EZURiO

Wireless Connectivity out of the box

An introduction to Wibree

Following an unexpected launch, Wibree has been subjected to an initial flurry of misunderstanding and then has been largely ignored.

The reality is that it is poised to become the fastest growing wireless standard ever. Its symbiotic relationship with Bluetooth will open up massive opportunities for network operators to deploy new consumer based services, kick-starting the C2M Consumer to Machine market.

This White Paper explains the reality and the opportunities.

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Wibree – introducing what will become the world's fastest growing technology

The recent announcement of the Wibree standard by Nokia seems to have caught the industry unawares. The initial response of many analysts and much of the media has been to categorise it as yet another competitor in the 2.4 GHz space. A significant number have announced that it obviously just a "Bluetooth killer". Nothing could be further from the truth. One of the most important aspects of Wibree is that it envisages dual-mode chips that can support both Bluetooth and Wibree. This symbiotic existence is key to Wibree's market success. There will also be single-mode Wibree chips that offer low power operation, which will enable a wide range of devices to talk to these dual mode chips.

Every wireless standard faces a problem of achieving a critical mass of nodes if it is going to enable mass market applications. Wi-Fi managed this on the back of laptops, Bluetooth managed it on the back of mobile phones. So far none of the other prospective short range wireless technologies have found a platform that will give them critical mass within the market place. The design of Wibree is particularly cunning as it builds in a route to mass deployment. Because the bulk of Bluetooth chips shipped by Christmas 2008 will include Wibree dual-mode functionality, effectively for free, it means that by the end of 2009 there could be over 100 million Wibree enabled handsets in existence.

It is a strategy that means Wibree will redefine the speed at which a new wireless technology can be rolled out into the market. If we look back over the last fifty years, it typically took years for new technologies to reach their first million products in the field. It took the colour TV eight years to reach the million mark. The PC was faster, at 28 months, the Palm Pilot set a new record at 9 months. That record for consumer products was shattered by the iPod, which took just 17 days. Wireless technologies have had even slower gestations. From the first to the millionth 802.11 chip took a leisurely 4 years. Bluetooth did better, but was still a slow starter taking 17 months from the first product to the millionth one, although it proved exceptionally active since that point, taking just another 5 years to get to the billion mark. All existing records, both in consumer goods and wireless technologies are set to be overturned when Wibree leaves the starting blocks. Because of the fact that it will be integrated inside Bluetooth chips, it is likely to reach that one million shipment milestone in just one week.

That combination of Wibree within a Bluetooth chip is vitally important in understanding its place and the role that it can fulfil. Because low power, personal Wibree devices will be able to communicate with handsets, it means that in time every mobile phone becomes a Wibree gateway to the mobile network. So every Wibree device can communicate with the internet, allowing information to be sent backwards and forwards. And because the data rates are low, the cost of this data transfer will be a negligible portion of the user's monthly phone contract. That paradigm change will enable a wide range of additional services that today are just too expensive for widespread deployment.

Where Wibree came from

Wibree didn't just appear from out of the blue this October. Although the current specification is still confidential a little digging produces a lot of its history and provides a good guide to its content.

There is an irony in the fact that the origins of Wibree were the alternative proposal for the radio and Media Access Controller (MAC) for the 802.15.4 standard, which is now the basis of ZigBee and other short range radio networks. Back in 2001 two industry groups put forward proposals for the form of this radio. Nokia headed one of the groups and proposed a development that was handset centric. A major tenet of their design was that "it can be deployed with minor effort into devices already having Bluetooth, e.g. cellphones" with the added requirement that a "common RF section with Bluetooth must be possible". Their vision was also broader that that of the competing camp in that it

envisaged a world of a trillion wireless, web connected devices. A key slide shows millions of connected laptops, billions of mobile phones and trillions of what could be interpreted as Wibree enabled devices.

In the event, the IEEE committee chose to adopt the alternative proposal for the 802.15.4 standard. However, Nokia didn't stop work on their proposal. Over the intervening years it has developed and matured into what has now been announced to the world as Wibree. The original proposals are still available for public viewing on the IEEE site [1].

