Smart Cars and the IoT

August 2014

Innovation at the Automotive Ecosystem Edge

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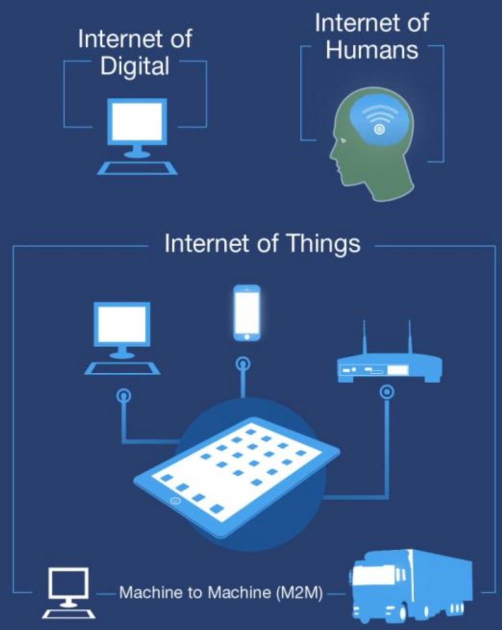

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INTRODUCTION

The connected vehicle automotive segment is at the intersection of the Internet of Everything (IoE), the Internet of Things (IoT), and the Internet of Humans (IoH), concepts that are defined and explained in the ABI Research White Paper "Internet of Things vs. Internet of Everything – What's the Difference?" From a vehicle-centric perspective, connected vehicles firmly belong to the M2M space, with remote diagnostics and over-the-air software updates as the signature services. But from a driver perspective, the links with the IoH and the Internet of Digital (IoD) are clear, respectively, through interactions with the embedded automotive HMI and the digital lifestyle brought into the vehicle *via* the smartphone. The focus of this white paper is the transition from M2M to the IoT, with vehicles scanning and interacting with their environments and applications, bringing synergies across and among different verticals and industry sectors.

The emergence of the IoT constitutes a disruptive and transformative environment characterized by value chain and business model upheaval and a "collaborate or die" ecosystem friction reality. It is prompting the automotive industry to redefine and reinvent itself in order to capitalize on the huge opportunities of this key vertical in the new IoT economy. The absorption of the automotive industry in the wider IoT is driven by new connected car use cases, such as electric vehicles (EVs) as a mobile grid and vehicles used as delivery locations. As this IoT revolution unfolds, automotive innovation and value creation will shift to the boundaries with other industries.

Cognitive, self-learning, and artificial intelligence (AI) systems will be key enablers of these new automotive IoT paradigms in the next frontier in automotive. Benefits will be huge in terms of both new functionality and cost savings.

AUTOMOTIVE IOT PHASES

The automotive IoT transition is evolving across four major phases. Connectivity and sensors progressively enable passive monitoring, interaction, ambient awareness, and automation.

Passive monitoring essentially consists of traditional telematics capabilities, such as emergency calling, roadside assistance, stolen vehicle tracking, and remote diagnostics, all of which are only activated after an event like a collision or a breakdown has happened. As such, they are reactive and passive in nature.

The second phase has added an interaction component. It allows the remote control of a vehicle through a smartphone and adds infotainment inside the vehicle, mostly through smartphone integration.

The transition to phase 3 will allow vehicles to be aware of what is happening in the immediate vicinity through Advanced Driver Assistance Systems (ADAS) sensors or even through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I). Phase 3 will have a major impact on safety, but will also result in big data collected by vehicle sensors to be shared on a wider scale, resulting in new services, such as micro-weather information.

The fourth phase introduces automation by making vehicles independent through autonomous and driverless cars. This will have a disruptive impact on transportation in terms of declining vehicle ownership in favor of car sharing (*e.g.*, Car as a Service (CaaS)).

