INTERNET OF THINGS
REAL-TIME VEHICLE TRACKING CASE STUDY

June 2019

Internet of Things SL
Sensing Assets

ABOUT INTERNET OF THINGS SL

Internet of Things SL ("IoT SL") is a global IoT solutions provider. We specialise in asset and inventory management, telematics, sensorisation, data analytics, machine learning, and blockchain technology. Our range of services in the Internet of Things ("IoT") sector is managed through our software platform.

The IoT SL Platform for Connected Assets and Blockchain (the "IoT Platform") is a versatile IoT platform that allows any asset to connect seamlessly, including electronic, smart, and telematics equipment, sensors, vehicles, as well as industrial machinery. The platform provides customers with real-time insight and control of all the assets and sensors in their entire business. The platform links together advanced inventory management solutions, vehicle telematics, data analytics, machine learning, sensorisation techniques, and device data in one easy-to-grasp tool to analyse, control, and improve business efficiency.

IoT SL is headquartered in Madrid, Spain, with an impressive list of customers and partners spanning a variety of industries across high-tech and industrial manufacturing, aerospace, defence, retail, global transportation, logistics, financial services, and agriculture. IoT SL has a proven track record of delivering results.

IoT SL has been in business since 2015, with offices and development centres in both Spain and the UK.

Our solutions are offered on a SaaS basis.

INITIAL SITUATION

Conde, a Madrid-based auto-dealer that refurbish used vehicles and then resells them, had a problem with locating vehicles at their workshops. A vehicle that is undergoing refurbishment can be either in the paint shop, at the chassis repair station, in the garage, etc. Business for an auto-dealer is oftentimes moving at a fast pace due to customers expecting vehicles at a moment's notice. Because of this, Conde wanted to reduce the time it took to process vehicles throughout the refurbishment process, so that they could be sold more quickly. The biggest bottleneck for Conde was to locate a specific vehicle at their facilities. Therefore, they wanted to implement a real-time vehicle tracking solution that allows them to have complete knowledge about all their current vehicles' whereabouts.

The solution must also be scalable in such a way that new vehicles that enter Conde's facilities can be easily integrated in the solution.

IMPLEMENTED SOLUTION

IoT SL proposed and implemented a solution utilising RFID-based technology. Each vehicle is equipped with one RFID tag (the vehicle is "tagged"). A tag is in the form of a small label, which works as a Radio Frequency (RF) beacon in our solution. The tags are positioned in the windshield of each vehicle so that they are easily detectable – both by our solution and by the human eye. In addition, the tags are designed to take up minimal space and not interfere with any other services. Figure 1 displays five such RFID tags that are used to locate vehicles at Conde's facilities.

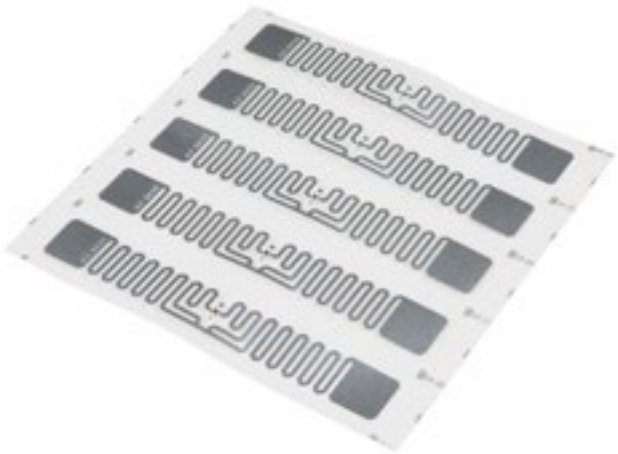

Figure 1. Five RFID tags in the form of small labels used for locating vehicles at Conde's facilities.

RFID readers have also been installed throughout the Conde facilities. Each RFID reader is scanning a region of the premises, effectively creating an interrogation zone. The purpose of the RFID readers are to register the presence of RFID tags in their respective zone. When a tagged vehicle enters an RFID reader's zone, the reader recognises the tag's Unique ID (UID) and instantly uploads that information to the IoT Platform. In the platform, each UID is linked to a vehicle, which makes it possible to distinguish which vehicle that is being detected. The RFID readers are connected to the Internet via an Ethernet cable, which allows them to communicate with the IoT Platform.

