

Vehicle Remote Access & FOTA

Overview

➤ Vehicle Remote Access:

Connected cars are part of the ‘internet of things’, a phrase that refers to everyday items being connected to the internet with the intention of making life easier.

As well as letting you control specific items remotely, often via a smartphone app, these cars can also communicate with other products.

Connected cars offer a wider range of communication possibilities than many other connected devices. As well as enabling their users to gain real-time access to all sorts of information, they can facilitate contact between the car and the dealership and alert the emergency services if you've been involved in an accident.

A connected car is one that has its own connection to the internet, usually via a wireless local area network (WLAN) that allows the car to share internet access and data with other devices inside and outside the car.

A connected car can assist with a wide range of potentially useful functions. For example, your car's sat-nav system may have a traffic monitoring feature that can alert you if there's a hold-up on your route and offer an alternative that avoids it.

You can also use a smartphone app to do things like start your car's engine remotely five minutes before you want to go out in it, so that the windows are frost-free and the interior is toasty when you're ready to leave. You can also remotely lock the car or make it flash its headlights or honk its horn to help you find it in a car park.

➤ **Firmware Over The Air(FOTA):**

Firmware-over-the-air (FOTA) is a technology that enables the operating firmware of a device to be upgraded and updated wirelessly over the network (“over the air”) without the need to connect directly to the device.

FOTA-capable devices can download updates from service providers or manufacturers in short time, depending on file size and connection speed. This saves businesses the time and money spent sending a technician to have each one of their devices physically upgraded or updated.

So simply A flash-over-the-air update is the wireless delivery of new software or data to mobile devices.

FOTA technology has increased in significance, as mobile devices evolve, and applications emerge. Mobile operators and telecommunication third parties can send OTA updates through SMS to configure data updates in SIM cards; distribute system updates; or access services, such as wireless access protocol.

In a well-known example from 2016, Tesla used FOTA to update each of their cars with the ability to self-park. Without FOTA, each car would have had to either be recalled or visited by a Tesla technician for these updates to be installed.

FOTA is particularly useful when it comes to IoT systems, especially those with large numbers of connected devices that require frequent updates. For example, updating hundreds of sensors measuring soil moisture levels across a large farm would be a near-impossible task using the traditional method, in which each sensor would have to be retrieved, connected to a computer or handheld device, reprogrammed with the new update, and placed back in field, creating unnecessary costs and performance disruption.

➤ **FOTA in the Times of ‘Connected Cars’:**

On an average, an automotive vehicle today comprises of approximately 100 **Electronic Control Units** (ECU) and over 100 million lines of software

code. And this number is growing rapidly since the introduction of Connected Cars.

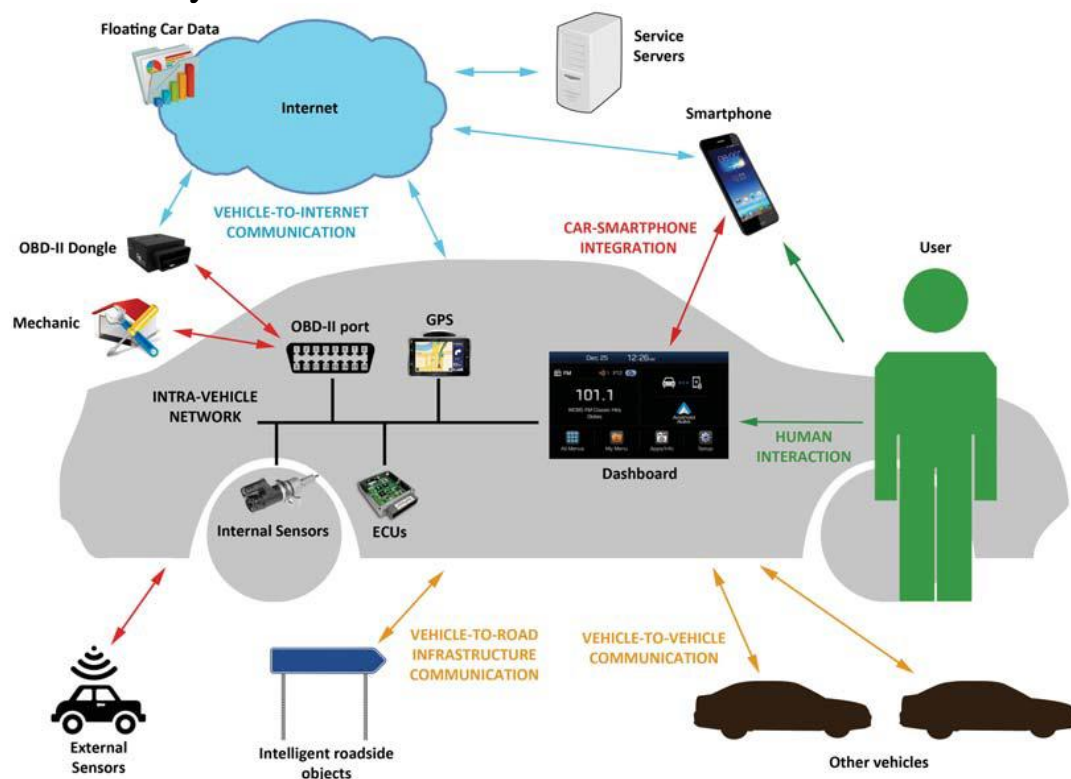
Market experts suggest that by 2020, there will be 300 ECUs in a car, managing most of the functions within a car.

