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ZigBee: Plugging the Gap in Bluetooth and WiFi

We've all just about got used to the idea of Bluetooth for "wireless cables" and WiFi for hotspots. So now along comes the oddly-named ZigBee, using the same frequency band (plus a couple of others), slightly less range and able to transmit at only much lower data speeds. So do we really need it and will it survive?

Home Networking or Home Automation?

"The Home" is receiving a lot of attention lately as the place that could do with a lot of new technology. Some of it seems like wishful thinking. Ideas that we want to connect all our electronic devices at home – from PCs, stereos, TVs and DVD players to the security system, all utility meters, microwave oven, fridge and even toaster – to a single home network that is then connected to the Internet does not stand up to much scrutiny at this time. Why would we all want to do that?

In fact, the home networking market appears to be fragmented into four different application areas:

- PC networking, connecting two or more PCs to a single broadband connection to the Internet as well as printers and other resources that can be shared.
- Home entertainment distribution, sharing content among televisions, stereos, and game consoles around the home.
- Home control, where one group of applications offers electronic control of heating, lighting and security systems.
- Home appliances, where your fridge can access recipes on the Internet or shop on your behalf and your washing machine can call a service engineer.

Then there is Microsoft's work on SPOT (Smart Personal Object Technology) that seems to be a way for Microsoft to try to "improve" everyday household objects like alarm clocks, key chains and pens.

Of these, PC networking is clearly in the ascendancy at present, as a direct result of the rollout of broadband connections to the home. The second typically involves connecting the TV to the stereo system, for example, and looks a little less certain as a mass market. It may well pick up steam though also as a result of broadband connections – transferring those music and video files from the PC to the home entertainment system perhaps.

Home appliances looks very experimental at this stage. The idea of home control, though, has been around for some time without ever taking off and clearly has nothing much in common with either of the first two.

Not Bluetooth, not WiFi

If the home control/home automation market is going to happen at all, it needs to be at the right price. The idea of controlling the lights, the heating, the security system and many other common items in the home from one remote control device has captured the imagination of inventors for many years but unless it can be done for a snip, it will continue not to happen.

This is the world of low cost sensors, embedded in walls and in products located

throughout the house like light switches, thermostats and utility meters. Cost is the major issue with these items, followed quickly by size. If you can make something small enough and cheap enough to be embedded in many of these products during manufacture, then you might have something to play with.

WiFi is an immediate non-starter. Far too costly, far too complex. Bluetooth may look like an obvious candidate, but it too has some key difficulties for this type of application. First off, it's quite expensive – more than the cost of the product it would need to be embedded in, in many instances. Secondly, it uses too much power. For a typical cell phone application – providing handsfree phone use or connecting a laptop to GPRS for example – sufficient battery power is on hand to make it not a problem and Bluetooth excels. For home control applications, though, you really don't want to recharge or replace batteries at all – ever.

In most sensor applications, proprietary wireless solutions are common. In nearly all of these cases, the main focus is on the sensor and its data, while the wireless component is there just to move the data. However, a lot of effort is typically spent just trying to get the radio part to work reliably enough to meet the requirement. Certainly, more effort usually goes into this than on the sensor itself. Even when that task is done, the result is a proprietary solution that reduces the customer's flexibility and future use.

Infrared is also in there, much in evidence for TV/video/DVD/HiFi remote control. It is a mature wireless technology with a long history. However it only provides single direction point-to-point and line of sight transmission between transceiver and receiver, so it isn't ideal.

Reaching parts that others do not reach

This is the world of ZigBee and machine-to-machine communications (M2M). Zigbee aims to provide an open standard for low-power wireless networking of monitoring and control devices. For those who care it works with the IEEE 802.15.4 standard (Bluetooth is standardised as 802.15.1). It is targeting home and building control, automation, security, consumer electronics, PC peripherals, medical monitoring and toys – to name just a few. Such applications require a technology that essentially offers long battery life (measured in months or even years), small size, high reliability, automatic or semi-automatic installation, and in particular low system cost. Signals that pass through walls and ceilings are also handy.

In many applications, you can't afford to make regular trips back to a sensor to change the battery. Ideally, the battery is good for the life of the sensor. The basic standard for ZigBee is fundamentally efficient in terms of battery performance. Battery lifetimes from a few months to many years are feasible as a result of a host of power-saving modes and battery-optimised network parameters.

It operates at multiple frequencies – 250 Kbps at 2.4GHz, 40 Kbps at 915 MHz (for American markets) and 20 Kbps at 868 MHz (for European markets) – and therefore occupies the same unlicensed band as WiFi and Bluetooth. It may not be obvious why a simple temperature or intrusion sensor needs to transmit data at 250 Kbps (at 2.4 GHz) or even 20 Kbps (at 868 MHz), but the reason becomes clear when you consider the need to prolong battery life. Even when the sensor is transmitting only a few bits or bytes, the system can be more efficient if it transmits and receives the data quickly.

It's range is short – typically 30 to 70 metres. It is also cheap and very small. The cost target for ZigBee chips is $1 or less. We've all heard of cost targets before that haven't been met (Bluetooth itself comes immediately to mind), but this time things seem to be happening. For example in February this year, researchers at the Korean Advanced Institute of Science and Technology announced that they had built a prototype radio that adheres to the IEEE 802.15.4 standard, making it the first radio to meet the

standard. They said their 2.4-GHz coin-sized radio (which measures just 8.75 mm2) costs less than a dollar. The device is essentially a system-in-chip, housed in a plastic package, with on-board transceiver, processor, antenna – and battery.

Also unlike Bluetooth, ZigBee can support 30-40 devices at the same time and is interoperable with different platforms.

What next?

ZigBee compliant products are now likely to come to market in 2004. The aim is that, eventually, ZigBee will replace all the Infra Red links in the home and a lot more besides.

It has some big names behind it too. Formed in October 2002, the ZigBee Alliance now has over 50 members worldwide, including Philips (the world leader in lighting and lighting electronics), Honeywell, Hewlett-Packard, Intel, Mitsubishi, Motorola, Omron and Samsung.

Many of these have high hopes for ZigBee. Philips, for example, are projecting sales of more than 500 million units of ZigBee ICs in 2005. Honeywell concurs, “We are very bullish on ZigBee. Particularly in a home scenario, we believe that no new wire is so critical.”

Looks like there is finally some momentum behind the home control/home automation market after all.

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