EB cadian Sync – software updates over the air
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For vehicle manufacturers, there is hardly any alternative to updating ECUs and systems over the air. This can be attributed to a variety of reasons: The development towards highly automated driving requires frequent and regular software updates or improvements with update cycles that are as short as possible. To tackle cybercriminal threats to connected vehicles, currently identified threat vectors and new vulnerabilities, manufacturers must be able to take swift countermeasures. If a software function makes a recall necessary, this can be done faster and more cost-effectively through an over-the-air update.

The possible adding of software-based functions and features additionally opens up new business segments for OEMs and therefore gives them new sources of revenue even after the vehicle is sold. Such offers can be implemented as “Software as a Product” (SaaP) or “Software as a Service” (SaaS). They are important building blocks in automotive manufacturers’ strategies for the future. And there are other applications such as remote diagnostic jobs in selected parts of the vehicle fleet that may even allow them to predict imminent failures of components.

Still another advantage: If ECUs and systems are designed for over-the-air updates, this method can already be integrated into the vehicle’s production process. This allows the firmware of individual ECUs to be installed, for example, simultaneously with the car’s mechanical assembly. Moreover, the software up to date prior to the time of delivery can be installed largely independently of the vehicle’s specific location.

End customers expect OTA updates

Nowadays, end customers take it for granted that necessary software updates are installed over the air (OTA). They are accustomed to this approach from their smartphones and other consumer electronic devices and no longer willing to take their vehicles to the workshop for the sole purpose of having a software update installed. Another aspect is that, for the above reasons, updates are required more frequently. As a result, it becomes impractical to install updates only in the workshop – especially as customers find frequent visits to the workshop hard to accept.

With EB cadian Sync, Elektrobit provides OEMs with a reliable, scalable, flexible, and secure complete solution. It allows them to prepare ECUs and systems for OTA updates and to manage and perform updates during the vehicle’s life cycle. The solution provides the necessary tools for installing in-vehicle OTA updates. It additionally includes a secure communication channel between the cloud and the vehicle and a backend that offers a user interface for managing software versions, campaigns, and vehicles. In EB cadian Sync, the actual rollout and installation of updates, but also functions such as monitoring and testing are implemented as service (Figure 1). The solution is not limited to head units and infotainment components. It is also specifically designed for “classic” ECUs in a wide variety of vehicles. The only essential requirement the relevant ECUs must meet is to support standardized diagnostics protocols.

This is where Elektrobit’s customers benefit from the software supplier’s decades of experience in areas such as security solutions, the provision of backend services and platforms, for example, for remote vehicle diagnostics. With EB cadian Sync, updates can be rolled out quickly, easily and cost-effectively over a vehicle’s entire life cycle. In addition, it enables manufacturers to create new business and revenue models that go beyond the mere sale of the car.
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Update mechanisms as required

EB cadian Sync allows both firmware updates in ECUs that use software environments such as AUTOSAR or OSEK and application updates in ECUs where, for example, apps run on a hypervisor in virtualized environments. In AUTOSAR environments, the solution adds those functions to the software stack that are required for installing OTA software updates. And the previous AUTOSAR software environment is provided with a new platform: AUTOSAR ADAPTIVE. This platform allows dynamization of the run-time environment by reloading and logging off components. In contrast to “classic” AUTOSAR where reloading or updating a function requires a complete update of the application software, AUTOSAR ADAPTIVE, on a standardized basis, contains essential functions for the targeted update of functions and components – such as the Diagnostic Manager (DM) and an Update Configuration Manager (UCM). As Elektrobit also offers the AUTOSAR ADAPTIVE basic software and other software solutions based on it, EB cadian Sync seamlessly supports this configuration and additionally makes the conceptual advantages of AUTOSAR ADAPTIVE directly usable.

In all cases, an end-to-end encrypted communication connection between the backend and on-board components and encrypted storage of the data in both the backend and the vehicle make sure that the update data is securely transmitted and stored. This not only ensures system reliability and prevents attempted misuse, but also meets the ever increasing legal requirements for privacy and security.

The backend platform can be operated in a public cloud platform or in a private cloud of the OEM. Its architecture allows the OEM and Elektrobit to split up functional elements (for example, vehicle fleet management, authentication, and software provision at the OEM and rollout campaign management and software distribution at Elektrobit). However, if requested by the OEM, the backend can also be implemented exclusively in the manufacturer’s data center. In both cases, the required backend components can be easily integrated into existing system architectures on the OEM side.

Measures such as load balancing and using content delivery networks (CDN) allow easy scaling of the platform so that even large vehicle fleets can be provided with updates quickly, reliably, and cost-effectively. The solution is then billed per vehicle involved, which allows OEMs to use transparent and clearly defined costs for their planning.

