IOT 2.0: when the IOT and micro location converge
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IOT 2.0: when the IOT and the micro-location converge
As you understood from my bio, I spent all my career in the industry where I had the chance to experience the whole value chain of the industry from the implementation of standards into chips, chips into end products, down to the end customer.
But I never had a chance to participate to an IEEE event, where the foundations of the technology are laid.
The goal of my presentation today is to give you a feedback of how the industry is leveraging an IEEE standard, the 802.15.4-2011, to design emerging applications as I believe a close interaction between standardization body's and the industry is key for innovation.
We have all heard about the IOT and its 10's of billions of connected objects.
But what if, on top of the benefits of the data collected, we had the capability to accurately locate those objects or have those objects capable to know where they are?
First, Adding positioning information to the collected data would dramatically increase the value of this data.
I was recently talking with someone in the aircraft industry, knowing I'm from Toulouse France you may guess who, who explained me that during the construction phase of the plane they mount hundreds of sensor in & on the plane to monitor various mechanical, electrical and hydraulic parameters. But quite often, the person installing the sensor is not correctly positioning the sensor or the sensor simply falls as not attached properly. This results in data that looks erroneous, triggering alarms, stopping the ongoing construction or test phase and thus loss of efficiency and extra costs.
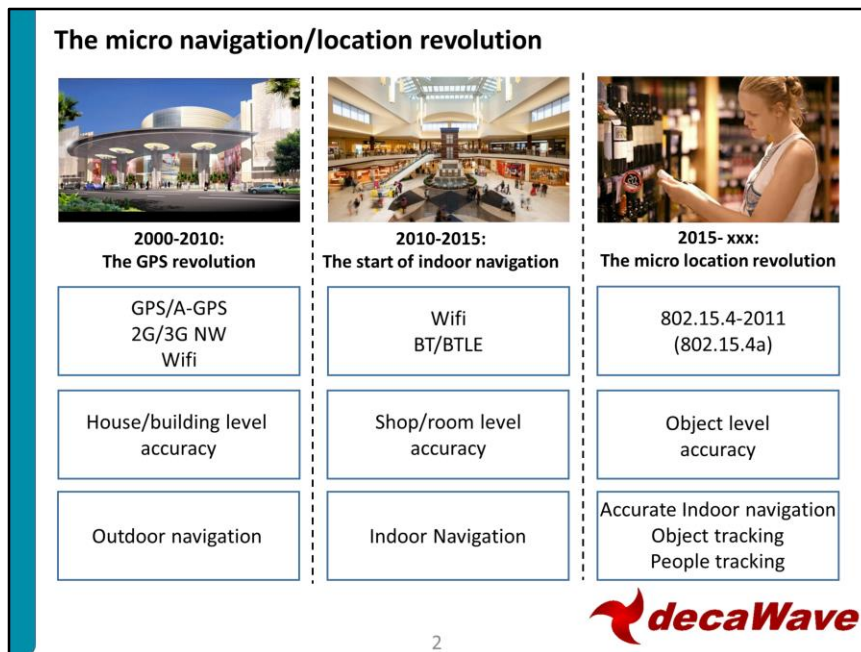So what this person is looking for is a solution allowing, on top of collecting data, to very accurately monitor the exact position of the sensors in real time to be able to immediately detect a false positioning.
This is a very unique scenario but it clearly shows that if you do not know exactly where the data is coming from on a location stand point, its value can be really limited.
Second, if an object can accurately determine its own position, it can start to take decisions and actions based on its environment and become more autonomous or even protect itself.
Of course you immediately think about robots. But there are plenty of applications in the industrial, automotive or consumer space that will benefit from such capability.
Let's take some use cases to better understand what the combination of data communication and micro-location is enabling.

The micro navigation/location revolution

2000-2010: The GPS revolution	2010-2015: The start of indoor navigation	2015- xxx: The micro location revolution
GPS/A-GPS 2G/3G NW Wifi	Wifi BT/BTLE	802.15.4-2011 (802.15.4a)
House/building level accuracy	Shop/room level accuracy	Object level accuracy
Outdoor navigation	Indoor Navigation	Accurate Indoor navigation Object tracking People tracking

Micro-navigation

Let's start with micro-navigation and micro-location.

2000-2010: The GPS revolution

After decades relying on paper maps, GPS really changed the daily life of 100's of millions of people and thousands of industries.

