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IN 30 SECONDS

- Software-over-the-air technologies enable automotive manufacturers to fix, maintain and improve vehicles through remote software updates downloaded to the vehicle from a cloud-based server.
- Such technology can deliver both costs savings and revenue gains for manufacturers, while also improving the customer experience and brand, with fixes, modifications and improvements applied quickly and conveniently.

Software-Over-The-Air: An Automotive Accelerator

Introduction

No one would dream of making a visit to their local phone shop each time their smartphone required a system upgrade or if they wanted to add an app. Instead they make the changes from the comfort of their home – or wherever else they happen to be – using a Wi-Fi or cellular network to download the software required while they wait. It's quick and effortless.

Now this functionality is coming to your car. By 2022, analysts expect automotive companies to be making 100 million updates a year to customers' vehicles using software-over-the-air (SOTA) technology¹. Those updates will span every aspect of the vehicle, from infotainment and telematics services to acceleration rates and parking controls.

This shift reflects the ever-increasing reliance on software in today's vehicles – including the autonomous and electric vehicles that account for an increasing proportion of the industry's production.

Indeed, the modern connected car now has 100 million lines of code according to BearingPoint's research² - which is more than the space shuttle, an F35 jet and the Hadron Collider combined. Cars in need of fixes, upgrades and maintenance are as likely to require attention to their software as something mechanical; in which case, SOTA negates the need for a trip to the garage.

SOTA technologies appeal to automotive companies and drivers alike. For vehicle owners, they represent a far more convenient and speedy way to have problems fixed or to make modifications and improvements. Why drive to a dealership, wait for an engineer and a service bay to become free, and hang around while the software update is completed when you can get exactly the same result by downloading the right software at home?

For manufacturers, SOTA offers a range of attractions. Vehicles that develop problems while still under warranty – a significant cost for many firms – can be fixed remotely, saving considerable sums. Indeed, IHS's work suggests SOTA could save the automotive industry \$35bn a year by 2022. Then there is the possibility of revenue gains, as manufacturers develop upgrades or new features that can be sold to vehicle owners and delivered via SOTA. And safety issues will be important too, with SOTA avoiding the need for large-scale recalls.

All of these will become more essential as the shift to autonomous self-driving vehicles continues. Not only will these vehicles be far more dependent on software but another problem could pose major safety concerns as well: the fact that SOTA offers a means to update and correct rapidly will be crucial.



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No wonder manufacturers are now racing to embrace SOTA technologies. Since Tesla launched its Model S in 2015 – with onboard Wi-Fi and an electronic architecture allowing every line of code to be changed over time – other leading automotive companies have been playing catch-up. For example, Porsche will use SOTA technology in its upcoming Mission electric vehicle³; Ford has begun SOTA-enabled updates to its interactive touch-screen systems⁴; Volvo is building SOTA capability into its new vehicle architectures⁵ and BMW⁶ and Toyota⁷ are promising the same.

There will be issues to overcome. Manufacturers worry about SOTA security, are wary of safety issues when trialling new technologies, and acknowledge the possibility of a backlash from dealers concerned about losing service revenues. Still, the potential gains from SOTA are so attractive that these barriers will be surmounted: as vehicles become ever more software-dependent, SOTA will become ubiquitous.



SOTA DEFINED

- Software-over-the-air means that files are downloaded to the vehicle having been sent from a cloud-based server across a Wi-Fi network or mobile network – either direct to the vehicle, or to the owner’s device and then uploaded, for example through a Bluetooth connection.
- SOTA is typically downloaded as a ‘delta’; rather than sending a full software installation file (a ‘full image’), the manufacturer sends only the part that needs to be changed. This can decrease the download time and reduces the manufacturer’s distribution costs.
- The combination of a software delta file and security credentials specific to the vehicle – crucial for both onboard and offboard - is called an ‘update package’. The package may contain several delta files, to update different modules on the vehicle. SOTA must be hack-proof: car manufacturers need to ensure that only appropriate updates get applied to their vehicles.
- Updates that can be sent this way include changes to the software that controls the vehicle’s physical parts, its electronic signal processing system, or user interfaces such as infotainment screens and instrument clusters.