In such a complex automotive electronics and software set-up, the need to remotely manage and update the vehicle ECU software becomes all the more important.

Any security attack on any Electronic Control Unit (ECU) of a vehicle may prove to be dangerous for the passengers, and cause a bad reputation for the automotive OEM.

To avoid such crisis, Firmware Over The Air (FOTA) updates have been identified as a robust, reliable and cost-effective method for remotely managing the software updates of connected car systems.

At a time when the automotive industry is witnessing some disruptive trends, including electrification and autonomous/self-driving vehicles, it is important for OEMs' to implement efficient software management strategies. And this is where FOTA update technology is being leveraged by the automotive industry.



Overview of the Connected Car System.

Problem Statement & Solutions

➤ Vehicle Remote Access:

The benefits of Car Remote Access run the gamut and can help with such tasks as receiving a vehicle health report, locking or unlocking your car doors remotely, finding parking or requesting help in an emergency. Thanks to a wide range of connectivity systems and with a compatible device where the app is available, Its Security and Services gives you confidence whether you are inside or outside your vehicle. It provides increased safety, security and important vehicle health information, while also boasting a package that helps in contacting emergency services or roadside assistance. It even sets a boundary alert for teen drivers. Other benefits in the area of assistance includes Stolen Vehicle Location Assistance for when the more emergent situation presents itself. Our Remote Access System has the following features:

- **Locate a parked car**

The mobile app can help locate your parked car, remotely check the vehicle's status or lock and unlock doors, among many more functions. Thanks to the new upgrades, you can also receive personalized push alerts based on location and weather conditions. For example, if it is raining and your window is down, you are alerted in time to remedy the situation. Or you can set up the system to alert you if you leave your car without locking it or closing your trunk.

- **Check your vehicle's health**

The app also allows you to pull up your vehicle's health report, which will reveal such information as mileage, the next scheduled maintenance or the ability to set up a dealer visit. This is vital information that is useful in tracking all that your vehicle needs in the area of maintenance

and upkeep. It is especially helpful in the event you forget what is due or when maintenance is needed.

- **Boundary/speed alerts**

Our App Security and Service is that extra layer of protection for parents of new drivers on the road. It offers boundary and speed alerts, sending a notification or email if the vehicle exceeds a pre-set speed limit or leaves a pre-approved boundary area. This is peace of mind and safety all rolled into one.

- **car anti-theft system**

The App gives you the ability to locate your car if it has stolen. It also gives the ability to lock it and disable its systems to prevent the thief from driving it . In a proactive manner the app also gives you alerts if a thief is trying to open your car.

➤ **FOTA:**

During the past twenty-five years, computer-based electronic control units (ECUs) have gradually replaced many of the mechanical and pneumatic control systems in vehicles. A 2013 study released by Frost & Sullivan found that mass market cars by then had at least 20 million to 30 million lines of software code, while premium cars could have as much as 100 million lines controlling essential systems. According to Frost & Sullivan, the average cost of the software code is \$10 per line, and it is steadily increasing. They estimate that by 2020 that the amount of software will increase by as much as 50 percent.

It is essential for vehicle OEMs to manage the software efficiently over the lifecycle of the vehicle, both to provide improvements in performance and to deliver corrections to faulty software that endanger lives or the environment and which could result in expensive product recalls. It is estimated that between 60 and 70 per cent of vehicle recalls in North America and Europe today are due to software problems, so this issue is clearly one that must be addressed aggressively by the OEMs. A topical case in point is Volkswagen

and the eleven million diesel vehicles it has sold during the past eight years with ‘faulty’ emissions control software. A portion of these vehicles also require hardware changes, but if VW could have corrected the problem with only a software update, the process would have taken far less time, cost much less and reduced the environmental impact.

FOTA is already in use among some vehicle OEMs (e.g., Tesla and Mercedes-Benz) as an alternative to performing the software updates using a vehicle workshop system, however this practice is still very new and limited. In a future OTA scenario, whether the updates are performed in the workshop or at the dealer with OTA technology, or remotely, there remain both technical and business reasons for using the dealer network for performing the updates.

