroundings and any other devices connected to it. It can also leverage digital information about a driver-personal and multimedia preferences and financial to medical information.

8.2 The power of Data

BMW and SAP have teamed up to create cloud-based services for a connected car, including notification alerts for drivers when they need to fill fuel. The driver receives retail coupons such as a free cup of coffee at selected service stations, based on an individual's recorded preferences. Mercedes-Benz is betting big on IoT.

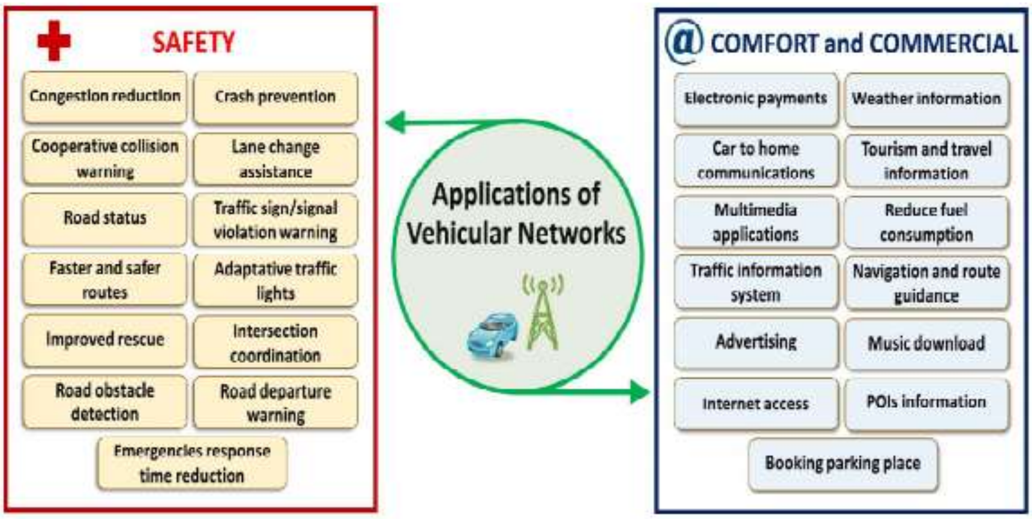

Figure 3 Challenging Services and Applications

Drivers can control several functionalities through the app- from heating and locks to navigation. For GM, connected cars By 2020, all its vehicles will be emission-free, and will feature autonomous driving and very high levels of internet connectivity. The 'me app' from Mercedes offers drivers real-time information about vehicle vitals, through smart-phones and smart watches that can communicate with the manufacturer via 4G or LTE are safer as well as more reliable. On star Corporation, a subsidiary of GM, provides subscription-based in-vehicle security, communication and remote diagnostics.

Real-time diagnostics can check the health of most important systems in cars, even while driving. By amassing data from all its vehicles, GM could detect potentially faulty parts in its vehicles, triggering a recall before an accident occurs. GM is looking to open up its databases to outside developers to produce new revenue streams. For example, an integration with Open Table could automatically load a driver's chosen restaurant address into the dashboard 30 minutes before reservation time.

Carmakers can leverage the data generated by connected cars to guide their internal decision processes. They can understand and predict customer preferences, and use analytics to support design, testing, production planning and quality assurance.

8.3 Connected Car Future

IoT is gaining traction in the automotive sector, but carmakers have only begun to scratch the surface. The reality is today cars are a combination of high-end hardware and software. Manufacturers will need to transform themselves into technology companies in order to leverage software applications, network management and analytics systems for expanding the IoT potential.

Automakers will also need to address engineering, legislative and market issues as they navigate change in an ever-expanding ecosystem of players. Standards will need to be established to ensure that data can be shared between systems and connected car applications will have to become more secure and reliable. As we move into the age of services and experience, building strategic partnerships across the value chain will be the key to delivering not just a connected vehicle, but also a holistic brand experience

8.4 Future Vision with IoT

The automotive industry is already looking ahead to the next phase and beyond: the autonomous or self-driving car. Automakers and software providers alike are pouring in R&D investments into self-driving technologies, and prototype self-driving vehicles are already on the road. As technology obviates human drivers, new interior designs for automobiles will create space and opportunity for passengers to enjoy greater productivity and personalization of experiences, while passenger data create ever-expanding sources of potential value. Self-driving cars require multiple connected technologies to work: GPS technologies to support navigation and routing; sensors including radar, lidar, high-powered cameras, sonar, and lasers that create and communicate a continuous, three-dimensional, unidirectional view of a vehicle's surroundings; sophisticated software that analyzes this information, including artificial intelligence that allows for self-learning capabilities; and technologies that translate the information collected and processed into action, including accelerating, braking, and steering.

