



## 1. Smart Home Networking

For decades the concept of Home Automation has been inspiring dreamers, first adopters and those who love technology in all its forms.

The dream is that one day we will be relieved from all the mundane tasks that interfere with the things that we would really love to do! The reality however seems sometimes far away from this – even to the point of getting tired when hearing about yet another bid for a standard Home Automation concept.

Just for clarification: in most of our homes we currently have several wired and wireless networks. There is a phone network, a data network, sometimes an audio/video distribution network. These are all networks distributing content through the home, a local distribution of what we are offered by cable operators or telecom and internet providers. Key for these networks is bandwidth: the more and the faster, the better.

But in this paper I would like to examine the network for Home Automation separately, as the nature of this network is quite different. It is not about content distribution, but about sensing and controlling. The essential elements are: availability, reliability and cost – while bandwidth is actually quite irrelevant.

So, with this as a background let's examine the state of Home Automation networking today. In our homes we have many incompatible devices connected with different forms of wires or wireless, communicating over different protocols, not able to communicate with each other. We have remote controls, garage door openers, thermostats and light switches – maybe even security devices and smart electricity meters! But did you ever try for example to use the TV remote control to change the thermostat, or use the garage door opener to turn on the garage lights?

Why is that? And why does a simple concept as an integrated Home Automation Network seem so distant and unattainable in this age of ubiquitous computers and smart phones?

The answer to this question can be fairly simple described as “the power of the status quo” or inertia. Why change if what you have works well enough?

Today's Home Automation Networks are essentially a jigsaw of all kind of proprietary stand-alone wired and wireless point-to-multi-point technologies. If one of pieces breaks down (which sometimes happens), then we will be happy to replace it. However: until it fails, there

---

is little incentive to get up one morning and to decide to replace all the jigsaw pieces with one integrated Home Automation Network.

So the question is: what is it going to take for the integrated Home Automation Network to become a reality? The good news is: it is on its way, but frankly, it may still take a little longer than predicted, and it may follow a somewhat different route than expected!

## 2. Integrated Home Automation Networks

Before trying to understand the timeline for the arrival of integrated Home Automation Networks let us make an inventory of the three necessary roadblocks that need to be achieved.

1. In the first place there is the requirement for an open communication standard, allowing product developers from different backgrounds to develop products that can communicate and interoperate. This open standard has existed for several years and is called ZigBee. This standard is supported by the over 400 ZigBee Alliance members, from chip providers to product brands, from manufacturers to operators. Very similar to Wi-Fi, this standard is based on the work of the IEEE (IEEE 802.15.4), runs in the 2.4 GHz worldwide available frequency band (like Wi-Fi) and has integration capabilities with IPv6 (6LoWPAN), the new Internet 2.0 that is in the process of replacing the internet as we know it today.

There are a few other contenders claiming to fill this spot (eg. ZWave or EnOcean). However, these technologies are limited in scope, frequency and/or closed and proprietary, and therefore on the long term likely to disappear.

2. The second requirement is that this ZigBee standard meets the technology usability requirements in terms of range, battery life and Wi-Fi (and Bluetooth) interference rejection.

The range of ZigBee devices is now very comparable to Wi-Fi and good enough to cover a complete home, if needed with the help of some repeaters. Also, the battery life of ZigBee devices has significantly improved over the last few years and it is now possible to make products, where the battery life time exceeds the product life time and/or products that do not require any batteries at all. There are several ZigBee devices that have been tested and can operate for ten years or longer without ever having to change or recharge the battery!

Many homes today have already a Wi-Fi network installed. Careful radio design and protocol implementation in ZigBee make it possible to reduce the Wi-Fi interference to a non-noticeable minimum, resolving this issue as well.