If requested, other services such as the EB cadian remote analytics solution or security products from

![Figure 1: Required parts for a software update OTA solution](image)

- **On-board components**
  - Connectivity client
  - Update master
  - Local storage

- **End-to-end security**
  - User and role management
  - Signature and encryption services for backend operation
  - Backend access validation
  - Secure cryptographic key management
  - Communication and data encryption

- **Backend**
  - User front-end & reporting
  - Campaign management
  - Software & vehicle management
security software experts Argus Cyber Security (that are part of Continental) can be integrated into the backend's modular architecture. Founded in 2013, the company is headquartered in Tel Aviv, Israel, and has offices in Michigan, Silicon Valley, Stuttgart, and Tokyo. It is the world’s largest independent supplier of cyber security solutions in the automotive market.

**Powerful backend functions**

If multiple backend services are integrated, a uniform user interface ensures that administrators and other backend users immediately feel at home. In this way, only one platform is used for different backend-based services and use cases. This significantly increases flexibility for OEMs and noticeably reduces the integration effort for the simultaneous provision of multiple services.

The security concepts implemented in the backend platform provide functional safety, protection against cyber attacks and ensure reliable data exchange at all system levels. Elektrobit also provides round-the-clock 2nd and 3rd level support to its customers.

The user interface for the backend services of EB cadian Sync supports software version management, defining and processing campaigns, selecting and providing update packages, and managing target vehicles. It additionally offers extensive monitoring and reporting functions. Vehicle management shows the hardware, firmware, and software version of all vehicles in the managed fleet.

The platform also provides third-party software suppliers with an interface that allows them to feed software or firmware updates into the system - for distribution to the vehicle fleet. If required, rollout processes can be interrupted, continued, or canceled using the user interface. In the latter case, vehicles that have already been updated are rolled back to the previous software version.

The platform supports both differential updates where only those blocks of an application are updated that require changes and delta updates where the target application is patched to the new software version (Figure 2).

Both mechanisms save bandwidth and reduce the time required for updates.

**Customized workflows possible when installing updates**

For the workflow of OTA updates, Linux-based ECUs offer yet another advantage: In this case, the sequence of the steps before and during the installation can be customized to the OEM’s specific requirements: The update master allows the desired workflow to be modeled on a graphical user interface as a flowchart. From the thus defined sequence, EB cadian Sync automatically generates appropriate code that can then be compiled for the update master component in the vehicle. For ECUs based on the AUTOSAR environment, updating currently requires a fixed sequence.

When an update is rolled out, the connectivity client and update master software components jointly work with local memory that is used to buffer the update data. The exchange of fingerprints and crypto keys ensures that the correct update versions are installed and that the transfer takes place on a secure, encrypted channel via the content delivery network.

The update master is responsible for the basic control of the update process, generates status reports on the actual sequence and works closely with the connectivity client to download the required update data. The update slave receives the downloaded up-
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EB cadian Sync operates by first retrieving data from the update master and then performing the actual installation on the target components (Figure 3).

The concept also supports failover scenarios such as A/B updates: if update “B” causes problems when booting the ECU, the device loads the previous software version, “A”, and thus returns to a stable operating state (Figure 4).

Depending on the vehicle architecture and the OEM’s requirements, the above components such as the connectivity client and update master/update slave can be integrated into different ECUs and gateways.

**Clear benefits for OEMs**

EB cadian Sync saves costs and time over the entire life of a vehicle. These benefits start with development and production and extend to the vehicle’s use on the road. EB cadian Sync therefore increases flexibility and efficiency on the OEM side. As the OTA solution enables OEMs to offer their customers better and faster service, it also helps strengthen brand loyalty. The powerful solution can be easily integrated into existing processes and architectures and allows OEMs to fully focus on their own core competencies.
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The highly qualified computer scientist Peer Sterner began his professional career during his Bundeswehr service where he worked as an IT security officer and data protection officer among other things.

In 2011, he joined Elektrobit and held various positions, e.g. as a Product Owner or Project Manager in customer projects. He also advised car manufacturers on the subjects of vehicle diagnostics, standard software, and AUTOSAR.

Since 2015, he has been developing a product line in the fields of connected services and software updates over-the-air. He is currently a Product Manager for various software products in the areas of connected services, over-the-air software updates, and vehicle safety.
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Notes
About Elektrobit (EB)

Elektrobit (EB) is an award-winning and visionary global supplier of embedded and connected software products and services for the automotive industry. A leader in automotive software with over 30 years serving the industry, EB’s software powers over 1 billion devices in more than 90 million vehicles and offers flexible, innovative solutions for connected car infrastructure, human machine interface (HMI) technologies, navigation, driver assistance, electronic control units (ECUs), and software engineering services. EB is a wholly owned subsidiary of Continental.