Phase 1

Passive Monitoring

- Stolen Vehicle Tracing
- Asset tracking
- Diagnostics

Phase 2

Interaction

- Remote Control
- Infotainment

Phase 3

Ambient Awareness

- Cooperative systems (V2X)
- Predictive analytics & Prognostics

Phase 4

Automation

- Robotic cars
- Car sharing

CONNECTED CARS AND OTHER IoT SEGMENTS

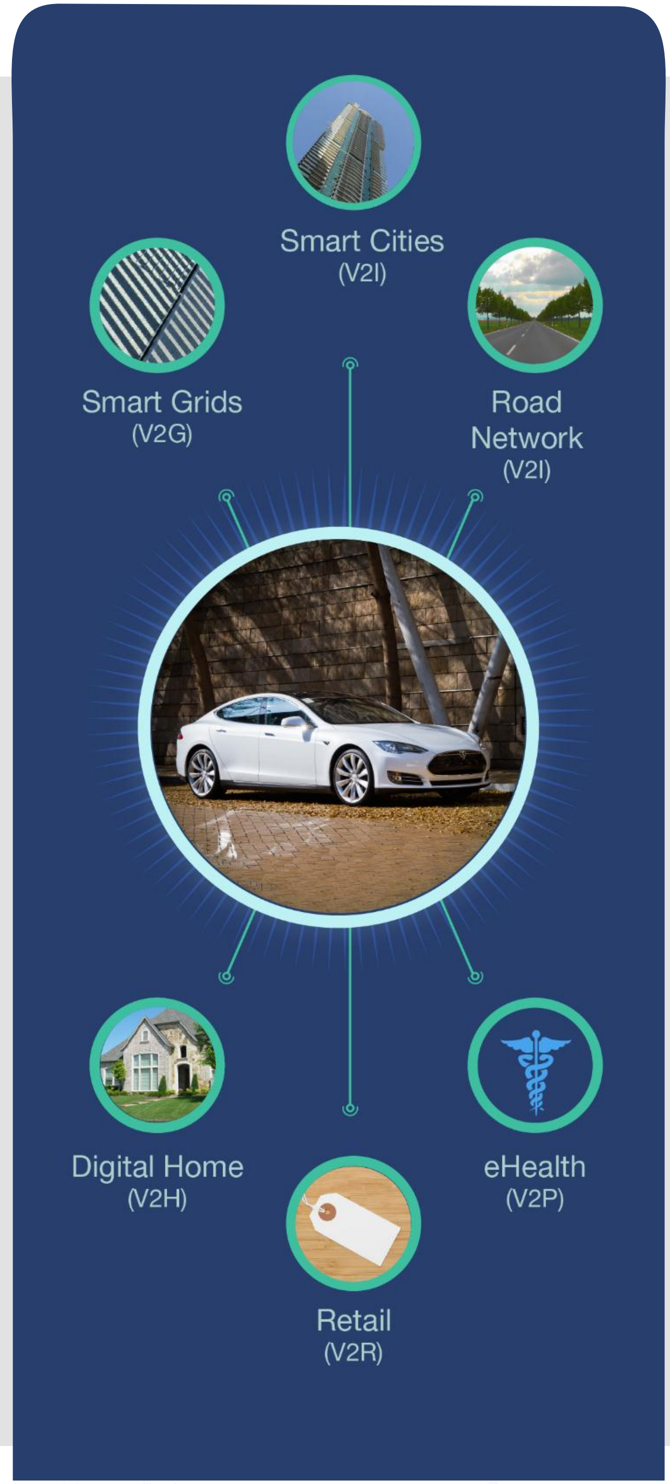
A defining characteristic of the IoT, as opposed to M2M, is the trend toward applications running in more than one vertical or segment, binding the IoT and the connected world holisticly together into one configuration. It is important not to just see it as cars merely interacting with objects or systems in other industries, but also cars taking on capabilities from other areas, such as healthcare and electric power storage, and consequently, new use cases. In this way, vehicles will be absorbed by and merged into the wider IoT.

Vehicle-to-Home

Vehicle-to-home (V2H) applications include a wide variety of services, the most important being remote home control and automation for heating, security (door locks and surveillance cameras), and appliances. Other V2H services include vehicle data uploads and downloads, and energy applications, such as crowd charging and the use of EVs as backup power sources for homes. Examples of V2H initiatives include Mercedes-Benz’s partnership with thermostat vendor Nest; home security vendor ADT’s Pulse application made available for Ford SYNC; and Toyota’s partnership with Panasonic.

Vehicle-to-Grid

Electrification is a key new paradigm in an automotive industry that has relied on combustion engine-based powertrains for more than a century. However, the EV and plug-in hybrid reliance on recharging infrastructure presents a huge opportunity for vehicle-to-grid (V2G) services, whereby vehicles communicate with the power grid to access demand-response services and be informed about the availability of renewable energy.



