Low-Power WiFi exists today, and it is called: ZigBee…

It is always interesting when new communication standardization activity is in development, in particular when it is in the area of WiFi, the ubiquitous standard that many of us are using on a daily basis, if not continuously!

So therefore we should pay attention to the fact that the IEEE has established a new WiFi working group (IEEE 802.11ah), also called: Low-Power WiFi. Because the final approval of this standard is not expected before 2016, we have some time to consider the question: what is this new standard activity going to deliver to the world, in particular since today we have already ZigBee?

The blunt answer is very little.

Low-Power WiFi IEEE 802.11ah could very well be a waste of time and effort, because it solves a problem that already has been solved. Low power, low data rate ZigBee is rolling out today in large volumes in set-top boxes and Smart Home offerings, in smart meters and lighting controls. Requiring a lot of resources and efforts, IEEE 802.11ah will attempt to redo what already has been accomplished… and providing a solution that nobody in the market needs.

Let's take a look at the recent past. The last 10 years already have shown significant efforts (and VC investments) in the low-power WiFi arena. Examples are: Aeroscout, G2 Micro Systems, Ekehau, Pango, Wherenet, ZeroG Wireless and more recently GainSpan. The common denominator between all these companies is (was) that they all attempted scale down WiFi complexity in order to increase battery life. Interesting results have been achieved – however, never good enough to make a real breakthrough. Battery life of low-power WiFi devices has stayed in the "few months" range at best.

When we started GreenPeak Technologies in 2005 with a few of the original WiFi inventors, we also looked at making WiFi as low power as possible. But we quickly realized that even with a lot of compromises, we could probably only push the battery life up to one year. For a large network (such as in building automation) with 5,000 sensor nodes in a facility, this would result in 100 battery changes required every week. We quickly realized that this would never lead to an attractive business proposition!

So we quickly moved on to investigate "no battery needed" solutions: energy harvesters like solar cells, piezo elements, etc. Today there are several start-ups working in this field. But here also we concluded that there would be no feasible business proposition. Although there may be some niche applications like light switches, in general energy harvesting plus the accommodating electric circuitry, is too expensive for mass consumption and not dependable enough. For instance: when there is no light there is no energy. Additionally, the harvesting mechanics are not durable enough.

The solution? IEEE 802.15.4

Our GreenPeak engineers looked closely at IEEE 802.15.4 (ZigBee) and found out that we can effectively implement low-power ZigBee as a solution. It successfully met all the market requirements: long battery life, low cost, good indoor range (comparable to WiFi), one worldwide frequency band (2.4 GHz), small antenna size, etc. ZigBee turned out to be in the sweet spot of the sometimes conflicting requirements between power consumption, range, data rate and cost. By using low cost batteries we can enable manufacturers to build fully networked wireless sensors in a $2 to $5 range (depending on the type of sensor): temperature sensors, open/close sensors, smoke/gas detectors, remote controls, etc.

This year (2013) the expectation is that about 100M ZigBee nodes will be shipped, more than

doubling compared to last year. Considering the number of emerging applications this number continues to grow rapidly and will further accelerate in the coming years. Starting with smart energy, remote controls, lighting and the smart home, the expectation is that the number of ZigBee nodes will grow to 5 billion or more in 2020, exceeding the number of WiFi nodes out in the world today.

So… where does this leave the new Low-Power WiFi?

A few things stand out on the IEEE 80211ah standardization activity. In the first place there is the compromise that puts this technology in the sub-GHz bandwidth (and not in the 2.4 GHz) to save power. but the price of this compromise is high: the so-called sub-GHz differs from location to location on the globe.

For instance, Low-Power WiFi will operate at 915 MHz in the USA, 868 MHz in Europe, 780 MHz in China, 950 MHz in Japan, and more different frequencies in other countries. For radio developers this poses an interesting technology challenge, but for worldwide product makers, this is a real logistical nightmare! Product makers will have to deal with differing sets of regulations and certifications for the various regions; they will have to provide different products for each country they want to sell in. Why would they want to tackle this manufacturing challenge when ZigBee is already available worldwide?

In this respect it is interesting to bring back into memory that in the early 802.11 days (the name WiFi was even not invented yet) WiFi-like products were shipping in the USA in the sub-GHz band (915 MHz) and that large companies (in particular IBM and Apple) told us: “Come back when there is one frequency band worldwide, we want to reduce product versions”.

At that time the 2.4 GHz ISM band was the only available possible option (ISM stands for: Industrial, Scientific and Medical), and it still took almost a decade (1990-2000) of lobbying work with local frequency responsible organizations as well as with the ITU, before most of the countries worldwide harmonized the license free usage of the ISM-band for high speed data-communication. This work in the IEEE resulted in a single product technology, usable worldwide – benefitting manufacturers, developers, networks, distributors, retailers as well as end users.

So how weird is it that the same organization is now going backwards – effectively retracing its steps by selecting the sub-GHz band for yet another flavor of WiFi? It is even stranger: calling something new like this “WiFi”, implies that in one or another way there is interconnectivity to WiFi as we know it today.

For instance: looking at Low-Power Bluetooth (BLE, Bluetooth Low Energy, or Bluetooth Smart 4.0): it at least works in the same 2.4 GHz band as regular Bluetooth. And although the MAC-layer (Media Access Control) of BLE is different, the PHY-layer (Physical RF, radio) of Bluetooth and BLE at least can be shared so products can be integrated. But with Low-Power WiFi the PHY, and probably also the MAC will be different: so in practice, there is nothing shared anymore between WiFi and Low-Power WiFi – not even the antenna… So even just calling this WiFi should create a major outcry, because actually has nothing to do with WiFi anymore.

