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## Case Study

Over the Air: secure, streamlined, and continuous remote updating to address the dynamic, evolving needs of automotive systems.

### Challenge

Over the Air (OTA) commonly refers to the ability to download applications, services, and configurations over a mobile or cellular network. In the automotive industry, OTA updates enable OEMs to eliminate the need for software-related recalls and make software updates easy and seamless, allowing for better maintainability of the overall system. The two key categories of OTA updates for automobiles are infotainment and drive control. These updates improve the overall driving experience and are considered critical.

OTA is becoming a necessity in the automotive industry. Most recall campaigns are software related and the amount of software used in vehicles continues to increase. The complexity of the vehicles, drivers' behavior, and safety regulations mandate thorough testing to capture all scenarios that could occur while performing an OTA update for the different electronic control units (ECUs).

For the OTA update to start, the backend Server has to recognize the availability of a new software package to be downloaded. Once recognized, the OTA process starts which consists of three phases:

1. Software package downloads from the server to the vehicle, in the background.
2. Software package starts unpacking in the background, internally in the infotainment system.
3. Software Package installation process starts in the foreground.

Figure (1) describes an overview of the OTA architecture. Automotive companies must ensure the system has enough CPU power and memory so that the load caused from the downloading does not affect normal use. The in-vehicle system must have a roll-back process in case of download failure. The driver should never experience issues utilizing the system, nor any decline in performance due to an OTA update. In addition, throughout the OTA process, the vehicle must be in a *safe to drive* state. Depending on the size of the software package, the speed and coverage of the cellular network, an OTA download and system update, can take up to eight hours. Since the average commute to work is twenty-six minutes, one OTA could easily take a whole week for the average user.

In this case study, EagleTC worked together with a major automaker’s software team to conduct system level testing. We captured all phases of the OTA update for their infotainment systems, across all of their vehicle lines.

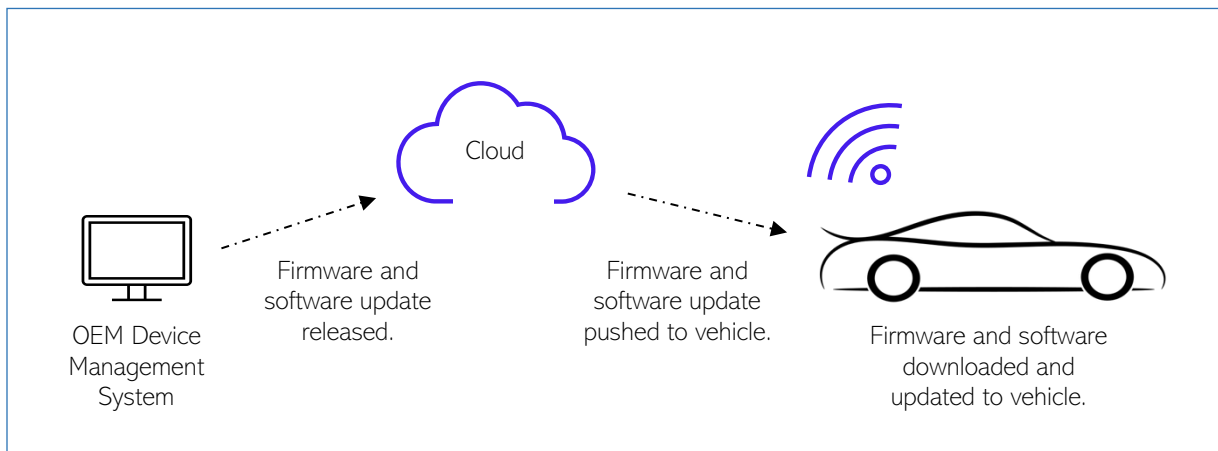


Figure (1) – OTA Architecture

## Solution

EagleTC’s engineers reviewed the specification provided by the automotive automaker for the OTA process. Test cases were then developed to test all the OTA features, this included high-level features of the infotainment system during all OTA phases, as well as different scenarios that could affect performance. Testing activities for this case study as well as the different scenarios (i.e., by changing different variables) are described in Table (1).

OTA Phase	Variables	Testing Activities
Software Download	<ul style="list-style-type: none"> <li>• Different package sizes.</li> <li>• Different cellular coverage for connectivity and different data speeds*</li> <li>• Different vehicle ignitions (ON/OFF).</li> </ul>	<ul style="list-style-type: none"> <li>• Perform testing to ensure download is successful.</li> <li>• Perform in-vehicle sanity testing for high-level features (Bluetooth phone, settings, navigation, media, tuner, etc.) to ensure no interruption of functionality during this phase.</li> <li>• Perform testing for connected services to ensure no interruption (locking, setting climate, sending location for maps, and locating the car).</li> </ul>
Software Unpacking	<ul style="list-style-type: none"> <li>• Different package sizes.</li> <li>• Different vehicle ignitions (ON/OFF).</li> </ul>	<ul style="list-style-type: none"> <li>• Similar testing to the software download described in the first phase.</li> <li>• Failed unpacking and roll back evaluation.</li> </ul>
Software Installation	<ul style="list-style-type: none"> <li>• Different vehicle ignition (ON/OFF).</li> </ul>	<ul style="list-style-type: none"> <li>• Perform system level testing to confirm new software is working as expected.</li> <li>• Failed installation and roll back evaluation.</li> </ul>

Table (1) – OTA Phases, Variables to Consider and Testing Activities

*\*It is possible that a user loses connection to the server during an OTA. When that occurs, engineers need to verify the OTA handles the disconnection properly. When server connection is lost, the OTA should pause and resume from the same spot. It should not revert to the beginning of the OTA download. Test cases are performed through the OTA to confirm it is functioning properly.*

## Results

Since being awarded this project in 2022, EagleTC’s worked hand in hand with the customer to perform OTA testing. Engineers developed test cases and executed testing following the guidelines in Table (1). Logs were taken for issues found during testing and provided detailed explanation of their observations during testing (i.e., system response and unusual circumstances) as well as investigate any potential fixes. Daily progress reports were given to the customer, detailing the issues and status of the software download/update. A summary of

the test results were also provided to the customer at the completion of each vehicle. With this project, EagleTC continues to demonstrate its ability to:

- Have teams on the ground, deployed, developing test cases and testing, with short-term notice.
- appropriate resources for designing test strategy, proper training for testers and strong program management processes also minimizes overhead.
- Find and analyze OTA issues in real time, resulting in improvements for future vehicle model years, providing a better user experience.
- Provide prompt support to customers and communicate issues and concerns as they arise.
- Adapt to unpredictable circumstances due to process issues (i.e., server issues, corrupted software packages, vehicle problems, etc.). EagleTC continues to work and deliver accurate and timely results.