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Secure car access: when proximity is the key

By Gerry O'Grady

PICTURE THE SCENE. It's late at night, dark, raining. A tired businesswoman approaches her car in the airport car-park, and sighs wearily as she puts down her files, laptop and luggage, searching through her bags and jacket for her key fob to unlock her car.

In the adjacent car-parking space, her colleague - similarly burdened down with files, laptop and luggage - simply walks to her car reaches out and the car boot unlocks as she opens it. She places her luggage in the boot, sits into the driving seat, presses the start button and salutes her struggling colleague as she drives away.

From next year onwards, this will be the reality of new keyless entry systems for the automotive industry using the power and precision of DecaWave's ultra wideband technology. Automobile manufacturers will only take up the technology if it meets a number of basic but essential criteria.

The technology must be able to operate in crowded car parks both indoors and outdoors, granting vehicle access within a relatively short distance of the vehicle. Such a keyless entry system should not be permitted to start the engine unless the driver is inside the car, which means it should be capable of determining precisely when the key fob is inside the vehicle. As well as being inexpensive and low power for several years of battery operation, the system must be secure enough to prevent potential thieves from "hijacking" communications between the key fob and the vehicle to gain access to the vehicle. Of course conformance with local regulations, in all geographies where the manufacturer's vehicles are sold, is a pre-requisite.

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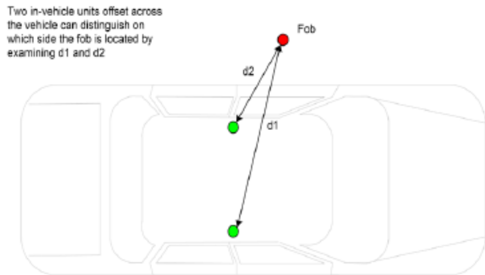

Fig. 1: Determining on which side of the vehicle the wearer of the fob is approaching.

Identifying the distance from the vehicle

Measuring the distance of the fob to the vehicle is not a problem since DecaWave's UWB technology allows distance to be measured with an accuracy of +/-10cm based on time-of-flight. A single transceiver in the vehicle can conduct a 2-way ranging exchange with the key fob, when the appropriate key fob button is pressed and calculate the distance from the fob to the vehicle. The tiny radio unit allows Line-of-Sight ranges greater than 200m. However, the in-vehicle unit can be configured to only take action when the measured distance is less than a certain value defined by the vehicle manufacturer. Thus, in the example above, when our driver comes to within a specified short range of the vehicle, the lock release mechanism is triggered.

Enabling the car to know which door to release

A single two-way ranging exchange between one in-vehicle unit and a fob, while sufficient to measure how far away the fob is from the vehicle, is not sufficient to determine on which side of the vehicle the fob is located because only one piece of information – a single distance – is available.

In order to determine on which side of the vehicle the owner (wearer of the fob) is located, two pieces of information are required, two distances from two in-vehicle units for example, provided of course that these in-vehicle units are positioned in an appropriate way. If the two units are mounted across the vehicle as shown in figure 1, then it becomes possible to uniquely identify the side of the vehicle on which the fob is located. Hence, in our previous late night car park example, the locking mechanism of the boot would be released automatically as the woman approaches the rear of the car to store her luggages.

Choosing a correct implementation

DecaWave's technology is based on the propagation of radio waves from the transmitter to receiver. The technology is exceptionally good in non-line-of sight- environments but like all radio schemes it will not propagate through metal plates; it can only propagate around them. This has important implications for the location of the in-vehicle units. Positioning the units low down in the interior of the vehicle will severely restrict their "visibility" of the outside environment. Hence, integrating them behind dashboards, door panels and the like will not work well. On the contrary, positioning the units high up in the headlining, the courtesy light, the sun visor mounts or other such elevated position will give a much better view of the outside environment, via the windows glass, and will give better performance – see figure 2.

Immune to relay attacks - by design

Existing key fobs solutions can be intercepted using a scheme known as "relay attack". Imagine a vehicle owner sitting in a restaurant with his car parked several blocks away. The key fob in his pocket is transmitting regularly "looking" for the car but the car is out of range. It is possible, with the right equipment, for a person to pick up those transmissions, relay them to another person close to the car and thereby open the car and drive away.

Manufacturers are constantly looking for technologies to help counteract this sophisticated method of theft, and DecaWave's UWB technology can give them a new and powerful weapon in that battle. Because 2-way ranging is used with very precise time stamps to measure the distance between the fob and the car it would be very difficult to intercept and "hijack" the messages being transmitted by the fob so that the car believes there is a genuine 2-way ranging exchange in progress from a fob close to the car. What's more, the IEEE802.15.4a standard on which is based the single chip CMOS Ultra-Wideband IC from Decawave supports AES-128 encryption making it even more difficult to interpret and modify the transmitted messages.

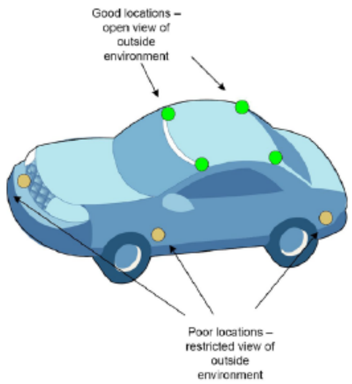

Fig. 2: Choosing a correct implementation through the placement of communication nodes.

Reliability and flexibility

Because the ScenSor node uses Ultra Wideband technology it is very immune to fading due Multipath propagation. This is particularly important in indoor environments with significant amounts of metal such as in indoor car parks. ScenSor has excellent Non-Line-of-Sight and Line-of-Sight range, this leaves the system designer decide on the distance within which the in-vehicle system should take action on receipt of a valid exchange. The highly accurate distance measurement capability allows the system to reliably determine if the fob is inside the vehicle, which will be the condition for starting the engine. Other benefits of using the IEEE802.15.4a protocol is the high data rates supported, which translates in very short on-air time and minimizes power consumption. What's more, the protocol incorporates a number of error checking methods to ensure communications is reliable. The frequency used is license free in most regions of the world so this solution can be used globally.