The gain in efficiency for individuals and the industry was huge, imagine for a salesman or a delivery man the number of hours saved per day, week, year.

It was also synonymous of the First location based services creating new businesses as the location data started to have value for commercial use.

Here I'm referring to find ATM, gas station kind of services but more importantly, fleet management and asset tracking services which brought a new level of security in the transport industry as well as increased the efficiency of the supply chain for the manufacturing industry.

2010-2015: The start of indoor navigation

Most of us are now dependant on GPS for outdoor use… but spend 85% of our time indoors where GPS does not work.

People are now interested in indoor navigation and we see the deployment of the first indoor navigation applications, based on Wifi and BT/BTLE, in our malls and other public places.

With such technology people are now able to find their favourite coffee shop or winestore, they can navigate in large unknown places in a pretty efficient way even if it is not 100% reliable.

In the industry, like the GPS was adopted to track assets outdoors, we also start to see new type of systems allowing to track assets indoors like the position of a car on the assembly line in a factory or the location of an infusion pump in a hospital.

Those professional systems also rely on conventional WiFi, BT/BTLE but also on Zigbee, LF, Infra Red, … and most of the time a combo of those technologies.

Why combo? The reason is simple. The industry, on top of accuracy, needs reliability. But none of the above technologies is capable of providing high accuracy and high reliability. Thus the industry designed those combo systems to try to reach the level of reliability they need meaning above 95%. Here we're no longer talking about finding a coffee place, reliability is a real concern.

With regard to accuracy, even with a combo of technology, the best performance achieved is 3 to 5m what allows to track medium to large items at the room level.

2015- xxx: Micro location and navigation to the scale of an object

Now, let's jump to 2015, tomorrow, and let's see what's coming on the micro location/navigation.

If we go back to the 1st years of GPS, the lack of accuracy/reliability of the 1st systems - whether it was intentional or due to the performance of the technology - gave a poor end user experience what slowed down its adoption. I personally got rid of my first GPS after a few month as I was doing better on my own.

I'm not saying it is as bad with the 1st indoor navigation systems.

But it's not reaching users expectation, which constantly grows as their exposition to technology increases, because the reliability and accuracy offered is not yet at the scale of a human and the objects around him.

Finding the sports shop in a mall thanks to your phone is nice and saves you a few minutes, but being able to find the red pair of basket-ball shoes your son wants in the 50.000 square feet of the shop would be much more helpful.

I took an example based on consumer but if we move back to locating an infusion pump in a hospital. Knowing that the pump is on a specific floor is good, knowing it is in this storeroom is better but knowing on which shelf of the storeroom will save you a few extra minutes that can make the difference. Same for factory automation to track the WIP. Knowing where the car is on the line is good, but what is needed is to be able to track every step of the assembly process meaning the spare parts, tooling and staff to ensure everything match.

As I said earlier, current systems do not offer enough accuracy/reliability to propose real micro location services down to the drawer or shelf level. And they are pretty expensive as they use a combo of multiple technologies to try to increase their performance.

It's not because those systems are poorly designed. It's simply because the underlying technologies, Wifi, BT/BLE, Zigbee, … were not initially designed for those

use cases. And it's usually hard to get a high level of performance at the application level when the underlying technology was not intended for such use.

But as you know, the IEEE defined a new standard, the 802.15.4a now part of the 802.15.4-2011, specifically targeting use cases requiring data communication AND accurate positioning.

Thanks to the new PHY based on IR-UWB, there is now a technology that can provide the level of performance needed by micro-navigation and micro- location.

Finding small objects as a pair of shoes thanks to an indoor navigation system will soon be possible.

But the industry is moving quicker than the consumers and are already adopting this new technology. Quickly Finding the infusion pump that just sent a reminder for maintenance thanks to an accurate asset tracking system is now possible as you can achieve sub 30cm/foot accuracy with 99% reliability.

Back to the navigation scenario, not only humans will benefit from it. Robots will also be able to navigate autonomously in factories without the need for laser, camera or wire guidance. And the same applies for the consumer robots like vacuum cleaners, automatic mowers, that are colonizing our houses.