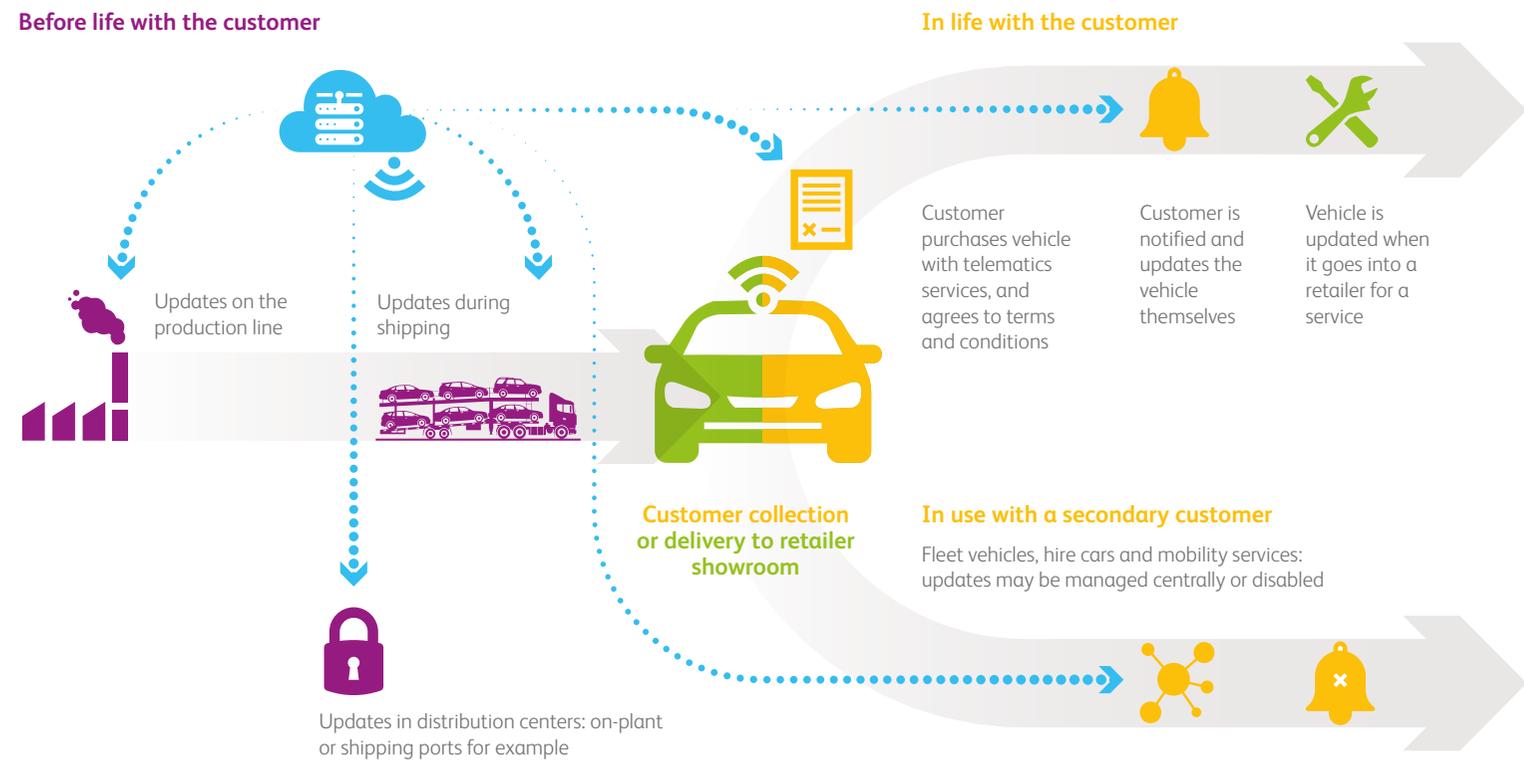


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Vehicle timeline: SOTA updates can be divided as 'before' or 'in life' with the customer