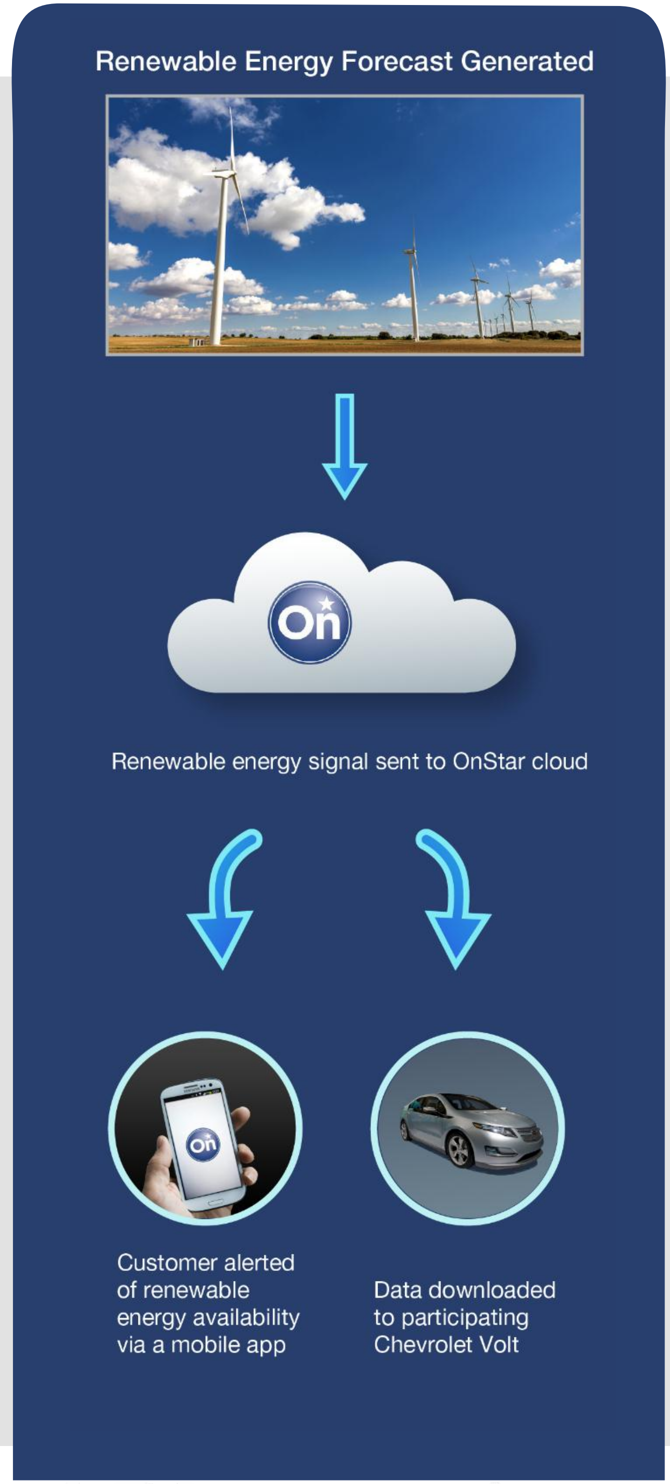
Excess EV rechargeable battery capacity can provide power back to the e lectric grid in response to peak load demands, while the same vehicles can recharge during off-peak hours at cheaper rates, while helping absorb excess nighttime generation (peak and dynamic load leveling). EVs will become an integral part of power utility systems, as these evolve from centralized generation and predictable consumption locations, toward distributed generation and consumption systems, especially as wireless charging equipment becomes embedded in roads in the future. As such, the relevance of EVs goes far beyond merely offering a new sustainable power train. GM, Toyota, and Ford are actively involved in V2G projects.

Vehicle-to-Person and Healthcare

In-vehicle healthcare monitoring is explored either *via* wearables like Nissan's Nismo smart watch or *via* embedded healthcare sensors as demonstrated by Ford. Biometric parameters and conditions monitored typically include heart rate, blood glucose levels, blood pressure, asthma, and allergies. Pedestrian detection is a special case of vehicle-to-person (V2P), whereby connected cars communicate with pedestrians to avoid casualties. Qualcomm recently announced a Wi-Fi chipset solution supporting DRSC, which could be used for this very purpose.