An operator of the platform can instantly access each vehicle's details in real-time, and thus find out precisely where in the facilities a vehicle is currently located. The location of each reader is known in the platform, which means that when a reader detects a vehicle's tag, the platform also knows that the associated vehicle is at the same location as the reader. The placement of the readers is very discreet – usually high up on the walls or in the ceiling – which makes them almost completely unnoticeable to the human eye.

The Conde facilities have got a bunker-like structure with thick walls made of mass concrete. This setting proved to absorb most RF signals, which made an RFID-based solution somewhat difficult to implement. However, thanks to smart implementation of the RFID reader network, IoT SL managed to provide a solution that covers every bit of space of the Conde facilities.

In addition to the fixed RFID readers, hand-held RFID readers were also provided to Conde. The hand-held readers are used to manually scan a vehicle, and also for provisioning of vehicles. An operator can manually scan a vehicle to immediately extract all data about that vehicle from the IoT Platform.

Provisioning a vehicle is a necessary step that has to be conducted for each new vehicle that enters the facilities and the solution ecosystem. Provisioning a vehicle is the process of first attaching an RFID tag to the vehicle, and then scanning the tag with one of IoT SL's hand-held readers put in "provision mode". This creates a new system of record of the vehicle in the IoT Platform. Afterwards, the vehicle can be located when the tag is detected by any reader. Provisioning of vehicles can be done in bulk, at the pace of several hundred in a matter of seconds. (However, in reality, vehicles are provisioned one at a time as they arrive at the Conde facilities.)

HAND-HELD RFID READERS

The hand-held RFID readers used to provision and scan the RFID tags are easy to operate, as their user interface is built on the Android Operating System. In order to scan a tag, the operator has to press the trigger on the hand-held reader, and point it towards one or several RFID tag(s). There exists great flexibility regarding what information that is obtainable from scanning the RFID tag of a vehicle, including (but not limited to)

- Type/description of vehicle;
- Serial, model and/or production number;
- Current location;
- What inventory category the vehicle belongs to;
- Manufacturer;
- Operational state; and
- Possible need for maintenance.

The hand-held RFID reader is visible in Figure 2, together with a close-up image of IoT SL's custom-made Operating System.

Figure 2. Hand-held RFID reader (left) and IoT SL's reader Operating System (right).

SOLUTION LIFETIME

The proposed solution is based on the unique identification of each vehicle through RF signals that are recorded on a chip integrated in each RFID tag. All tags are passive, meaning that they have no on-board battery and are not constantly transmitting their ID signal. Instead, the passive RFID tags are activated in the presence of an RFID reader's RF signals. The RFID readers are constantly powered by a wall socket, and the hand-held readers are rechargeable. Therefore, the proposed RFID solution will never run out of battery, nor will it reach any other end-of-operation state within a reasonable time frame.

SOFTWARE PLATFORM

Vehicle data is handled in the IoT Platform, which is a cloud-based (online) software platform that manages all its connected assets (in this case vehicles) in real-time. Once a vehicle is detected by a reader, its status is automatically updated in the platform. The status of a vehicle can be either "in room X", or "outside of space Y", where X and Y refers to unique names of locations on the premises – which are chosen by the customer at their convenience.

The data from each RFID tag is analysed by the platform's back-end cloud architecture, and visualised via a convenient graphical user interface that is accessible from any conventional Internet browser on any device, including computers, tablets, and mobile phones.

The IoT Platform is a full-scale Internet of Things platform, where a customer can access many types of data about their assets in real-time, e.g. location of assets, current inventory, etc. The platform's user interface is depicted in Figure 3.

Figure 3. The IoT Platform is used to manage all of a customer's assets through an easy-to-grasp web browser interface.

The level of information that can be obtained about each asset in the IoT Platform is unlimited. The platform displays the unique tag ID, the assets status, its location, and other potential information such as references, SKUs, barcodes, and current orders. All assets and their data are displayed in the Assets tab, as is seen in Figure 4 overleaf.