Updates can be performed at different stages in the vehicle lifecycle, each with unique challenges



Source: BearingPoint Institute



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SOTA in practice

As automotive technologies continue to develop, the drivers for SOTA will continue to multiply. But there are already a broad range of use cases:

- **FIX:** Manufacturers will replace previous recalls with SOTA updates to remedy safety or compliance issues – a faulty airbag sensor, say. This will enable them to meet their legal and regulatory responsibilities more quickly and cost-effectively than through calling vehicles in, and ensure drivers do not have to stop using their vehicles.
- **IMPROVE:** Manufacturers will also issue non-recall SOTA updates where there is an opportunity to improve quality – to reduce a vehicle’s fuel consumption, perhaps.
- **MAINTAIN:** Manufacturers will be able to use SOTA to ensure services remain up-to-date – with new navigation maps for the vehicles infotainment system, for example, or updates to autonomous vehicles.
- **EXPAND:** In some cases, manufacturers will offer commercial products via SOTA, giving customers the opportunity to purchase upgrades – a system to improve acceleration, say.

- **LEARN:** SOTA can support two-way information exchanges. Collecting data from vehicles for manufacturers’ analytics tools can support prognostics and tuning – perhaps to prevent failures by applying software tuning – R&D for future vehicles, promote better customer experience, and underpin sales.

Each of these use cases offers benefits. Using SOTA to fix vehicle problems will be less costly operationally and will help protect the manufacturer’s brand. Improve, maintain and expand use cases offer manufacturers cost savings over traditional delivery mechanisms, but they can also support revenue gains, both directly from sales of new services and features, and from increased future vehicle sales as customer satisfaction grows. The opportunity to use SOTA to learn, meanwhile, should provide manufacturers with valuable customer and marketplace insight, crucial for future competitiveness.

Importantly, SOTA will be a key technology for manufacturers prior to the sale of vehicles, as well as after customers have driven off the forecourts. Software updates may be issued when parts have been shipped to assembly plants, while vehicles are in transit, or once they arrive

SOTA will be a key technology for manufacturers prior to the sale of vehicles, as well as after customers have driven off the forecourts

with detailers. In each case, it may be necessary to fix, improve or maintain the vehicle even before it is sold

Planning for an end-to-end SOTA process

While SOTA represents a huge opportunity for the automotive sector, putting the technology into practice will require manufacturers to redesign end-to-end processes for releasing new software updates.

Simply to get to the stage where new software is available for release will impel manufacturers to address some key questions: for example, how to identify the need for software updates, how to design and build software for delivery in this way, how to time updates, and how to identify innovation opportunities that SOTA technologies enable compared to existing processes. In addition, the



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software will need to be extensively tested – including trialing of its release using SOTA.

Where manufacturers are releasing software to vehicles already sold, focusing on the customer experience will prove crucial. This will require many manufacturers to develop new competencies, given that customer-facing tasks have traditionally been carried out by dealers and retailers. Some manufacturers may even be lacking the customer data they need to keep track of vehicle locations and the current status of in-vehicle software.

Not only will manufacturers have to work out how to run campaigns that maximize take-up of updates by customers, but also, they will need to develop secure

and reliable delivery infrastructure built on cloud-based servers with sophisticated cyber security controls. Another consideration is how to prioritize updates: safety issues will clearly need to be addressed first, while legislative imperatives are likely to supersede other initiatives, including commercially driven initiatives.

Nor can manufacturers rest on their laurels once the update has been delivered. They will need to review customer penetration rates carefully. Customers who fail to download the update may suffer technical issues with their vehicles. And how will manufacturers respond when a customer does not (or cannot) install a safety- or security-critical update?