Another item to mention about the sub-GHz technology is the required antenna size, something else that also really supported the early day’s move from the sub-GHz bands to the 2.4 GHz worldwide frequency band. To be effective, sub-GHz antennas need to be inconveniently large. In general sensors are small and inconspicuous, which means smaller antennas are definitely preferred.

Although designing antennas is an art in of itself, generally speaking keeping everything else the same, the rule is: lower frequencies require larger antennas, and where a ZigBee 2.4 GHz product can work well with a 6 cm/2.5 inch antenna, a sub-GHz product will require under comparable circumstances a 17 cm/6.6 inch antenna, nearly three times the size! Well… that is quite large for a small sensor…, and therefore usually more expensive as well. Of course antennas can be miniaturized (e.g. by “folding”), but this will have either a negative effect on the range, or a negative impact on the energy consumption to compensate for this.

Low-Power WiFi also stands out negatively on the data rate that is expected for the IEEE 802.11ah standard: 100 Kb/s (26 channels) – compare ZigBee with 250 Kb/s (15 channels), with proprietary implementations going up to 1 Mb/s, to support for instance walkie-talkie voice. Keeping everything else equal: lower data rates usually mean less power consumption or more

range. Agreed: for standard usage in sensor networks, 100 Kb/s may be enough data rate, but during installation and commissioning with security key exchanges and multiple handshakes, the raw data rate of 100 Kb/s may prove to be inadequate. For both IEEE 802.15ah and ZigBee the number of channels seems to be more than sufficient because the duty cycle of sensors is generally speaking quite low (less than 1%).

For the remaining tech specifications, IEEE 802.11ah and ZigBee are quite comparable. Both standards support thousands of devices (actually ZigBee supports 64K devices on a single network, Low-Power WiFi is still to be defined), and both standards support meshing/relaying techniques that can be used to expand coverage through concatenating networks.

Smart Home Requirement	Power consump-tion	Range	Cost per chip	Antenna size	Standar-dization	Net-working	Data rate	Multi-vendor	Frequency band	Location detection
	Battery life exceeds product life	Home	Low (<$0.50)	Small/ Un-obtrusive	Open standard compliant	Full capability (>1000 nodes /net)	Sufficient for sensor network operation (>250 Kb/s)	At least >10 providers	World-wide uni-formity	Required for future appli-cations
ZigBee™ IEEE 802.15.4	Yes	Home	Yes as of $0.50	Yes 6cm/2.5"	Yes	Yes	Sufficient 250 Kb/s	Yes (>10)	Yes 2.4 GHz	Yes
Wi Fi Prop LP-WiFI	No < 1 year	Home	No as of $1.25	Yes 6cm/2.5"	No	Yes	Sufficient >1 Mb/s	No (4)	Yes 2.4 GHz	Limited
Wi Fi IEEE 802.11ah	Target: on par with ZigBee	Home	Target: on par with ZigBee	No 17cm/6.6"	Yes	Yes	Too low 100 Kb/s	None available yet	Fragmen-ted by region	Yes
Bluetooth	No < 1 year	Room	No as of $1.00	Yes 6cm/2.5"	Yes	No	Sufficient >1 Mb/s	Yes (>10)	Yes 2.4 GHz	No
Bluetooth SMART	Yes	Room	Yes as of $0.50	Yes 6cm/2.5"	Yes	No	Sufficient >1 Mb/s	Yes (>10)	Yes 2.4 GHz	No

ZigBee is ideally suited for Smart Home Networks.

This also includes Bluetooth and Bluetooth Smart, as some times people wonder whether Bluetooth would be an alternative for ZigBee. The answer is clearly that Bluetooth is not an alternative. In the same way as WiFi and Bluetooth each have their own application space and coexist in devices like computers and smart phones, ZigBee (low-power WiFi) and Bluetooth Smart (low-power Bluetooth) will also in the future peacefully coexist.

Summarizing and looking at the total picture.

The success of WiFi is quite unique. Before its market acceptance, 15 years ago, selling WiFi was an uphill battle. Today the technology has become a key facilitator for the growth of a ubiquitous internet and for the usage of laptops, tablets and smart phones almost anywhere. Key to that success was the worldwide available, license free ISM-band in the 2.4 GHz. This unique fact is similarly driving the success of ZigBee today. ZigBee also seamlessly fits the larger WiFi architecture. Suppliers like GreenPeak with an in-depth knowledge of WiFi have taken extreme care in how to share the same 2.4 GHz spectrum, even with WiFi and ZigBee radios located in the same box.

Furthermore, today ZigBee is available from multiple vendors, shipping technology products worldwide, and enabling product makers to ship single products with worldwide certifications, leveraging product manufacturers' experience of mass production in the 2.4 GHz to reduce cost. ZigBee is extremely low power: the battery life of ZigBee based products can be (depending on the configuration) more than 10 years. In many cases, the battery powering the ZigBee radio can exceed the life span of the product it is built into. ZigBee's range is comparable with WiFi and it fits the WiFi set-up in integrated access points, as well as supporting stand-alone implementations through mesh networking capabilities.

Today, we already have low-power WiFi, and it is called ZigBee. Who needs Low-Power WiFi?

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