Vehicle-to-Infrastructure

V2I services allow vehicles to communicate with connected road infrastructure, such as traffic signs, digital signs, light poles, and parking spaces, for a wide range of applications, including traffic signal violation warnings, bus priority signal control, adaptive lighting, green-light optimum speed advisory (GLOSA), and bridge and parking structure height warning, many of which are critical for smart cities deployments. While IEEE 802.11p-based connectivity has been touted as the standard of choice for V2I (as part of the DSRC standard), other technologies will also play a



role, such as Bluetooth low energy for parking sensors or as roadside traffic probes, low latency 4G LTE cellular, RFID, and radar and machine vision systems. While most regulatory and commercial efforts currently focus on V2V (U.S. mandate and CC-C2C consortium in Europe), these initiatives will be extended to V2I.

Vehicle-to-Retail

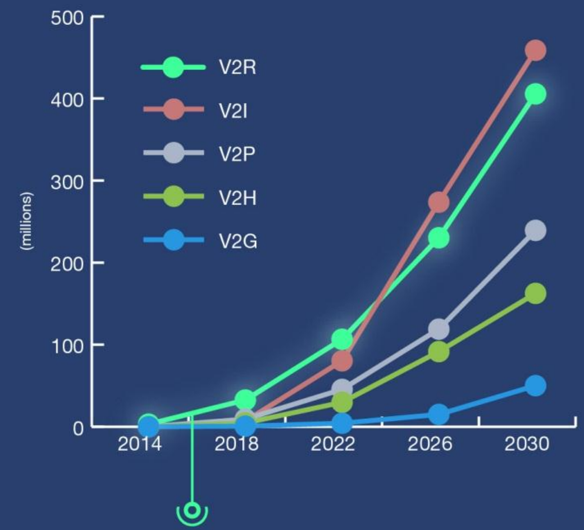
One of the main use cases for vehicles, apart from commuting, is transportation to a shop or shopping center. The retail industry has been exploring presenting drivers with location-based advertising or even coupons while driving in the vicinity of a shopping mall. Similarly, applications to book restaurants have been quite popular. At CES 2014, Ford announced a partnership with Domino's Pizza, allowing registered users to place their saved Easy Order from their SYNC-equipped Ford vehicles through a voice interface.

Interestingly, and unexpectedly, car OEMs are exploring other vehicle-to-retail (V2R) applications. Volvo has set up its Roam Delivery trial, which allows delivery companies to locate and unlock a connected vehicle to deposit an item purchased online.

FORECASTS

On a global level, V2R applications will be adopted first, followed by accelerating V2I. V2P, and V2H, which will enjoy average uptake, while V2G applications will remain limited due to the slow adoption of EVs. V2I and V2R will be the dominant segments with 459 and 406 million vehicles, respectively, featuring smart car IoT applications by 2030, followed by V2H and V2P with 163 and 239 million vehicles, respectively. V2G services will be offered on 50 million vehicles in 2030. North America and Asia-Pacific will remain the leading regions for V2G uptake, driven by strong government action to promote and/or mandate EVs and smart grids for sustainability reasons. North America is also the leading region for V2R due to its advanced state of retail

Registered Vehicles with IoT Application by Type
World Market, Forecast: 2013 - 2030



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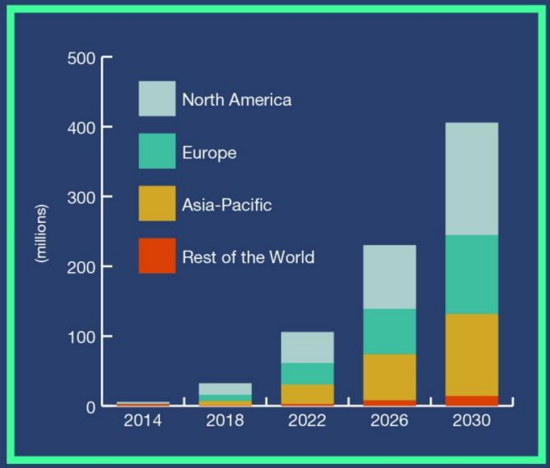