Indeed, unless manufacturers plan for these customer experience issues, crafting their SOTA solutions according to customer behaviors and environments, they risk missing out on some of the dividends available from the technology, particularly if satisfaction levels are adversely affected. For example, they will need to consider how to adapt interfaces for different types of users. Data protection will be crucial, both for customer confidence and to avoid regulatory or legal breaches. How update failures are dealt with will also be critical – manufacturers cannot afford to leave customers stranded or without their vehicles because of an update problem, so support services will be needed.



SOTA ISN'T ONLY FOR AUTOMOTIVE

While the automotive industry is embracing SOTA space, these technologies have applications in many other industries. Some use cases are already well-established with smartphone, tablet and PC manufacturers now using SOTA routinely to provide system updates or to deliver new services, some of which customers are happy to pay for. Other use cases, however, are just emerging.

In fact, SOTA can be a game changer in any industry that relies on technology incorporating software – that's most industries today. There are exciting possibilities in areas such as building management, security systems and estates, as well as healthcare and across the manufacturing and industrials space.

In the retail sector, too, SOTA is beginning to excite leading companies. It offers the opportunity to upgrade point-of-sale equipment quickly and cheaply; for example, supporting advances in payments technology and the customer experience.

Similarly, devices for ideas such as smart cities and the internet-of-things depend on increasing numbers of sensors and local computing devices installed in diverse places that would be expensive to update manually. Examples range from cars talking to traffic lights and other sensors in the roads to smart-homes with garage doors that automatically open as your car approaches. For these scenarios, SOTA is the only way to create a sustainable ecosystem of updatable communicating technology.