The name has also raised eyebrows. Like Bluetooth, it is a new word that tells us little of the technology. It derivation shows some of the same interest in northern European history and mythology that generated Bluetooth. The "Wi" is the now obligatory prefix for "wireless", with Nokia claiming that the "bree" comes from the Old English word for a crossroad. I'm not totally convinced – I have a suspicion that this definition of bree is a Tolkien invention, as my Old English dictionaries define bree as "agitation", "to frighten" or "eyebrow". Both of which seem equally appropriate. So we have "Wireless at the Crossroad", "Wireless to be scared of" or Wireless eyebrows". Whichever takes your fancy; one thing is certain - Wibree will certainly herald a new era of personal wireless connectivity. And the engagement of the major Bluetooth silicon vendors will ensure that it will quickly appear in hundreds of millions of handsets.

What Wibree does

The original documents, plus information gleaned from the Wibree web site give us a good idea of what it will be able to do. With the engagement of the new partners there will be a wider input into the standard before its public release in mid 2007 and some aspects will almost certainly change to reflect current market requirements.

Wibree's main application is to provide an ultra low power radio within the 2.4GHz band. Low power is always determined in large part by the application – the longer a device is active, and the more data it transmits, the shorter its battery life will be. Wibree is aiming to produce a radio that can transmit a small packet of data approximately every second for a year using a small button cell, such as a CR2430, with a capacity of around 280mAH. If the duty cycle is reduced to one transmission every 15 to 30 seconds, then the battery life effectively becomes the leakage life of the battery.

This low power drain is achieved by designing a radio and protocol that lets the radio stay asleep for most of its life. It can wake up quickly, when it will broadcast its requirement to transfer data on a number of advertising channels across the spectrum. The receiving device, which is likely to contain a larger battery as it will be on for more of the time, will acknowledge the message and tell the first device which channel to send its data on. It will then acknowledge receipt of this data, at which point both can go back to sleep. The whole process will take less than three or four milliseconds. More details of what this process is likely to look like can be found in the original IEEE submissions [1].

Cost is a key advantage in Wibree existing within a Bluetooth chipset. But it's not the only advantage of that symbiotic existence. A major concern abut radio deployment in the 2.4GHz band is the growing level of interference that is likely to exist. That's already resulting in a resurgence of interest in Bluetooth for industrial applications because of its resilience to interference. Where ultra low power is a requirement, there is still no satisfactory solution – a situation that has persuaded groups such as ISA [2] to look afresh at their radio requirements for a robust industrial wireless standard. Wibree provides the answer. Because the conversation between devices allows the responding device to select the radio channel to use, it introduces the concept of frequency agility, where the two radios can move to undisturbed parts of the spectrum for their data transmissions. In most cases, this receiving device will be a mobile phone, which is acting as a gateway. The same Bluetooth chip that contains the Wibree radio within the phone will be constantly scanning the radio spectrum as part of its adaptive frequency hopping requirement to see what spectrum is free. It makes perfect sense to share this

information with the Wibree radio to give it the frequency agility that it needs to meet high reliability applications. So living inside a Bluetooth chip becomes a doubly positive advantage for Wibree.

The current description of Wibree on its web site [3] firmly positions it as a low range radio, suggesting that it will be limited to around 5 metres. That would appear to be driven by a marketing requirement rather than a more considered analysis of how it is going to be deployed. In that sense it's probably the same type of understatement that has haunted Bluetooth; although Bluetooth is normally referred to as a short range technology for less than ten metres, the reality is that it is successfully used for many applications over hundreds of metres [4].

Looking more closely at what we know about the parameters that will determine Wibree range, the first point is that it will share the radio and receiver of Bluetooth chips. The most recent generation of Bluetooth chips have receive sensitivities around -85dBm and can directly output at transmit powers of around +4dBm. With careful RF design that gives an open field range better than 200 metres. The higher modulation index of Wibree suggests that for the same receive and transmit values the link budget should be improved giving an additional 20% of range. Dual Mode Wibree chips will use the same receiver and transmitter technology within these chips, which means that there should be no problem in expanding Wibree's usage from devices that we wear or carry with us to sensors anywhere within the house or factory floor. Adding a Power Amplifier to boost the output to 100mw (+20dBm) should make it possible to reach an open field range close to one kilometre. That's going to require the addition of power control, which isn't mentioned within the published documents. But as more designers see the potential of Wibree it is certain that it will be demanded.

The initial Wibree profile set and what they mean

Wibree is adopting the principle of profiles to define its most common application areas. In its initial release, these cover the watch, sensors and Human Interface Devices (HID). Although this may seem a somewhat esoteric selection, together they enable far more than a first glance would suggest.