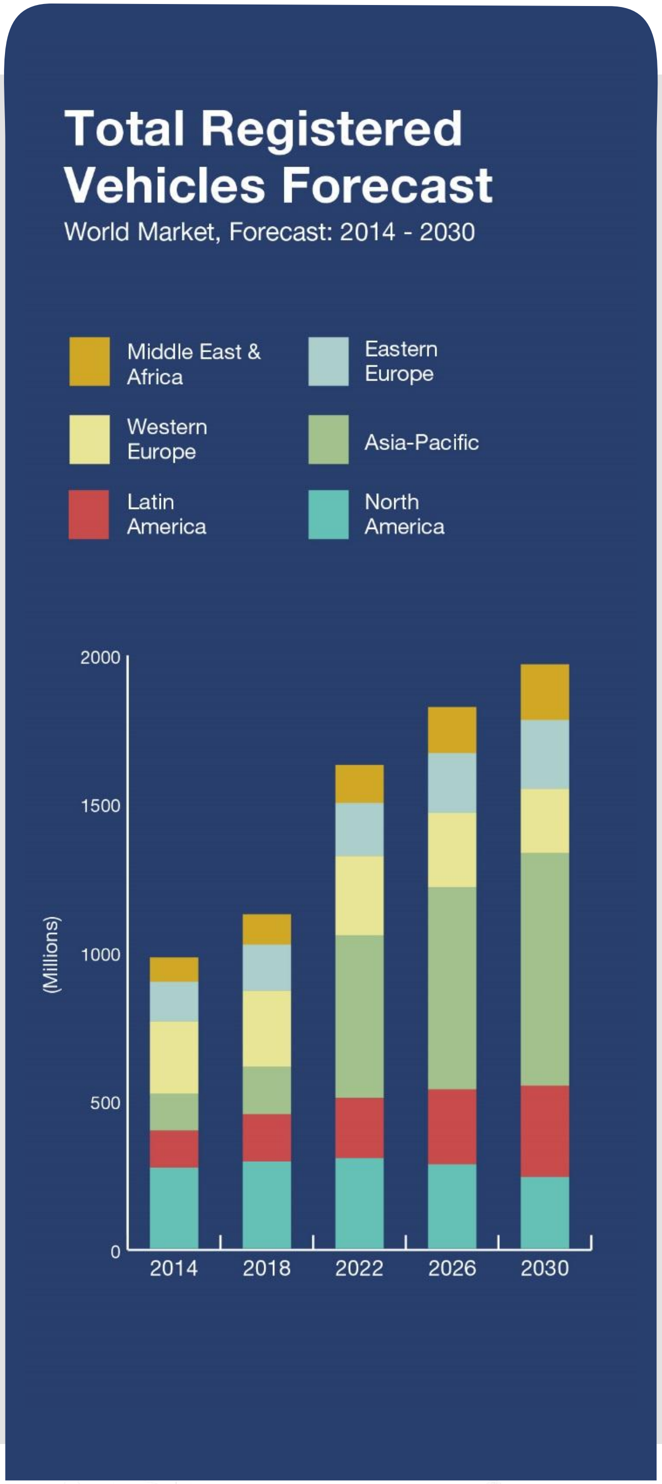
technology and advertising approach, and for V2H due to the combined effect of large (expected) penetration levels of both connected cars and automated homes. Driven by the overall uptake of wearables and the focus on fitness and/or healthcare, North America and Europe will be the leading regions in V2P. North America will initially be the leading region for V2I, driven by a high government focus on safety, which likely will result in a V2I mandate toward the end of this decade. Europe, followed by Asia-Pacific in a later phase, will see strong growth driven by concerns about mounting traffic congestion issues.

CONCLUSIONS

Car manufacturers, such as Volvo, Ford, Toyota, GM, Nissan, and Mercedes-Benz, are starting to explore solutions in the emerging smart car IoT application space by partnering with vendors from other IoT segments, such as Panasonic, ADT, Nest (Google), and Microsoft. While many projects are just trials, with only a few expected to launch as commercial solutions, they do provide a strong indication, even if still anecdotal, that the automotive industry is increasingly becoming aware about this new innovation frontier.

However, in order to fully unlock the automotive IoT potential, it will be critical to address a wide range of barriers, including security, safety, regulation, lack of cross-industry standards, widely varying industry dynamics and lifecycles, and limited initial addressable market sizes.