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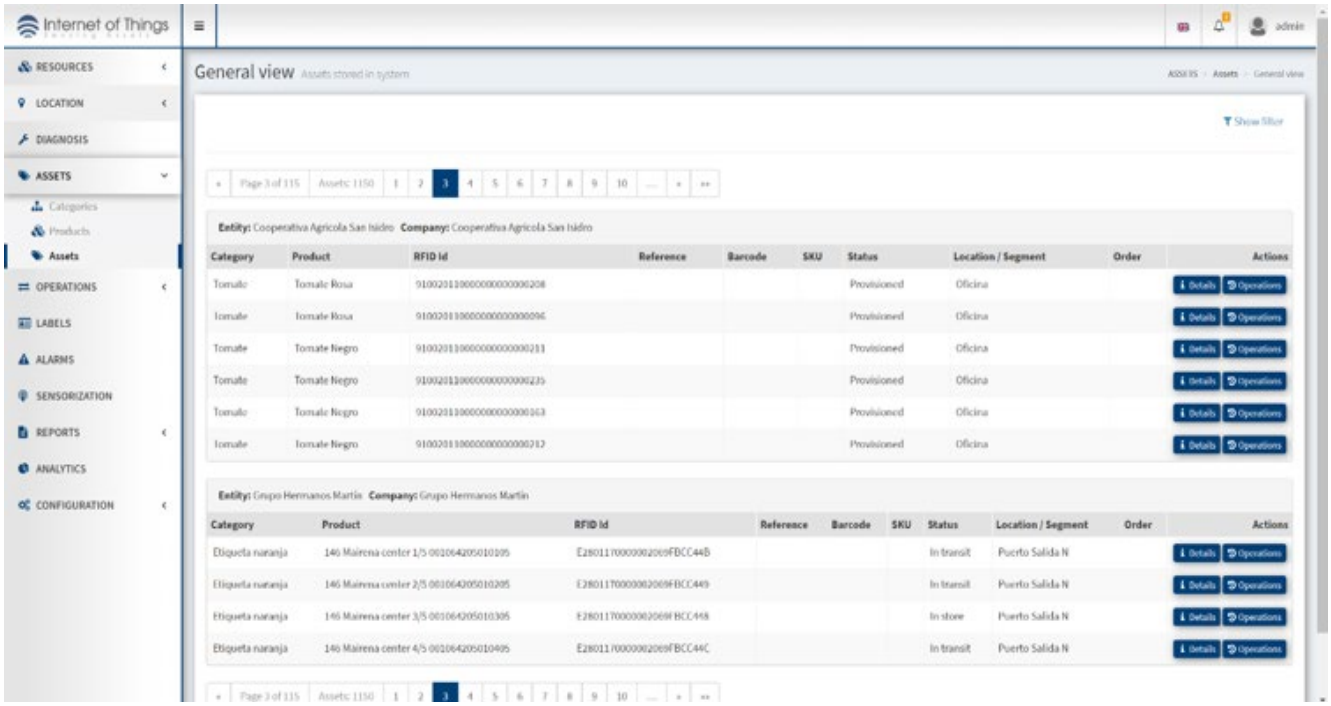

Figure 4. Assets currently provisioned in the IoT Platform.

By selecting the Details button, a new window will open where asset information is visible, and conveniently categorised. An example of this feature is depicted in Figure 5.