3. The last requirement is cost effectiveness. Home networking devices, of which there are expected over time to be at least 50 in every home, need to be at an effective price level to be justified. The good news is that with the growth in volumes in the ZigBee market, the costs have come down as well. The expectation is that this trend will continue in the coming years, allowing the product manufacturers to effectively compete against many of the current fit-to-purpose proprietary technologies out in the market. A first example

---

is in remote controls, where the cost of ZigBee solutions can compete effectively with the cost of outdated infra-red technology.

The conclusion of the above is that the necessary conditions for the arrival of open standard ZigBee based integrated Home Automation Networks have been fulfilled. Clearly, further technology implementation improvements can be expected, however range, battery life and reliable connectivity at a cost effective level can be achieved. So, what more is needed?

### 3. Convergence: the “5<sup>th</sup>-play”

Back to the original question: how will the jigsaw of proprietary Home Automation Networking solutions get resolved, if no one wants to start rebuilding his home (networking) from scratch? The practical answer will be one of convergence. By simply starting with a new piece of the puzzle using an open standard Home Automation Network solution (ZigBee) and then slowly, but surely building upon it. New solutions will add to the open standard and updates of existing older proprietary solutions will one by one be replaced with this new standard.

What could be the point of convergence?

The most appropriate candidate for this is interestingly enough the set-top box and its remote control. This device originally started as “that ugly box” next to the beautifully styled television set, now has all the potential to become the pivot around which the whole concept of Home Automation will start converging.

Instead of being controlled by an old fashioned infra-red remote control, the new generations of these set-top boxes have a ZigBee communication chip inside that allows the set-top box be controlled by a ZigBee RF4CE standard remote control.

This new remote control has immediate advantages for the cable operator: it has better range than infra-red (not requiring line-of-sight) as well as the longer battery life (not requiring batteries to be changed) and this benefit translates for the operator by reducing the amount of support calls: the total solution is just more robust.

In addition, ZigBee’s two-way communication capabilities also allows for more versatile functionality, like menu control and browsing on the television, sending a warning signal when a favourite program starts on another channel, or even a “find-me” function, where pushing a button on the set-top box will make the “lost” remote control blink and beep – so: no more missing remote controls!

But there is more at play. Cable operators consider the set-top box as the gateway server for the home, building a path to the future, where the same ZigBee radio not only communicates with the remote control, but also controls other devices in the home. And here is where the convergence starts to kick in! More applications can easily connect to the Internet via the ZigBee chip in the set-top box.

By the way: cable operators have another motive as well. Their subscriber base as well as their product portfolio is slowly but surely eroding, because people are moving more and more to watching TV or listening to music via the internet, not needing a cable subscription anymore. So, in order to engage their subscribers and keep them as customers, operators are looking to deliver new services to the home, like security, energy management or home

care, together referred at as “the 5<sup>th</sup>-play” (after phone, TV, internet and cellular) These 5<sup>th</sup>-play services require a home network that is standardized and can integrate with the technology in the set-top box: ZigBee standardized Home Networking is the logical choice achieving this. Using a standard technology also enable these operators to turn on an ecosystem of suppliers of products that can implement these services for them.

Comcast, one of the world’s largest cable TV networks has already announced that they will be switching over their systems to a ZigBee based set-top box and remote controls. Many of the competing cable TV providers are also quietly making this change as well.

If the subscriber wants to install a security system, that same set-top box that is used for TV channel distribution can provide an internet connection for the security system. If the subscriber has an electricity company that wants to install a smart meter that is equipped with a ZigBee device for communication to the external world, this smart meter can immediately talk with the gateway and over the internet, without the electricity company having to build its own infra-structure.

And it will not stop here either! Through the smart phone this gateway will enable a subscriber to monitor and control residential applications from any location in the world.

When a subscriber wants to install a central door locking system for his/her house, state of art ZigBee equipped door locks can easily be checked and controlled securely from any location via the web connected set-top box. For instance when traveling, the home owners can check to make sure the doors are locked using a smart phone app, or: if the kids are locked out, the doors can be remotely unlocked.