Google's Self-Driving Car project, which the company expects to be commercial by 2020, exemplifies all of these capabilities. Google began by retrofitting a Toyota Prius with driverless technology and has moved on to its own designed prototype vehicles, with neither steering wheel nor pedals. The car is driven by sensors that can detect objects and steer around them: Google Chauffeur artificial-intelligence software processes the sensed information, predicts how these objects might behave, and makes decisions on how the car should respond. The car's self-learning capabilities allow it to identify, respond to, and learn from new situations.

The vehicle's functioning is based on its ability to respond instantly to stimuli and make decisions that drive the right response: that is, the timeliness, accuracy, and frequency of communication and processing of the information. At the same time, with little direct human control over the vehicle, security of the data communicated will be a critical value driver. And as connectivity expands and the vehicle is increasingly integrated into a broader ecosystem of other devices and infrastructure, still other capabilities will likely arise, such as smart traffic routing of self-driving vehicles, aimed at improving roadway efficiency.

The scope of the technologies involved appears to imply, as it has in the past, an expansion of the ecosystem needed to enable this Value Loop and a consequent further shift in the balance of power among the relevant players. However, the potential impacts on the automotive business model in this case indicate a more fundamental and widespread transformation of the industry itself.

8.4.1 Here's a look at what to expect in the immediate future:

- By 2020, the connected car will be the top connected application.
- In 2020, 250 million vehicles will be connected and fully packed with sensor technologies.
- Connected vehicles will produce 350 MB of data/second by 2020.
- One-third of consumer data will be stored in the cloud by 2016.
- In-vehicle software will be updated over the air through cloud connectivity.

The search to build creative applications with this data that can be sustained through business models and enable new value streams is just unfolding. Automakers are recognizing that a successful strategy is one that can be utilized across a variety of transformative scenarios. Automakers need to consider several features.

8.4.2 The technology infrastructure:

- Secure two-way vehicle communications through a hybrid cloud that scales to tens of millions of vehicles across the globe
- Globally distributed cloud data centers that are in compliance with consumer privacy laws, which vary internationally
- Per-vehicle pricing to alleviate large up-front costs

8.4.3 The platform:

- Delivered through a cloud-based, hybrid cloud-based or on-premises solution

- Built on open standards supporting a range of industry protocols and integration with third-party services
- Supplies a rich set of analytical tools to handle data streaming, modeling and reporting along with image and natural-language processing

8.4.4 Large use-case portfolio development flexibility:

- Designed to enable a nearly limitless set of use cases through V2X electronic data interchange
- Utilized in a recipe-based interface that quickly wires together data, logic and business rules
- Sophisticated automotive use-case solutions such as advanced driver assistance systems (ADAS) and detailed, multilayered map technology with support for multiple vendors, providing real-time insights on vehicles and usage for autonomous driving

8.4.5 Differentiation:

- The ability to quickly showcase advanced technology, appealing to today's consumer and balancing time to market with the latest technology
- Integration across the platform, use cases and infrastructure to deepen the overall touch points for consumer engagement

9. Conclusion

The Internet of Things consists of Smart Things. Smart Things are playing an active role in our everyday life, and these applications are fabulous and countless. They are not only into our domestic applications, but also into business and industrial applications comprising of manufacturing, chemical, productions, medical, pharmaceutical, Research & Development. In addition the applications are spreading into other sectors like government, education, mining, geo-spatial and disaster management. The best part of Smart Things is that they are bringing the quality of life to human beings, operational efficiency and handles the situations where human being intervention is not at all possible. In the future, we need to focus more on Smart Things in terms of development, deployment, architectural, global level standardization, and ethical issues. We also need to concentrate on network communications protocols, as much trillions of smart devices or objects are connecting to the virtual world. Security is one more aspect, when things are communicate among themselves, which are not having intelligence power except via AI. Let us develop useful, harmonious Smart Things for easy, happy and secured life.

In the Internet of Things (IoT), formerly unconnected devices are wirelessly linked to the Internet so that they can report and collect data or automate systems. It's fairly clear that the IoT will soon be a multitrillion-dollar business. Connected cars, autonomous driving systems, artificial intelligence, cloud computing, and a host of other technologies are driving huge changes for carmakers, and the IoT has a hand in them all. By 2020, consultancy Gartner estimates that nearly 250 million cars will be connected to the Internet and Price Waterhouse Cooper forecasts that the connected car market will be worth $149 billion by that year.

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