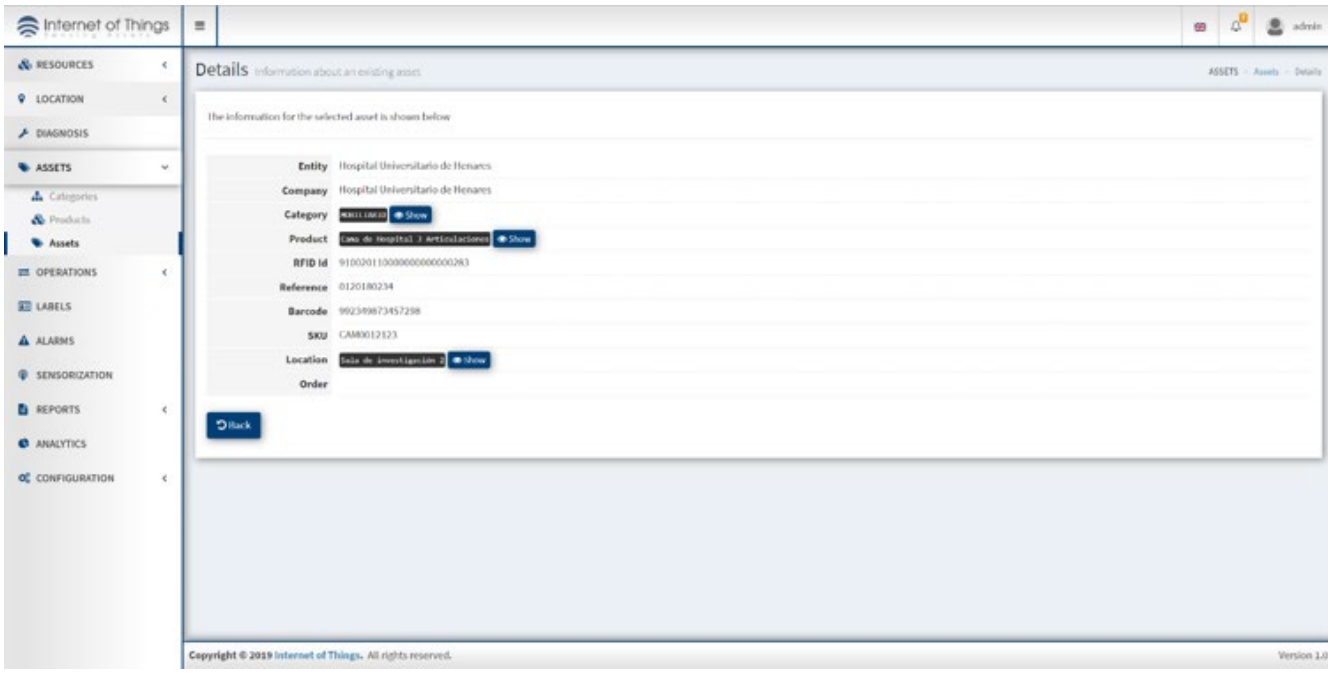

Figure 5. Detailed information about one asset in the IoT Platform.

Note that the type of information that is visible when scanning an RFID tag is highly flexible – any asset data that is in the system can be displayed. Assets can also be sorted with respect to different categories; location, type, manufacturer, brand, current stock, etc.

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REPORTING AND ANALYTICS

It is also possible to retrieve visual data analytics about all assets with the IoT Platform. Such data analytics are constructed with high-end algorithms that easily can be applied to all assets in the platform. It is also possible to generate reports about all the assets currently in stock. An example of data analytics is displayed in Figure 6, and Figure 7 depicts an inventory report of all current assets.

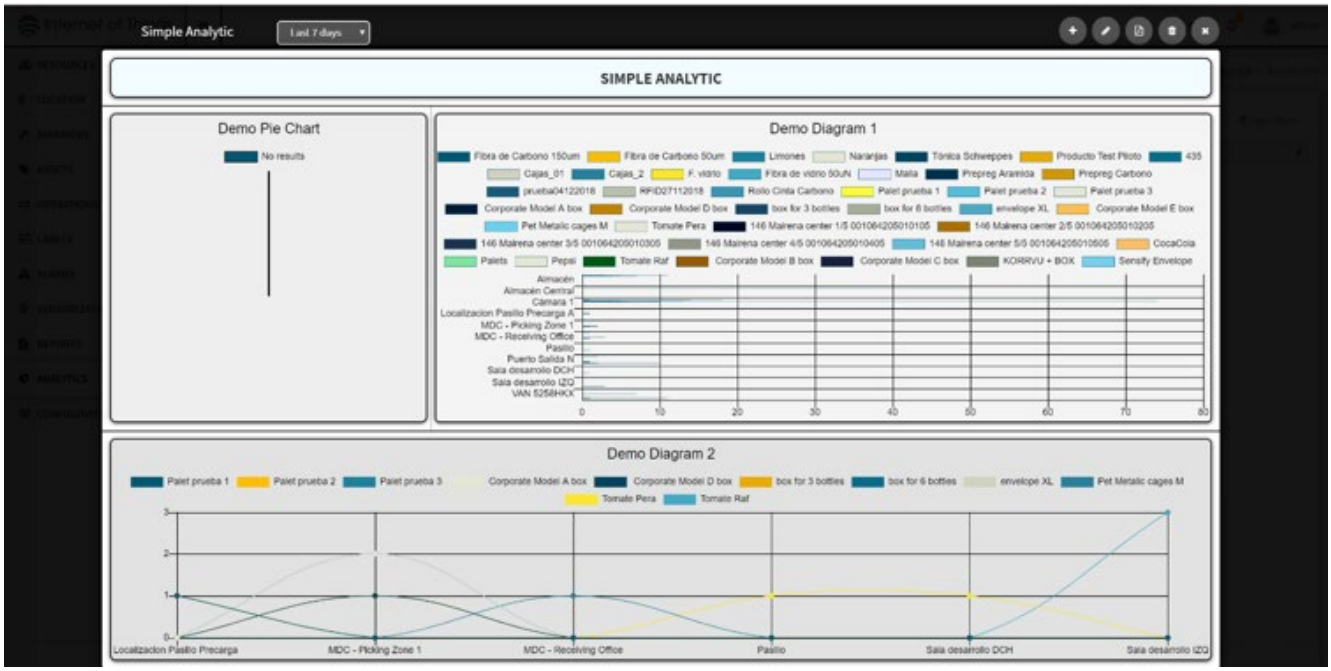

Figure 6. Data analytics displaying information about the assets currently in operation in the IoT Platform.

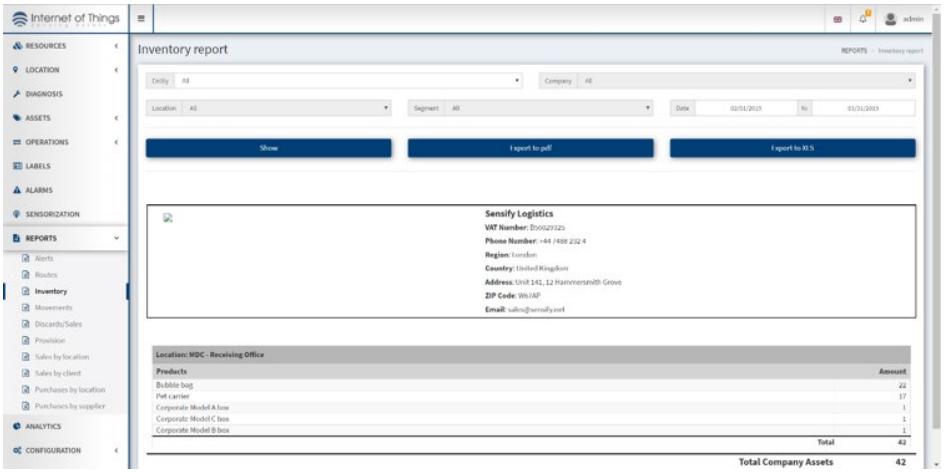

Figure 7. Generated report of current asset inventory in the IoT Platform.

The IoT Platform can generate any type of bespoke reports and analytics as required by the customer to include all the information shown in this use case, as well as any other additional data the customer would like to receive. These reports can be created for the customer at low cost on a standard day rate of relatively short notice, subject to receipt of a Statement of Work. Reports and analytics are updated in real-time in the IoT Platform, and they can be exported to both PDF and Excel formats.

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CLOUD-BASED PLATFORM

As the platform is cloud-based, there is no requirement for external hardware. (The platform can also be installed in an offline fashion, as an "on-premise" solution, should there be no available Internet connection at the customer facilities, or if the customer considers the offline solution to be more appropriate. This will require either i) new computer hardware on the premises that can run the offline solution, or ii) integration of the offline solution into already existing computer hardware.)

There was no interruption or downtime of currently ongoing refurbishment work at any facility during the implementation of the proposed RFID-based solution.

PLATFORM WHITE LABELLING & MULTI-LINGUISTIC CAPABILITIES

The IoT Platform can be white labelled to suit each customer's needs. For our Conde solution, the platform user interface is displayed using Conde's colour scheme and logo, as is seen in Figure 8. As Conde is a Spanish customer, the platform is presented in Spanish. The IoT Platform can also be provided in English, German, and French.