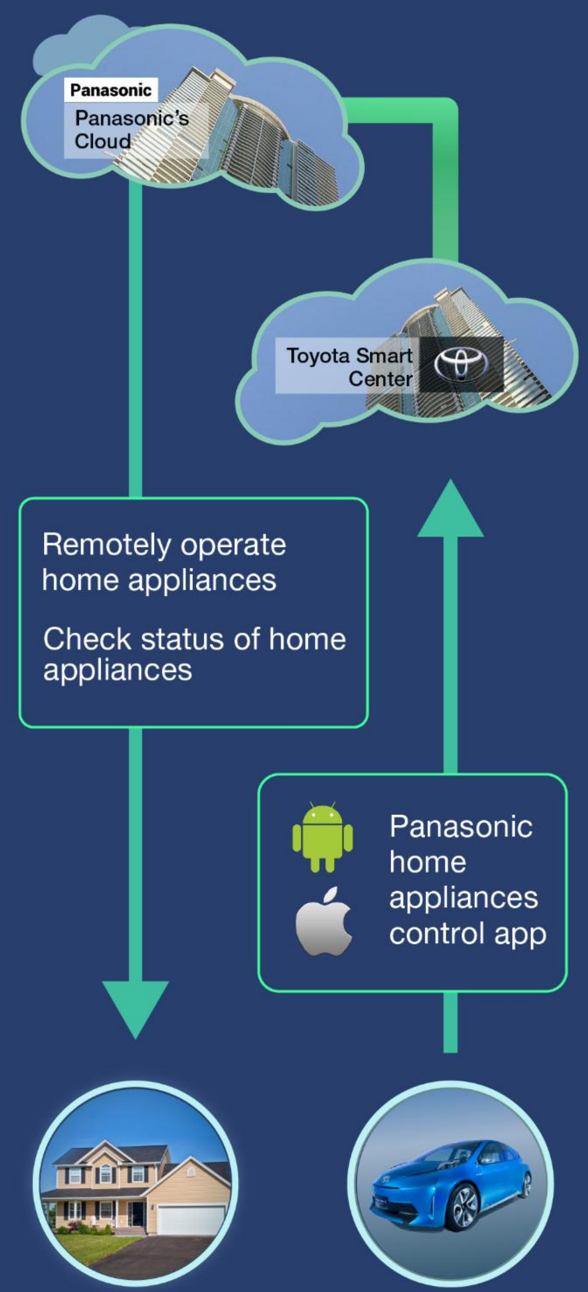
While the automotive industry is already struggling to match its own design and product cycles with those of the mobile and consumer electronics industries, which are typically an order of magnitude shorter, an IoT environment with multiple industries and verticals interacting exacerbates this issue. For example, technology lifecycles in energy and industrial segments are even longer than in automotive.



A lack of standards has always been a barrier for the uptake of new technology, but even more so in the IoT, as so many widely different industries need to cooperate and exchange data. An interesting initiative to address this fragmentation is AllJoyn, initially launched by Qualcomm, but now managed as an open source initiative by the Linux Foundation, and recently also attracting interest from automotive players. With many M2M solutions relying on private clouds, mechanisms to connect isolated clouds will prove important to unlock the potential of the IoT. Similarly, providing open APIs to facilitate cross-vertical innovation will also be a key enabler.

For most smart car IoT applications, the addressable market is the intersection between the subsets of connected vehicles on one hand, and a particular connected industry vertical on the other hand. For a smart car IoT application to be available, the double condition of the car being connected and, for example, the home being equipped with a home automation system is required. This problem is compounded because, initially, with low penetration rates on both sides of the equation, the likelihood of a connected car owner also owning a connected home is very small, though early adopters can be expected to embrace IoT solutions in different segments simultaneously. One way to mitigate this issue is by engaging in cross-marketing efforts, promoting home automation to connected car owners, and *vice versa*. In any case, with rising penetration levels, the addressable market for smart car IoT services will rise exponentially.

Open connected platforms and in-vehicle smartphone application integration are strong drivers and unifying technologies for deploying cross-segment IoT applications by a developer ecosystem, which is just starting to realize the innovation and value creation opportunities that lie hidden at the boundaries between the IoT segments and the monetization possibilities offered by cross-industry synergies. Ultimately, the success of the IoT will, to a large degree, depend on bringing all hitherto isolated connected ecosystems together into a seamless universal framework, in turn, providing essentially unlimited scope and scale.



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