Unlike a company like Tesla Motors, which sells cars directly to customers and which does not have a dealer network, vehicle OEMs are dependent on their dealers and National Sales Companies for customer contact information. Many, if not most, car OEMs do not have a central database containing the names and most recent contact information on the owners or drivers of their vehicles. Dealers with workshops want to continue to have the direct relationships with customers to sell service and accessories, and to eventually sell the customer a new car. They will resist any attempt to short circuit them.

The Technical Approach & Project Design

➤ The Expected Deliverables:

1. The System Hardware which contains of:
 - a) **The main ECU** that has some of the system features and it's the responsible of updating the other ECUs with the new software update.

- b) **Diagnostic ECU** that has a diagnostic information about the system and it's responsible to send the diagnostic report to the OEM website to ask for a new update if needed. It also contains some of the system features.
- c) **Dashboard ECU** that is the infotainment system for the driver to make some of the appropriate interaction.
- d) **Gateway ECU** that connects the system to the server.

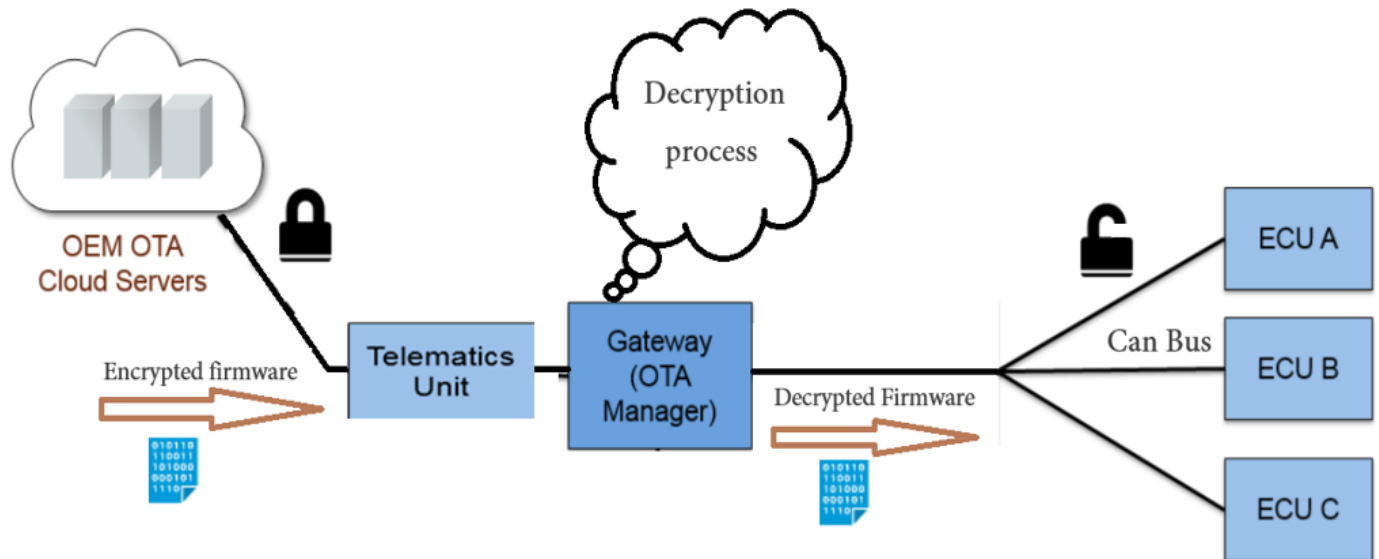
- 2. Mobile Application that is used to remote access the car.
- 3. A website to manage the FOTA updates and other system information.

➤ **Vehicle Remote Access:**

To give a more technical view of the vehicle remote access system, We will have a mobile app connected to the car network through a wireless communication protocol like WiFi or 4G. The mobile app gives us the ability to access the car network through the Gateway ECU then based on the feature or action we choose from the app the expected response would take place for example, If we remotely want to lock the car door, we will click on the corresponding interface to lock the door then the mobile app would send the door locking command to the Gateway ECU then it will lock the car door. Depending on the feature we will choose the appropriate implementation which will be defined in details later.

➤ FOTA:

In the following Figure



we can see the overall view of the system; in an abstracted way we see four main components:

1 - OEM cloud server :

It is where we will upload the new update through a defined user interface and will have the needed information about the products and the new update.

2 - Telematics unit :

It is our way to connect to server and download the code it has the capability to connect to Wi-Fi for example to has access to internet and will access the server easily.

3 - Gateway

Will receive the update from telematics unit and important data about the update like the CRC and target ECU ID and will decrypt the code before sending it to the target ECU.

4 - The target ECU

It is the ECU which the update is directed to and connected to the gateway through a communication bus like UART or CAN. There is a fifth hidden component which is crucial for the whole process, it is the bootloader. A bootloader which supports FOTA updates must be installed in the ECU before shipping the product, the definition and mechanism of bootloader will be discussed later.

The OEM will have to a defined interface to access the server and manage the updates easily. A graphical user interface will make it easier and more reliable.