As you understood form this 1st use case, the 802.15.4-2011 standard and the associated technology was long expected by the industry and it's completely fulfilling the industry expectations and even open the door to even more game changing applications.
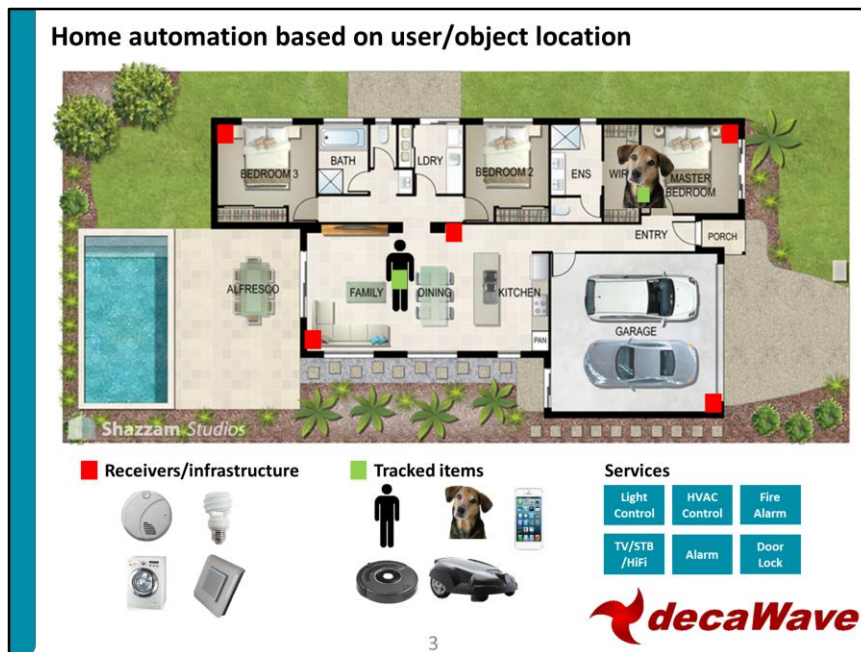
User presence based Intelligent Home
Let's have a look at a 2nd use case where accurate positioning will be beneficial, the intelligent home.
Personally, I would not use the word "intelligent" yet to describe those houses.
The reason is simple. Despite being fully connected and Automated, the house is not aware of 1 key parameter: where we, the person living here, are.
The house has no clue whether we're in front of the door, in the living room or the bedroom and thus cannot take actions accordingly.
The only thing it will know is if we're gone for the week… hoping that we did not forget to turn the alarm on… manually.
That's pretty unfortunate to have a home automation system, supposed to make our life easier, still requiring so many inputs from us.
So what about a house adapting the environment based on the exact location of a person in or around the house?
With really accurate location/positioning, you could turn on/off lights or dim based on user exact location down to the level of which sofa the person is sitting in.
No more kids leaving the light on in their room, or the TV on while going outdoors... if only the house could know. That would be good for energy savings and for your electricity bill.

The same applies to HVAC that could turn on/off and adapt temperature in different zones of the house based on user exact location and preference.

HVAC's manufacturers tried to implement some equivalent functions with programmable systems. But again, it is not what I call automated as I need to manually program week-end/week- day/hour with associated temperature. If I go on week end and forget to switch it off… it will just run as usual and the opposite, if I stay a week day at home I'll have to switch it to fully manual to turn it on... and forget it in this mode for the next days…

They also came with infrared motion sensors to try to make the system aware of its environment. But those systems leave you cold on your sofa as you do not move enough while watching a movie or heat the house all day because cats run around. I know it well as it is exactly what I have at home.

Again, the missing part for a really autonomous and intelligent house is the user presence and exact position information.

I'll not detail all the applications but you could also do:

Pre-set the TV or remote control as it knows who is using it. Adapt the TV orientation based on user(s) location in the room.

HiFi: adapt volume and sound effects based on your location in the room.

May be more important, Automatically close the windows/curtains, lock the doors and turn on the alarm as soon as the user leaves the house.

This "really" intelligent home may look a bit "buzzy", but that's what the end users, us, and the industry are looking for. And that's what is already happening as some industry pioneers start to implement this new technology based on the 802.15.4-2011 standard into home automation products.