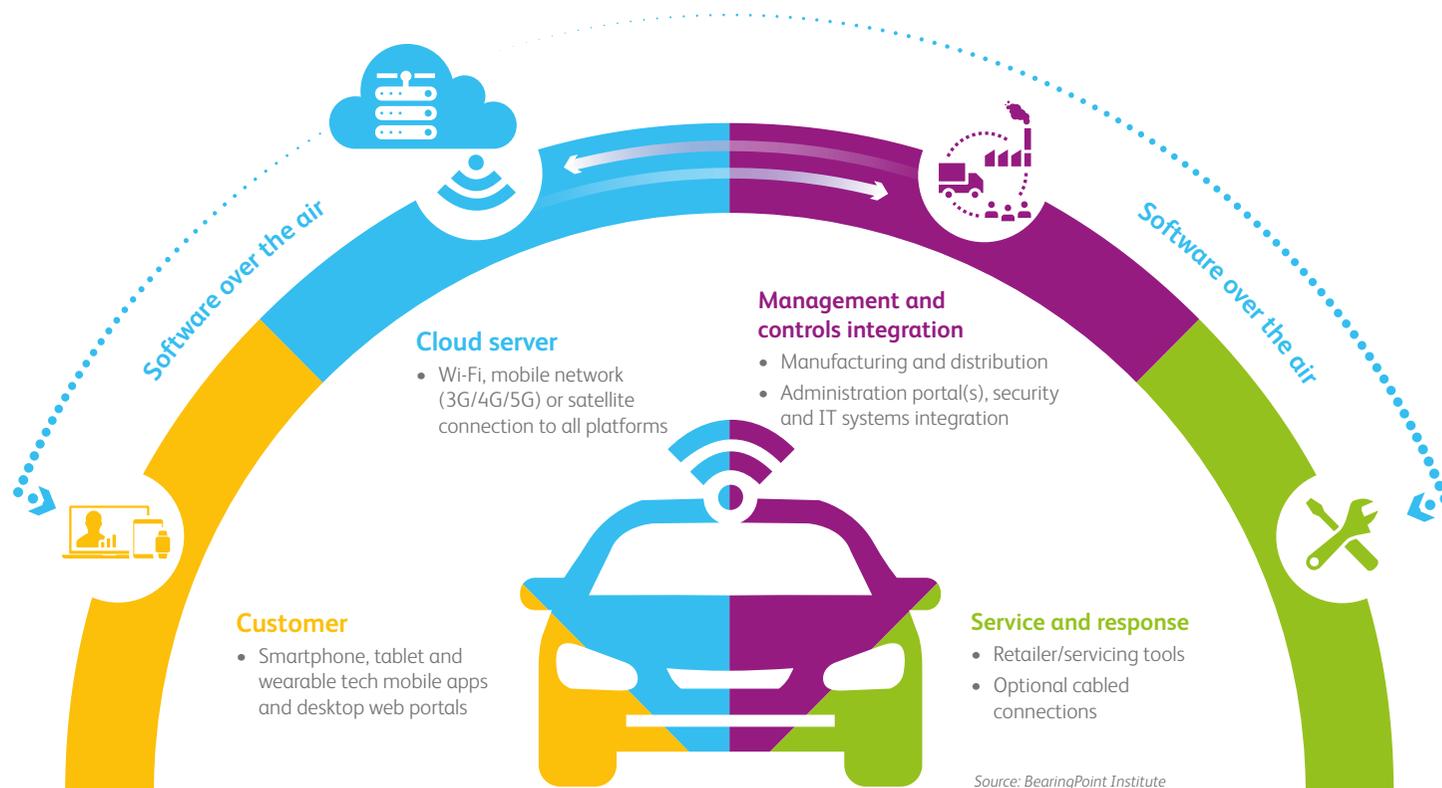


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Software over the air (SOTA): connecting customers, vehicles, retailers and the automotive OEM

The OEM now has a direct bridge to the customer through the vehicle's life offering opportunities for reduced warranty costs, increased revenue from aftersales, stronger customer relationships and fast analytics to support research and product development



Source: BearingPoint Institute



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Key SOTA challenges and how to solve them

While SOTA offers exciting opportunities, delivering solutions effectively will require manufacturers to resolve technical issues and make the case for the technology to customers. There will be a host of challenges to overcome.

Developing technical capabilities

Connectivity will be a significant issue. Vehicle owners' ability to download large updates may be limited by the loss of mobile network signals or poor Wi-Fi connectivity when the vehicle is in use. Further, satellite connectivity may be expensive for some customers. Manufacturers will therefore need to be imaginative: it may be necessary to send updates to devices sticks or smartphones, from which customers can upload updates via Bluetooth.

Manufacturers also need to think hard before issuing updates that require the vehicle to be immobilized for a period, as it risks inconveniencing customers, particularly where the installation takes time. Some manufacturers are now exploring the use of dual memory banks, where updates are downloaded into one area of memory while the original software is retained in another area to

When managing software updates, it will be vital to account for dependencies: updating one module may mean updating others to ensure they remain compatible

continue powering the vehicle until the new version is available.

Battery management must also be addressed: if the software is installed while the vehicle is immobilized, there will be no power supply from the engine and the battery may be drained during lengthy updates. Conventionally fueled vehicles may need to be fitted with charging plugs to overcome this issue. Manufacturers may also want to give customers more control over how updates are managed.

Another issue is that modern, connected cars have many electronic control units (ECUs) all containing software. Often, software in one ECU is dependent on software in other units, as these modules talk to each other to get things done. For instance, the sensors on the car may communicate with the module controlling cruise control so it can update its speed appropriately. When managing software updates, it will be vital to

account for dependencies: updating one module may mean updating others to ensure they remain compatible. The management of these dependencies and SOTA campaigns for performing updates requires its own system and governance across the different teams in the organization responsible for the various modules.

More broadly, the automotive sector will need to rethink its development models. Agile software development is a poor fit with the protracted timeframes of automotive engineering, and manufacturers will need to think about the memory requirements likely over the next 10 to 15 years. In practice, it will be necessary to decouple software development from the vehicle program – updates can be pushed in small batches following production. Be prepared to embrace different corporate cultures – SOTA development may require a “start-up” business mindset.