Taking the watch profile first, its main task would appear to be transmitting information to a watch to allow it to act as a micro-display. That may be seem to be a very "James Bond" sort of usage, and time will tell how attractive a user feature it really is. What's important is to realise is that it provides a method of transmitting information to any display. And the most prevalent portable display is the screen of our mobile phone. So the scenario can be turned around, with the watch profile being used to make a handset a general purpose display for other devices. That can be anywhere. At home, or in the wider world, such as public transport information broadcast from a bus stop or in a railway carriage.

The receiving device doesn't need to be static for this scenario. A feature of the short time required to complete a data transfer means this profile can be used with moving receivers. If we consider a transmitter with a 100 metre range, a vehicle moving at 100 km/hr will be within range of the transmitter for around 4 seconds – more than enough time to pick up traffic information from a beacon. An increasing number of vehicles already have a driver display that is Bluetooth enabled – it's called their satellite navigation system. There's only a minimal incremental cost to Wibree enable it to receive additional messages from roadside transmitters. It makes Wibree a very interesting proposition to those developing ITS (Integrated Traffic System) applications.

Perhaps the killer application for the watch profile is to use it for remote control of home entertainment, where the handset acts as a remote control for the PVR or entertainment centre. That's an application that has been bubbling around for many years, but has never been cracked. It has always been my belief that the wireless standard that can gain ownership of the universal remote control will own the home automation space. The issue

has been the low cost of an infra red transceiver, which is way below that of any current radio technology. Wibree will be the first wireless standard that approaches the cost of infrared. It has an additional advantage in that if you use your mobile phone, the set top box or PVR manufacturer can enable your mobile phone at no cost to themselves, as it already contains the Wibree radio. Because the Wibree watch profile lets another device "take over" the display of a consenting handset, it offers a technology route for far more advanced control and user feedback than is addressable with mass market remote controls. So the PVR manufacturer can ship a simple, low cost remote control with their box and enable the customer's mobile phone to add additional functionality and interactivity.

Wireless sensing is another great market waiting to happen. It doesn't just cover industrial monitors in factories, but encompasses pulling information from medical devices, home alarms and anything where some form of device needs to send information. The low power of Wibree makes if suitable for a host of battery powered devices. It also opens up the market for "power-free" devices that either use solar energy, or some of the more recent energy scavenging power sources that produce power from thermal heat (such as the human body) or vibration.

Finally HID is important because it takes account of latency. Latency in wireless systems refers to the delay between something happening at the sensor and the time that it is reported back to the receiving system. Delays can happen for many reasons – both external factors such as interference, and internal ones, such as the devices turning off to save power. For many applications a short delay doesn't matter, but for some it is vital that data is transferred at carefully controlled times. Human Interface Devices such as keyboards and mice are one such application where delays become very apparent, and the HID profile addresses these concerns. The application extends far outside these devices and is particularly relevant to industrial control systems.

Putting these together, the three Wibree profiles of Watch, Sensor and HID enable most of the prospective applications currently envisaged by wireless device developers.

The new opportunity for network operators and service providers

One of the most important features about Wibree is that it will quickly become embedded into a wide range of mobile phones. That allows the phone to act as a gateway for information, transmitting it back over the network to an internet based monitoring service. In general the data throughputs involved will be small, so the transmission costs will be low and will not swamp the networks' capacity.

It opens up a whole new market for monitoring consumer applications that is largely untapped. Today the GPRS network is used for Machine to Machine (M2M) and telematics applications, but these generally carry a significant hardware cost, as they require an integrated GPRS modem as well as an individual SIM and network contract. That prices them above what is acceptable for consumer oriented applications. With Wibree, the additional cost to the sensor will be the cost of a Wibree chip. The phone and contract are already paid for by the consumer, so network operators and service providers have the platform to enable a whole new generation of services.

The range of these is limited only by consumer demand and developer imagination. The obvious ones are healthcare. Less obvious ones will rapidly evolve. For example, consider emergency messages. If Wibree is fitted into the airbag in your car, then whenever it is deployed in a accident, the airbag could send an emergency call out through your phone. The cost of implementing that is around a dollar for the chip, plus the cost of the monitoring contract, which a network could offer for a minimal annual premium. Compare that to the cost of current systems, which involve several hundred dollars of hardware in the vehicle and a similar annual monitoring cost. It also plays to the current legislative requirements for mobile phones to provide emergency location information.

The same economics come to play in almost every scenario where a low cost alarm or monitor will be within range of a consumer handset. More and more government legislation around the world, such as that for food safety, vehicle tolling and medical compliance raise the need for data to be recorded, which in turns puts pressure on the market to deliver low cost wireless sensors. Wibree is appearing just as these programs are moving towards deployment.

Wibree and Bluetooth – Setting the agenda for wireless healthcare development

There is one area which Wibree will revolutionise more than any other, which is wireless healthcare. It's another market that has been waiting to start for many years, but there is a growing perception that its time is ripe.

Earlier this year, in his presidential address to the IET [5], Sir Robin Saxby, founder of ARM, predicted that healthcare monitoring would be the next wireless revolution. He explained that we are currently in a mobile phone economy driven world, but in the next decade his vision is that we will see a major wealth creation growth drive within healthcare, where wireless devices will drive things like telemedicine, helping a global aging population stay fitter.

That reflects a widespread understanding that healthcare needs to encompass remote monitoring in order to service the aging population. Depending on the application this goes by a variety of names, including eHealth, telecare, assisted living and wireless wellbeing. It encompasses everything from personal fitness plans to disease control and dementia monitoring. And it provides the means for an increasing proportion of the population to live independent lives, rather than slipping into institutional care which governments find ever more difficult to fund.

What these initiatives need is a low cost, low power wireless standard to allow the mass availability of sensors that are worn or which surround us and which have a method of transmitting the data they measure to a central server for analysis. Although personal monitors may only need a short range, a large percentage of the lifestyle monitoring applications require these sensors to be distributed around a house, placing a demand for significant range coupled with low power.

Although solutions are available today, they tend to be inconvenient, have short battery life, or require specialised gateway equipment to relay the data back. What Wibree offers is a low cost wireless solution for the sensor along with a ubiquitous gateway for the data transfer in the form of the mobile phone. In one stroke it enables a mass market for personal health sensors and also gives the mobile networks the means to provide monitoring services, or the pipe for others to implement them.

Now's the time to start planning

Bluetooth, Wi-Fi and other short range wireless technologies have already spawned a first generation of personal wireless devices and embedded applications. However, neither address the dual requirements of the myriad of devices that must operate off a small battery for a period of years and also have a readily available portal to send their information back to the internet. Wibree ticks both of these boxes.

More importantly, Wibree comes built within Bluetooth chips. Current development in Bluetooth, with the evolution of a medical profile, automation profiles and broadcast capability are paralleling the same developments within Wibree. What that means to a product designer is that they can start to design their products with Bluetooth today, knowing that there is a low power roadmap that will transition the mass of consumer devices to Wibree within a few years. That allows early deployments, which will start the collection of data for the expert systems that will need to sit behind so many of the wireless health applications that we will need in the future.

In parallel, the work currently being performed within the Bluetooth and IEEE organisations to standardise profiles and data formats for medical devices is also likely to encompass Wibree based products, providing the foundations for the growth of the new wireless healthcare sector that Sir Robin Saxby has predicted.

Conclusion

Taking all of these factors together, Wibree has the potential to transform consumer devices. It will solve the technology and monitoring issues that are currently hindering the adoption of wireless healthcare services and enable a whole new generation of lifestyle, monitoring and safety products. By making the mobile handset the gateway, it brings the network operators into the equation. And they have the resources to aggregate and enable service provision.

Today Wibree is a Nokia solution. However, it is being supported by the major Bluetooth chip vendors including Cambridge Silicon Radio and Broadcom. That means it will reside within the chips in almost every brand of handset. It is unlikely that other phone vendors will not take advantage of its presence, not least because it offers the network operators an additional revenue stream. Its presence will make it very difficult for any other short range, low power wireless technology to gain traction in the handset, ensuring that Wibree is placed to own the wireless healthcare market.

It may not become the accepted acronym, but Wibree will enable C2M - “Consumer to Machine” or “Consumer to Middleware” applications at a price point that makes them mass market. M2M is only just beginning to deliver against its promises. Wibree may result in C2M delivering an even larger promise in a shorter timescale.

By the end of 2007 EZURiO expects to be able to provide the first modular products to allow developers to start work on Wibree designs for wireless healthcare. In the meantime we also expect to see networks engage in investigating the infrastructure requirements to provide the data services to support these applications.

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