As you can see on the picture, this technology can easily be implemented in light bulbs – one of our customers is already building 802.15.4a compliant bulbs, fire alarms, appliances, … becoming your infrastructure to an indoor positioning system.
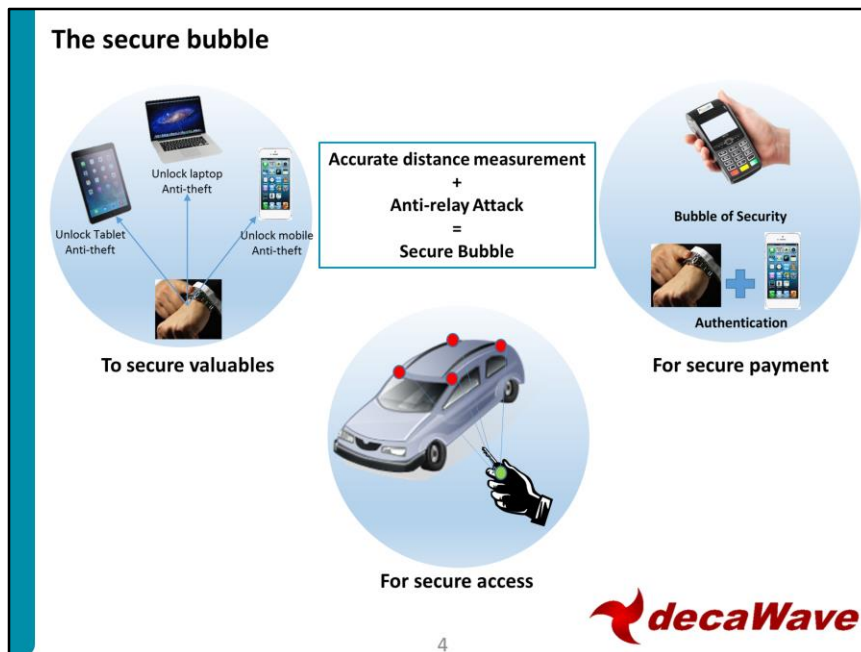
The Secure Bubble

Let's move to our last use case, the secure bubble.

It's a bit different from the 2 previous use cases but still based on the capability for 2 objects/things implementing a technology based on 802.15.4-2011 to accurately locate/position themselves.

As its name stands, the secure bubble aims at creating a safe zone around an object/application or between 2 objects.

The 1st step if you want to create a secure bubble is of course to authenticate the user. In this 1st example, on the top left, this would be achieved by reading your fingerprint on your smartwatch. Then, you can "pair" all your valuables with your smartwatch so your watch knows which objects to look after. Once this is done, your smart watch would constantly monitor the distance between itself and each of your valuables.

This allows to raise alarms as soon as one of your valuable exits the secure bubble like if you forget your wallet on the restaurant table or your laptop under the seat of your car.

Of course it's not only for the absent minded, it is also a perfect tool to protect your valuables from thieves.

Other functions that are really interesting are the automatic lock/unlock of your

laptop/tablet/phone as it would know that you, no doubt it's you as you're authenticated, are in close proximity or leaving the bubble. Would be fantastic to get rid of all those passwords we have to remember of to unlock our devices.

Another area where being able to create a secure bubble would bring lots of value is the secure payment, top right.

Contact less payments are really trendy nowadays but as with every trendy technology, we start to see some malicious persons trying to hack the system and succeeding.

Here the idea is to avoid what is called relay attack.

How relay attack works is fairly simple. Using two fake points relaying the messages between two honest points, the POS and your NFC credit card for example, thieves can pay using your card and you would not even notice.

Now, if you are capable of accurately measure the distance between the POS and your credit card, one of them can detect the relay attack as the measured distance would be much larger than usual (less than a meter) and could turn down the transaction.

This scenario has been taken to reality by Gemalto, world leader of Secure elements, for a pilot project called e-Go.

Last example around the secure bubble, the automotive industry and more precisely the passive entry systems.

The current key fobs are very vulnerable to relay attack and it's a real concern for car manufacturers especially the premium car manufacturers.

On a technical stand point, it is the same principle as for the secure payment. By adding the key to car distance information you had a new level of security to the communication.

This will be implemented in a car by end of 2015 by a 1st car OEM and others will follow shortly.

Conclusion

There is still a lot to be done to make the 802.15.4-2011 standard a defacto standard when it comes to accurate location and positioning.

But as you've seen during this presentation, the industrial, consumer and automotive markets are already starting to leverage the capabilities of the technology based on this standard as it really solves industry issues and opens the door to game changing applications.

Join the pioneers!