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Providing a positive digital experience

Cost will be a crucial question to address, with customers accustomed to receiving free updates of software on their phones, for example, despite the expense of developing these improvements. Customers are also likely to balk at high mobile data charges. In practice, safety and security critical updates will have to be free, as will improvements made during warranty periods. However, manufacturers will need to decide for themselves when and how to charge for new services and improvements, which may help to sharpen brand differentiation.

Equally, how will manufacturers manage their relationships with vehicle owners to ensure consistency of messaging and good adoption of SOTA-delivered updates, particularly where packages are inter-dependent? Developing a single customer relationship management system will be important.

That system will need to incorporate robust legal and compliance procedures. While standards are not yet well-defined

Developing a single customer relationship management system will be important for manufacturers

across the sector, regulations are swiftly evolving and manufacturers will need to be on the front foot. Good record-keeping will be vital to ensure customer permissions are sought, received and tracked, but manufacturers will also need to be conscious of data protection laws, including the European Union's new GDPR regulation. On another note, independent garages will need access to SOTA offerings to comply with the right to repair regulations.

Above all, safety concerns must be paramount – both vehicle safety and cyber security (see box-out below) – with rigorous testing to mitigate the risk of an update crashing the vehicle's systems or introducing dangerous faults.



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Engaging with customers

As SOTA adoption rates rise, many manufacturers will be moving into uncharted territory, with respect to engaging with customers in new ways. They will need to offer a choice of channels – in-vehicle, users’ own devices, or traditional retailers – and to develop interfaces to engage a range of different demographics. The right delivery mechanism may vary from market to market, depending on local connectivity capabilities.

Data analytics tools can help manufacturers to model campaigns, learning from each update process to improve future take-up rates and to understand where and how failures occurred. Moreover, analytics can help manufacturers decide which updates should be offered to only certain market segments – in some cases, new features and services are likely to see poor take-up in specific geographies or demographics, undermining the case for providing them.

Over time, manufacturers will need to think about how to influence customer behaviors. Free upgrades offered alongside routine maintenance may encourage greater take-up of all SOTA offers; for example, offering an easily accessible charging point for vehicles with internal combustion engines could overcome power and battery issues during installations.



PUT SECURITY AT THE HEART OF YOUR SOTA STRATEGY

Concern about security is a clear obstacle to SOTA adoption, since the technology introduces a range of new risk points. Third-party software, cloud-based services, communication channels and onboard diagnostics functionality all pose attractive targets for malicious hackers with a range of motivations.

Standard risk mitigation strategies will certainly be important – from pen-testing to on-boarding hardware security modules. It will be vital to make sure technical updates do not actually cause problems - by undermining the alarm system, for example, or disabling vehicle tracking.

However, manufacturers will also need to understand customer behaviors and to build security into their engagement processes. Hackers will seek to circumvent technical solutions using customer-focused attacks such as phishing scams and fake calls.

Security testing should be integral to every part of the end-to-end SOTA process, from checks on third-party software, to the uploading of the update to the cloud and the final release to vehicles.



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Conclusion

SOTA technologies represent a huge opportunity for automotive manufacturers, with a clear route to cost savings, especially during vehicle warranty periods; revenue gains, from sales of new features and services, and a more engaged relationship with customers.

The imperative to move towards SOTA comes from the trend towards autonomous, connected and electric vehicles in the automotive sector. As these vehicles use ever more complex hardware and software infrastructures, manufacturers will need a mechanism for fixing, maintaining and improving every aspect of vehicle performance.

While manufacturers’ capabilities are yet to fully evolve – and the industry lacks agreement on consistent standards – early adopters will secure key competitive advantages. However, the infrastructure required for large-scale implementation of SOTA technologies will be considerable, and automotive companies must find a way to integrate these tools with existing systems. Confronting the security challenge head-on will be another piece of the jigsaw to get right.