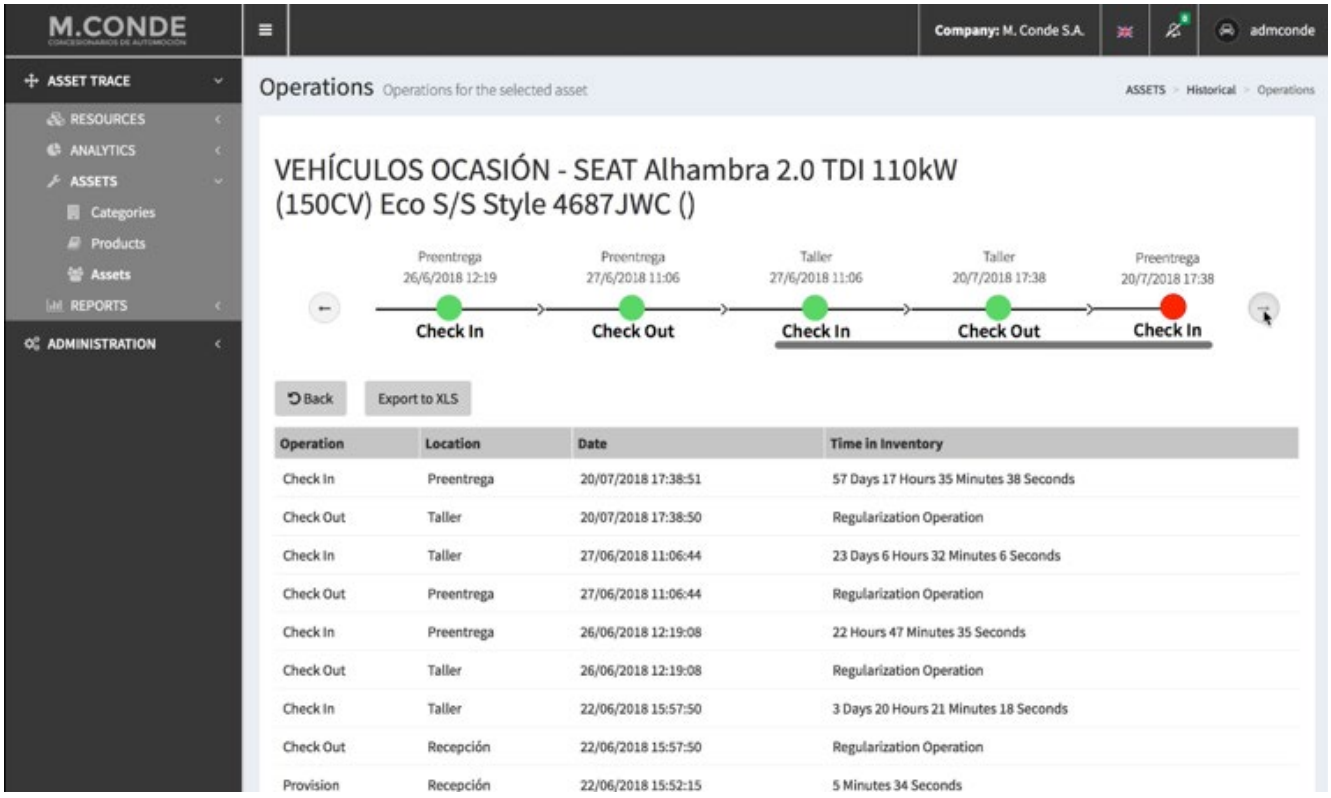

Figure 8. White labelled platform as seen by Conde operatives. The figure displays the status of one of their vehicles.

VEHICLE OPERATIONS

The IoT Platform comes with an excellent tool to check the current status of each vehicle, as displayed in Figure 8. An operator has full visibility of what and when a vehicle updates its status, such as location, driver, inventory, etc. The history of each vehicle is also accessible. This tool is updated in real-time as the vehicle is being operated. The status of each vehicle can be exported to an XLS format.

SUMMARY OF SOLUTION

Combining the IoT Platform with the appropriate RFID tags and readers results in an ideal asset management solution. The proposed solution works in real-time during all hours of any given day, allows complete visibility of all assets without interfering with everyday work, and is convenient to operate with minimal requirement for training or instructions.

SOLUTION BENEFITS

The solution is scalable in such a way that when a new vehicle enters the facilities, it can be easily integrated in the solution ecosystem in an instant. All it takes is to attach an RFID tag not currently in use to the vehicle, and then provision the vehicle using a hand-held reader. The arrival of new vehicles does not hinder or in any other way obstruct the solution from providing real-time location information of all vehicles.

POTENTIAL SOLUTION EXTENSION

The proposed solution provides complete vehicle management functionality for tracking of all vehicles on the premises. However, it is possible to increase the capability of the solution to also keep track of which worker/s that is/are currently refurbishing which vehicle, effectively showing who is/are responsible for each vehicle.

The names of, and contact details to, each worker can be added in the IoT Platform. Each worker is then provided with a card that contains an RFID tag. When a worker is refurbishing a vehicle, their card is also detected by the RFID readers. This will link the vehicle to the worker in the IoT Platform, which makes it possible to display who is currently responsible for each vehicle.

In addition, if needed by the customer, the IoT Platform can also be used as a clock in system, where workers cards' are automatically scanned when arriving at, as well as leaving, the facilities.

The possible extensions adds increased granularity to the proposed solution. They simplify life at the customer's premises as the whereabouts – the available resources – of each worker is known. In addition, the IoT Platform also provides an easy system for keeping track of how many hours each workers spend at the facilities, where those hours are spent, and which vehicles that are being worked on by each worker.

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