When the thermostat is equipped with ZigBee, the heating or air-conditioning can be controlled in the house via the remote control over the internet as well, from any location via the smart phone again. No more wondering whether the heating or air-conditioning was turned off, after you have left the house! Or, on your way home from work on a cold day, you can turn on the heater to warm up your house before walk in the door.

## 4. Multiple (wireless) standards in the home

In homes of the future, just as in homes today, there will be many networks working in parallel. But there essentially will be two main networks that will use internet technology as a platform.

One network will distribute content through the home, and can be a mixture of Wi-Fi, Ethernet, maybe MoCa, and then connecting via a set-top-box to “the internet”. The name of the game here is: bandwidth for high quality content – HDTV everywhere. This network is measured on throughput and capacity and we are using this already every day.

The other network will be the sense and control Home Automation network. Today this is a jigsaw puzzle of all kind of proprietary mostly isolated stand-alone point-to-point connections (eg. garage door openers or infra-red remote controls), but in the future, based on the scenario described above, converging to a single ZigBee standardized solution. The name of the game here is: ease of use, availability, and long battery life.

In this perspective it is probably interesting to mention why long battery life is so important. In an average home, there will be perhaps 50 battery controlled devices (remote controls, doors and windows for security, heating/air-conditioning controls, lighting controls, curtains and window shades, etc.), each with a battery life of one year. This means that the homeowner has to change on average one battery per week. In this perspective, it is easy to understand that battery life exceeding the life of the product is a necessity for a sense and control network to become functional.

This Home Automation network is also connected via the set-top box to the internet, but it is good to realize that now we will be talking about the new internet, Internet 2.0, or the IPv6 based Internet of Things – for the simple reason that the number of connected devices in the coming years is expected to explode – accelerated by a factor 10 to 100, to get Home Automation implemented over the internet. IPv6 expands the number of possible internet addresses by many orders of magnitude. Therefore each device can now have its own unique internet address for connectivity, communication and control.

The immediate other question is: why do we need ZigBee?

Why can't we use Wi-Fi for Home Automation?

Technically this is possible; however the battery life of devices running Wi-Fi is short so this will create a maintenance nightmare. And although there are efforts underway to improve the battery life with technologies like Low-Power Wi-Fi and Wi-Fi Direct, the actual consumption of these technologies exceed the energy consumption of ZigBee by orders of magnitude.

Bluetooth, or Bluetooth Low Energy, has been proposed as possible technology for sense and control networks in the home, and some efforts are underway for instance to equip remote controls with Bluetooth instead of ZigBee RF4CE. However, Bluetooth is not a local area network technology, but a personal network that an individual carries with him around in and out of the house (eg. with a headset connected to the mobile phone). It does not have the range or the networking capabilities to become more than a connectivity technology. Therefore and despite claims of the opposite, it is quite unlikely that Bluetooth will play the role of the sense and control network for Home Automation, in the same way as Bluetooth has never played the Wi-Fi role for the internet connection in the home.

## 5. Conclusions

Home Automation exists already today, but is built up from a set of incompatible applications that do not communicate with each other and usually also do not communicate with the outside world. Over time these two shortcomings will disappear, but this will not happen by revolution, but by evolution: the roll-out of new applications around the set-top box that comply with the new ZigBee standard, and that seamlessly integrate, making existing solutions redundant and go away.

Operators have an incentive to rebuild their set-top boxes to become the point of convergence for Home Automation, moving to radio based remote controls will reduce the number of service calls and at the same time opening the opportunities to deliver additional services to their subscribers, creating for them a new revenue stream, a 5<sup>th</sup>-play, that will help to stop the revenue erosion that they are facing, because of people getting TV and entertainment services via the internet.

This will pull in more and more applications onto a single ZigBee platform creating a Home Automation Network connected to the internet, that will create a safer, more secure, more convenient and a more energy conscious home environment.

Download this white paper in pdf from the GreenPeak website:

