A

Seminar report

on

“Wibree”

Submitted in partial fulfillment of the requirement for the award of degree
of Bachelor of Technology in Computer Science

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Preface

I have made this report file on the topic **Wibree**, I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the prepration of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

INTRODUCTION

Now that wireless connections are established solutions in various sectors of consumer electronics, the question arises whether devices that draw long life from a small battery could find benefit as well in a global standard for wireless low energy technology. Makers of sensors for sports, health and fitness devices have dabbled in wireless but not together, while manufacturers of products like watches have never even considered adding wireless functionality because no options were available. Several wireless technologies have tried to address the needs of the button cell battery market, but most were proprietary and garnered little industry support. However, none of these technologies let smaller manufacturers plug in to a global standard that provides a viable link with devices like mobile phones and laptops.

However, companies that wants to make their small devices wireless need to build and sell either a dedicated display unit or an adapter that connects to a computing platform such as a mobile phone, PC or iPod. There have been few successful products that followed this route to a mass market. A new flavor of *Bluetooth* technology may be just the answer, and a more efficient alternative for yet another wireless standard.

In the ten years since engineers from a handful of companies came together to create the first *Bluetooth* specification, *Bluetooth* technology has become a household term, a globally recognized standard for connecting portable devices. The *Bluetooth* brand ranks among the top ingredient technology brands worldwide, recognized by a majority of consumers around the world. A thriving global industry of close to 11,000 member companies now designs *Bluetooth* products and works together to develop future generations of the technology, found in well over 50 percent of mobile phones worldwide and with more than **two billion** devices shipped to date. *Bluetooth* wireless technology has established the standard for usability, ease of setup and compatibility across all

manufacturers. A well-established set of *Bluetooth* profiles define the communication needs for a wide range of applications, making it easy for a manufacturer to add *Bluetooth* wireless connectivity to new devices — from phones to headsets to printers — with a minimum of programming and testing work.

Bluetooth technology's consumer brand recognition and its years long experience of software development, testing and validation, are tremendous advantages for any device that bears the *Bluetooth* logo. The current *Bluetooth* radio delivers a combination of fast data rate and low power consumption that has proven to be the right choice for a range of mobile phone and PC applications, including hands-free communication, streaming music, printing and file transfer. But its speed is wasted in applications that require only small bits of information to be sent infrequently. The Bluetooth Special Interest Group (SIG) recognizes that no single radio design will ever offer both maximum data rate and maximum battery life. With this in mind, the Bluetooth SIG has focused efforts on uniting several wireless technologies under a single *Bluetooth* wireless umbrella.

In 2001, Nokia researchers determined that there were various scenarios that contemporary wireless technologies did not address. To address the problem, Nokia Research Center started the development of a wireless technology adapted from the Bluetooth standard which would provide lower power usage and price while minimizing difference between Bluetooth and the new technology. The results were published in 2004 using the name Bluetooth Low End Extension. After further development with partners, e.g., within EU FP6 project MIMOSA, the technology was released to public in October 2006 with brand name Wibree. In June 2007, the Bluetooth SIG announced it would bring Nokia's Wibree under the *Bluetooth* umbrella to create a low energy version of *Bluetooth* wireless technology. The result: a wireless technology with a considerable battery life that will be measured in years and even lower power consumption than other standards based technologies, but able to communicate with over a billion of *Bluetooth* devices shipped each year. As of June, 2007 Wibree is known as Bluetooth ultra low power, in 2008 renamed Bluetooth low energy.

In December 2009, the Bluetooth Special Interest Group (SIG) announced the adoption of *Bluetooth* low energy wireless technology, the hallmark feature of the *Bluetooth* Core Specification v4.0. *Bluetooth* low energy technology enhances the opportunities for developers and manufacturers of *Bluetooth* technology and will bring to life entirely new markets for devices requiring low cost and low power wireless connectivity.

Specification for the technology is currently ongoing. Nokia is defining the Wibree interoperability specification together with a group of leading companies representing semiconductor manufacturers, device vendors and qualification service providers. The technology will be made available to the industry through an open and preferably existing forum enabling wide adoption of the technology. The forum solution is under evaluation and will be defined upon finalization of the specification. Members of the group defining the specification include Broadcom Corporation, CSR, Epson and Nordic Semiconductor, having licensed the Wibree technology for commercial chip implementation and Suunto and Taiyo Yuden, contributing to the interoperability specification in their respective areas of expertise.

Wibree is a short-range wireless protocol optimized for low power consumption. Wibree is intended to compliment Bluetooth communications in certain PAN applications where small, lightweight design makes standard Bluetooth communication unsuitable or difficult. For instance, Bluetooth-enabled wristwatches require relatively large transmitters and batteries, making the devices heavy and uncomfortable. Wibree-enabled wristwatches can use smaller transmitters and smaller batteries, increasing user comfort and reducing fatigue while extending battery life.

Wibree operates in the same 2.4 GHz frequency band as Bluetooth, which ensures backwards hardware compatibility. Due to this, a single antenna can support both protocols, and many existing Bluetooth devices will require only a simple software

update to communicate with Wibree devices. While these upgraded devices will not benefit from the size savings dedicated Wibree models enjoy, they will see much improved battery life. Additionally, compatibility with newer Wibree models will help prolong the lifespan of existing equipment.

Wibree technology is an important development that opens up new market opportunities and a whole new range of possibilities for mobile users. In addition to creating a vast market for sensors, watches and other existing devices, *Bluetooth* low energy technology's ability to connect low power devices to the mobile phone will open new applications.

Wibree - Bluetooth low energy technology promises a new answer, one with a proven global standard at its heart.

SPECIFICATION

Bluetooth low energy technology is a next generation wireless communications specification from the same group that created and continue to expand the original *Bluetooth* specification to cover new use cases. *Bluetooth* low energy technology enables new classes of devices that can only be viable when an ultra low power radio technology, interoperable profiles and services are combined together to create an industry wide technology platform. *Bluetooth* low energy technology connects everything to anything, phones and watches, watches to shoes, shoes to web services, and web services to the home answering the long awaited standardization from many different markets.

Technical Specification	Wibree -Bluetooth low energy
Radio frequency	2.4 GHz

Distance/Range	200 m (660 ft)
Over the air data rate	1 Mb/s
Application throughput	0.2 Mb/s
Active slaves	Not yet available
Security	128-bit AES with Counter Mode CBC-MAC and application layer user defined
Robustness	Adaptive fast frequency hopping, Lazy Acknowledgement, 24-bit CRC, 32-bit Message Integrity Check
Total time to send data (det.battery life)	<3 ms
Government regulation	Worldwide
Certification body	Bluetooth SIG
Voice capable	No
Network topology	Star-bus
Power consumption	0.01 to 0.5 (depending on use case)
Service discovery	Yes

Profile concept	Yes
Primary use cases	Mobile phones, gaming, PCs, watches, sports and fitness, healthcare, automotive, home electronics, automation, Industrial, etc.

IMPLEMENTATION

Bluetooth low energy technology is designed and optimized for applications with low effective data throughput. The exciting aspect of Bluetooth low energy is its ability to enable low cost devices to be made that can send their data all of the way to the web. It's based on over ten years of experience and promises to have the fastest growing ecosystem of any wireless standard.

Bluetooth low energy (previously known as Wibree) has the potential to be the fastest shipping wireless technology ever. On April 20th 2009, Fiona Thomson – a key analyst from IMS Research told the media that the feedback they have had from a market survey was so positive that they are no longer asking when it will happen, but how long it will take to ship the first billion chips! That figure could easily be reached and surpassed in the first four years of shipments. Three chip vendors – Nordic Semiconductor, Texas Instruments and Cambridge Silicon Radio formally announced their single mode Bluetooth low energy chips at the meeting, with TI also announcing a dual-mode chipset. Taken together with previous public statements from CSR, Broadcom and EM Microelectronics, that brings the tally of Bluetooth low energy chipsets to four single mode chips and three dual mode chips. As well as the chips themselves, Texas Instruments gave information about a $99 developer's kit due later this year and Anritsu supported the momentum with a demonstration of their test system for Bluetooth low energy, showing live analysis of radio packets.

A key concept in Bluetooth low energy technology is the two implementation options:

1. Single mode implementation

2. Dual mode implementation

Single mode implementation:

The single mode is the one that truly delivers the ultra low power consumption by being a pure low energy implementation. While classic Bluetooth solutions typically provides battery lifetime of days to weeks on a rechargeable battery, single mode Bluetooth low energy technology implementation can provide months to years of lifetime on a standard coin cell battery. The Wibree stand-alone chip is designed for use with applications which require extremely low power consumption, small size, low cost and where only small quantities of data are transferred.

It's an ideal solution for small devices (like heart-rate monitors) that use only short data messages and must have long battery life.

Examples of devices that would benefit from the Wibree stand-alone chip are: watches, sports and wellness devices and human interface devices (HID) such as wireless keyboards.

Dual mode implementation:

The dual mode combines classic and low energy Bluetooth on a single chip at a very small price delta compared to a classic Bluetooth chip. In addition the radio circuitry is also shared between the classic radio and the low energy radio. The dual mode is designed to enable fast adoption of low energy in classic Bluetooth applications like mobile phones and PC by providing a very low cost delta as well as removing the need to add another radio. Several major mobile phone vendors have indicated that they will adopt dual mode devices in their upcoming phones. The Bluetooth-Wibree dual-mode chip is designed for use in Bluetooth devices. In this type of implementation, Wibree functionality can be integrated with Bluetooth for a minor incremental cost by utilizing key Bluetooth components and the existing Bluetooth RF. This type of implementation allows Bluetooth devices to connect to a new range of tiny battery-powered devices.

Examples of devices that would benefit from the Bluetooth-Wibree dual-mode chip are mobile phones and personal computers.

	Stand-Alone IC	Dual-Mode IC
Data rate	1 Mbps	1 Mbps
Range	5-15 m	5-15 m
Power	BTH x 10-25%	BTH x 75-80%
Cost	<<€1	BTH + <€0.10

Network topologies

Bluetooth low energy technology supports star and star-bus network topology with a no theoretical limit on the number of active slaves. There are two different cases for the network topologies:

1. Single and dual mode topology
2. Single mode only topology

In the single and dual mode topology, the dual mode devices acts as the Hubs and the single mode devices acts as Nodes. The connection between Hub and Node is a Bluetooth low energy technology, while the backbone connection between different Hubs is classic Bluetooth. A Hub does not need to be a dual mode device, meaning that dual mode devices also can connect to classic Bluetooth devices.

An example of this topology in its simplest form is a mobile phone equipped with a dual mode device that maintains low energy connection to a single mode pedometer and single mode watch and at the same time has a classic Bluetooth connection to a stereo headset.

Single mode devices can also be networked on their own without the presence of a dual mode device. In this case the supported topology is star, where one of the single mode devices acts as the Hub.

An example of this topology is a TV with a Bluetooth low energy technology remote control. A single mode device is used in both the remote and the TV, but the one in the TV acts as the Hub.

Bluetooth, Zigbee, and Wibree: A Comparison of WPAN Technologies

Introduction and Background

Wireless Personal Area Network (WPAN) designs have been flourishing in recent years. The pervasive success of Bluetooth has been a boon to all devices in the IEEE 802.15 working group. Wibree is a technology that has been under development by Nokia since 2001. It was originally adapted from the Bluetooth specification, and in 2006, the Bluetooth Special Interest Group (SIG) announced it would be adopting Wibree into the Bluetooth specification. Integrated Bluetooth/Wibree devices are not yet shipping, though Nordic Semiconductor has published a preliminary product specification. While the Wibree and Bluetooth specs are being integrated, the new name of the Wibree technology has changed several times.

While Wibree has been under development, the competing IEEE 802.15.4 technology of Zigbee has been available to the public for several years. ZigBee was designed as a low power, low-cost, low-speed solution, and has many benefits over Bluetooth, though fewer benefits over Wibree.

Detailed Technology Comparison

1. Frequency Band

All three technologies operate in the unlicensed 2.4 GHz spectrum, while Zigbee can also operate at reduced speeds at 915MHz and 868 MHz

2. Antenna and Hardware

Wibrees adoption into the Bluetooth spec was directly related to the fact that it can coexist on BT hardware. Devices that wish to take advantage of both Bluetooth and Wibree will not need to add extra hardware; one antenna will do for both. Zigbee support, however, requires its own hardware and antenna.

3. Power and Battery Life

Zigbee, designed to be a low-power alternative to Bluetooth, offers 30mW performance compared to Bluetooth's 100mW. However, Dr. Bob Iannucci, Senior Vice President and Technology Advisor at Nokia, claims that Wibree is "up to 10 times more energy efficient than Bluetooth", putting Wibree around 10mW. Zigbee is designed to "run for six months to two years on just two AA batteries". This led to Wibrees design goal of 1-2 years on a single battery.

4. Range

Both Bluetooth and Wibree are designed to operate within a 10m range, though Bluetooth 2.1 now states a maximum range of 30m. Zigbee, being designed to enable "home and industry automation", allows a maximum range of 75m.

5. Data Rate

Wibree has caught up to Bluetooth's original data rate at 1Mbps, while Bluetooth has proceeded to reach maximum rates of 3Mbps. Zigbee intentionally lags far behind these numbers, sacrificing data rates for power savings, and so transmits only 20-250Kbps.

6. Component Cost

In 2003, when Zigbee was targeting a $2 component cost, Bluetooth support cost $5 per device. Now Bluetooth pricing has fallen to $3, while Zigbee costs $2. More importantly,

integrating Wibree into an existing Bluetooth implementation adds around 20¢, making Wibree a much more attractive addition to Bluetooth-enabled devices than Zigbee.

7. Network Topologies

Bluetooth and Wibree operate primarily in ad hoc piconets, where a master device controls multiple slaves. These piconets are limited to 8 devices. Zigbee has far greater flexibility in this arena, supporting mesh and star configurations. Star configurations at the ends of the mesh allow clusters of Zigbee devices to interact with the outside world, While the mesh devices focus on data transmission.

8. Security

All three technologies support state-of-the-art 128-bit encryption, and all three continue to be scrutinized for key distribution vulnerabilities and the like.

9. Time to Wake and Transmit

One of Zigbee's greatest strengths over Bluetooth has been its freedom to sleep often. This comes from its quick wake-from-sleep design. A Zigbee device "can wake up and get a packet across a network connection in around 15 milliseconds," while a Bluetooth device would take 3 seconds. A Wibree device would presumably behave more like the Zigbee device, but this remains to be seen.

Table of Feature comparisons:

	Bluetooth	Wibree	ZigBee
Band	2.4GHz	2.4GHz	2.4GHz, 868MHz, 915MHz
Antenna/HW	Shared		Independent
Power	100 mW	~10 mW	30 mW
Target Battery Life	Days - months	1-2 years	6 months - 2 years
Range	10-30 m	10 m	10-75 m
Data Rate	1-3 Mbps	1 Mbps	25-250 Kbps
Component Cost	$3	Bluetooth + 20¢	$2
Network Topologies	Ad hoc, point to point, star	Ad hoc, point to point, star	Mesh, ad hoc, star
Security	128-bit encryption	128-bit encryption	128-bit encryption
Time to Wake and Transmit	3s	TBA	15ms

APPLICATIONS

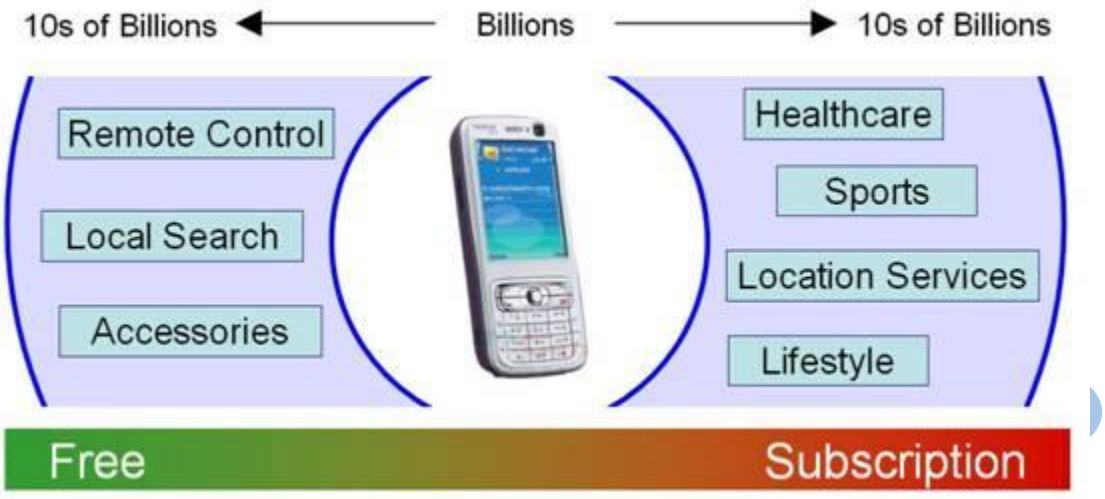
1. Wibree –The Marvelous World of Wireless Microdata

Wibree offers low power – as low as any of the other contenders, but it does it in a way that sets itself apart from them. Its unique feature is that it cohabits with a Bluetooth radio in a new generation of wireless chips. To reduce cost it uses the same radio circuitry that's already there for Bluetooth and squeezes in a small, complementary protocol stack. These dual mode chips will cost at most a few cents more than today's Bluetooth only chips. That means Wibree will quickly achieve a high penetration in mobile phones because it is riding on the back of an established technology. There are two important things to realize about that symbiosis: firstly, Wibree deployment will happen quickly and happen in volume. Secondly, it means that every Wibree enabled mobile phone

becomes a ready built, wide area gateway capable of transferring data from a peripheral Wibree device to a remote network or service.

The sheer speed and scale of Wibree deployment in mobile phones in the next few years is the first step to its goal. It will provide the critical mass that product designers need to justify incorporating wireless connectivity into a new generation of products. Low cost, Wibree only chips will find their way into a whole new range of accessories, such as watches and lifestyle devices. Dual-mode Wibree + Bluetooth chips will give added functionality to the phones themselves, which will become usable for location specific data searching and remote control. Most importantly, Wibree opens up a raft of new opportunities for mobile network operators. As each Wibree equipped handset is a mobile gateway for Wibree devices, operators will be able to offer new services, such as health monitoring. Such services provide a route to new revenue streams, as well as being a powerful tool for operators to increase customer loyalty and reduce churn.

The important point to understand about Wibree is that it is going to build upon the volumes of mobile phones. Unlike other low power standards it's not starting from scratch, but will ride on an industry that already sells a billion devices every year. Wibree has the goal of enabling a multitude of products to connect to each and every one of these handsets. That adds up to a potential that is an order of magnitude greater than mobile phone sales. Unlike other short range standards, Wibree's goal is not to ship mere millions, but tens of billions.



The new markets that are enabled by *Bluetooth* low energy technology include but are not limited to:

2. Health and Fitness - Everything from shoes and heart rate straps to weighing scales and bicycle computers. These devices will connect with the phone and watch to allow everybody to monitor their bodies' performance while exercising. This segment also includes health maintenance devices like blood oxygen meters, blood glucose meters that can raise alarms when there are problems, or send their data to the healthcare monitoring web services to monitor long term trends.

3. Home - Everything from using your phone as a remote control for your entertainment system to monitoring the temperature and controlling the heating and ventilation systems will be possible with *Bluetooth* low energy technology. The key element in this is that the phone can act as a remote control for all these devices.

4. Office -Typical wireless office devices like mice and keyboards will use Bluetooth low energy technology to increase their battery lifetimes. Also intelligent energy use will be enabled by enabling office buildings to monitor the presence of workers and visitors around the building, and adapting the environment to keep them comfortable while also saving energy and money.

5. Automotive - Tire pressure monitors and other remote monitoring of devices will reduce the weight of the wiring loom within a car. Bluetooth low energy technology can also be used to make the various controls, like rear entertainment controls, use fewer wires. This reduction of weight can also save energy as it will take less energy to accelerate the vehicle.

6. Watch - The only really true wrist computer that most people will accept is the watch. The Bluetooth low energy technology has been designed alongside watch companies so that it meets their requirements. The watch can display caller ID information, allow the user to accept or reject calls, all without looking at the phone. The watch can be used to control other devices like music players to enable volume and track changes.

Bluetooth low energy technology is a next generation wireless communications specification from the same group that created and continue to expand the original Bluetooth specification to cover new use cases. Bluetooth low energy technology enables new classes of devices that can only be viable when an ultra low power radio technology, interoperable profiles and services are combined together to create an industry wide technology platform. Bluetooth low energy technology connects everything to anything, phones and watches, watches to shoes, shoes to web services, and web services to the home answering the long awaited standardization.

MERITS AND DEMERITS

Bluetooth technology is the most successful short range wireless communications technology incorporated into billions of devices from cellular phones, headsets and stereo headphones, through to medical devices, portable media players and games consoles.

Bluetooth low energy technology is the next generation of wireless standard from the Bluetooth Special Interest Group. It is a new design that has taken the best parts of the existing *Bluetooth* specifications and optimized it for a new set of applications.

The core values of *Bluetooth* low energy technology are similar to the existing *Bluetooth* core values:

1. Low Power – *Bluetooth* technology has always strived to utilize as low power as possible. The power consumption of *Bluetooth* technology has improved in every specification version, from interlaced page scanning in v1.2, faster data rates in v2.0, and sniff sub-rating in v2.1 to be the most power efficient standard for its applications. *Bluetooth* low energy technology will dramatically improve the energy efficiency when devices are connectable and discoverable, and also enables devices to send a small quantity of data very quickly from a disconnected state. These new low power features enable new market segments where there is a need to transmit only small amounts of data.

2. Low Cost – *Bluetooth* technology has always been the lowest cost standard short-range wireless technology. Not only are there no royalties or specification a patent to worry about, but also the specification is designed around mass production using bulk CMOS technology. *Bluetooth* low energy technology will further reduce these costs, by relaxing important specification parameters, and by reducing the implementation size significantly (approximately half the die size).

3. Short Range – *Bluetooth* technology has never attempted to be a long-range technology. By concentrating on short range applications, it has successfully created the first truly adhoc technology. Any device can connect with any other device, create a temporary or permanent relationship, and transfer data quickly and easily. *Bluetooth* low energy technology enables similar ranges as *Bluetooth* technology; they are still fairly modest compared with cellular radio links.

4. Worldwide – *Bluetooth* technology can be used and sold in almost every country on the planet. *Bluetooth* technology therefore enables a single seamless market for wireless devices, enabling huge mass market, rather than country or regional specifications or devices.

5. Robust – *Bluetooth* devices just work. Having a robust radio is essential when you are trying to gather a measurement from a sensor, or controlling something. *Bluetooth* technology has learnt that being robust is what the consumers demand, and it is therefore something that people now take for granted. *Bluetooth* low energy technology has not compromised anything for robustness.

Bluetooth low energy technology is a new specification; it is not a small additional feature within *Bluetooth* technology. This new specification has been designed by a team of experienced wireless experts, who have extensive experience of both *Bluetooth* solutions as well as proprietary radio systems. This combination enables a completely new generation of wireless standard that can build interoperable products.

6. Number of devices - The number of devices that can be active within a *Bluetooth* low energy network has been significantly increased to many thousands. The network topology has been kept as simple as possible to reduce the cost of each individual part, while allowing more complex star-bus networks to route information around multiple piconets (ad hoc network of one master and seven slaves).

7. Web Service Integration - the ability for small *Bluetooth* low energy wireless devices to send a small quantity of data to a web service is vital for a large number of use cases. This enables weighing scales to automatically send data to your weight loss website (via the mobile phone), allowing you to check on your progress over time, using the best possible user interface.

8. Fast Connections – the time it takes to make a connection, and send some data is very important to reduce battery life. A target of 3 ms was set, and has been met by *Bluetooth* low energy technology. This means that a device can wake up, connect and send some application data, and then disconnect again within 3 ms. This uses the lowest amount of energy, while also having the fastest possible transmission of event based data.

9. Interoperable Sensors – a consumer electronics based specification will always favor interoperability over proprietary solutions. The profiles that have been created for health and fitness, medical and automation markets enable the creation of fully interoperable devices. This means that if you buy a pair of weighing scales, or a *Bluetooth* low energy enabled heart rate strap, they will always interoperate with devices, regardless of the manufacturer of the various devices. This interoperability is tested via the unique *Bluetooth* qualification program.

DEMERITS

- Data transmission is very slow, i.e. only 1Megabit per second
- Cannot be used in high bandwidth required applications

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.

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