For a sector that traditionally works to lengthy development timelines, planning new vehicles for years before launching

While manufacturers’ capabilities are yet to fully evolve – and the industry lacks agreement on consistent standards – early adopters will secure key competitive advantages

them on the market, agile software development with new functionality rolled out incrementally and regularly, may feel uncomfortable. In this regard, it will need to be decoupled from vehicle design.

Undoubtedly, however, SOTA will be an integral element of the automotive sector’s future. Successful manufacturers will design SOTA functionality into their vehicles and processes, rather than trying to retro-fit it, or add it on.

How BearingPoint can help

Globalization, digitalization, uberization, platform economy: four words to describe the environment in which CEOs are driving their companies. The accompanying IT transformations are often very complex undertakings with extensive risk for the competitiveness of the business. With a higher pace of change due to increasing technological disruption, the conversion of thought

leadership into concrete results can make the difference between success and becoming irrelevant.

By listening to our clients and really understanding their people, process and technology, BearingPoint enables clients to prepare for the future. We help organizations to innovate and develop new business models and processes to leverage technology innovation and deliver growth. We offer a range of solutions that have helped our clients accelerate growth four key dimensions: new geographies, new customers, new products/services and new business models, including digital platform business models. We analyze future trends to create a growth solution that is relevant not only for today, but more importantly, for tomorrow and beyond. ◆



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KEY TAKEAWAYS

- Software-over-the-air (SOTA) technologies enable automotive manufacturers to fix, modify or improve vehicles through remote software updates downloaded to the vehicle from a cloud-based server, reducing or eliminating the need to bring the vehicle to a service outlet
- SOTA technology offers automotive manufacturers the opportunity to reduce costs – cutting the cost of managing warranty problems, for example - increase revenues through after-sales initiatives and manage safety issues without the need for mass recalls
- SOTA technology offers vehicle owners a far more convenient and speedy way to resolve problems or to make modifications and improvements; drivers will no longer need to take their vehicles to a retailer or service outlet for such fixes
- SOTA technology will require manufacturers to overcome technical challenges such as connectivity issues, battery management and the inter-dependency of electronic control units, build customer engagement to ensure trust and buy-in, and, above all, to prioritize safety and security – SOTA technologies must not undermine vehicle safety and must be hack-proof
- SOTA technology will require manufacturers to develop new ways of working that provide an end-to-end governance model for developing, releasing and managing updates; this may require them to build new digital infrastructures



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Mark has over 22 years' experience in Enterprise Architecture, IT Strategy and Innovation. He has an MA in mathematics and computing from Oxford University. He started his career in Automotive, finding ways to exploit new technologies and software engineering techniques before moving on to Enterprise Architecture and IT strategy. After becoming chief architect for a number of firms in different industries – including a global aerospace firm, an international logistics firm, and a UK-based Systems Integrator – Mark became Chief Innovation Officer for a major SI and outsourcing firm before working on continuous improvement an IT strategy in banking and insurance and doing data warehouse and digital strategies for several central government agencies and several UK banks. Since 2012 Mark's focus has been on Connected Car, where he has worked across multiple OEMs and has been acting as Design Authority for a major OEM responsible for the end-to-end architecture of the Connected Car, working across feature owners, component suppliers and cloud-service providers.

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At the BearingPoint Institute, our ambition goes beyond traditional 'thought leadership'. We aim to contribute original ideas to the science of business management whilst equipping decision makers with practical advice gained in the field and through our research projects.

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BearingPoint consultants understand that the world of business changes constantly and that the resulting complexities demand intelligent and adaptive solutions. Our clients, whether in commercial or financial industries or in government, experience real results when they work with us. We combine industry, operational and technology skills with relevant proprietary and other assets in order to tailor solutions for each client's individual challenges. This adaptive approach is at the heart of our culture and has led to long-standing relationships with many of the world's leading companies and organizations. Our global consulting network more than 10,000 people serves clients in over 75 countries and engages with them for measurable results and long-lasting success.

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