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Presenting the (economic) value of patents nominated for the European Inventor Award 2012

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1. The invention

1.1 Historic account

The invention analysed here is the development of the Bluetooth standard. The technology is nowadays widely in use to connect, at short range, various kinds of devices such as mobile phones with headsets, computers with printers, etc. Dr. Jaap Haartsen and his team at Ericsson performed the invention in the 1990s.

Jaap Haartsen, a Dutchman, received his PhD at the Delft University of Technology in electrical engineering. His first job was at Ericsson, where he was sent abroad to the U.S. in 1991 to work on advanced mobile communications systems. In 1993, he returned to Europe and began working at the Ericsson Mobile Terminal Division in Lund, Sweden, where he was tasked with development work in the field of in-door communication systems (at that time, for example, one development topic was the use of mobile phones within a house with local base stations).

Dr. Haartsen recounts:

> *"In 1994, I was tasked with finding solutions for short-range radio connections, at distances of around 3m to 4m. The company was looking for a way to enrich the functionality of the mobile phones, which would act as enabler for new sales."*

When he started to work on this task, Dr. Haartsen quickly realised that he had to develop a completely new concept to fulfil the required performance characteristics. One such performance requirement was low power consumption, as – particularly at that time - mobile phones drew a lot of battery power. *"Available technology or technology in development in 1994, such as WLAN and GSM, would not offer a viable solution"* recounts Dr. Haartsen. For example, these technologies used asymmetric communication and required a base station (in the case of WLAN, an access point) to which the different devices ('slaves') would connect. A design with base stations would, however, draw too much power on the device that would act as base station. There was a need for a symmetric, peer-to-peer, design. Another important performance requirement was that the technology needed to operate worldwide, in frequency bands subject to different local regulations.

There were various technical barriers that had to be overcome. While it was early on decided to base the new technology on frequency hopping – a concept which was already known in the first half of the 20th century -, there were a lot of adaptations and enhancements necessary. One critical issue was, for example, the need that devices have to find and connect to each other before exchanging data. Without respective technology development, this process would have drawn too much power if implemented in rather straightforward manners. Another issue was increasing demands placed on usage profiles:

> *"We had an already working solution in the 2.45 GHz frequency range which would rely solely on frequency hopping. This solution was in line with the requirements regulatory bodies put in place for devices operating at those frequencies, such as with regard to maximum sending power (despite of the fact that the frequency range is unrestricted, there are still some minimum requirements that need to be met). When other firms joined the development process, there were demands such as for increased sending power and/or for use scenarios that were beyond the original specifications. So we could not rely solely on frequency hopping any more"*. (Dr. Haartsen)

While Dr. Haarsten was working initially alone, a team was quickly built. In 1995, he was joined by Bluetooth co-researcher Sven Mattisson, and in that year the team grew

to 5 staff, working mainly on hardware, then to 15, eventually to up to 30 people when software layers had to be developed, too.

The development codename in the initial development phases was MC (Multi-Communicator) Link. The name change to 'Bluetooth' occurred once Sven Mattisson and a co-researcher, Jim Kardach, had a beer after a presentation in Canada. They talked about the book 'The Long Ships' by Frans G. Bengtsson, and the fascination for the hero´s father-in-law Harald Blatant (a 10th century Danish king). This codename was to become the official trademarked name, as a) it made reference to the fact that the technology was developed in Scandinavia and b) because Bluetooth was able to connect devices from different industries.

By 1997, the team had a workable solution and a parent company that realised that, in order for the technology to become a success, it needed to collaborate with other firms: *"Ericsson was a mobile phone producer, and we had a technology that would also be viable for things such as keyboards, computer mice, etc., things, that were not within the core business of the company. The decision to take other companies on board was a natural one"*, says Dr. Haartsen.

In 1998, the Bluetooth Special Interest Group (SIG) was formed by five founding members: Ericsson, Nokia, Intel, Toshiba and IBM. The Bluetooth SIG is responsible for encouraging and supporting research and development in Bluetooth technology. The SIG has formed a patent pool for Bluetooth, defines the standard, provides licenses to manufacturers of Bluetooth devices and undertakes to examine devices for compliance with the standard, after which the devices are allowed to carry the Bluetooth trademark. In 1999, Bluetooth specification 1.0 was released.

Initial reception of the technology was not always met with enthusiasm, for example when Bluetooth´s speed was compared to that of WLAN (which was developed, however, for a different type of usage). Furthermore, it took some time till Bluetooth was supported by default by the major operating systems. Nonetheless, success came and the timeline shows a continuous thread of improvements and achievements in the market.

Some milestones were:[1]

- In 200o, the first mobile phones with Bluetooth appeared, as did first PC cards and prototype mice, keyboards and USB dongles.
- In 2001, the first Bluetooth-enabled printers, laptops, and freed-hands car kits were introduced.
- In 2002, the IEEE standardisation body approved Bluetooth as standard 802.15.1
- In 2003, the Bluetooth specifications were amended to Version 1.2. Around 1 million Bluetooth-enabled products were delivered each week.
- In 2004, the specification was amended to Version 2.0
- In 2008, the 10th anniversary of Bluetooth, the amount of Bluetooth-enabled devices shipped in the ten years was 2 billion. The SIG welcomed its 10,000th member.
- In 2011, the SIG had 15,000 member firms. Bluetooth specifications were upgraded to V 4.0

After serving as Chief Scientist of Ericsson Technology Licensing AB from 2001-2004, Dr. Haartsen moved to Sony Ericsson in 2007. In March 2010, he left the company to become CTO of tonalite B.V in the Netherlands. He still works there today. The company creates, develops, and markets 'wearable wireless products' and also

[1] Homepage of the Bluetooth SIG, www.bluetooth.com/Pages/History-of-Bluetooth.aspx

supplements implementation of wireless technologies such as Bluetooth, in different systems such as audio headsets and medical devices.

'tonalite B.V.' follows, on the one hand, a licensing business model, where it licenses a technology to larger firms for production. But it also acts as a broker firm with contract and service expertise, which connects different parts of the value and production chain to get a – customised - product on the market. tonalite B.V. currently has around 30 employees.

1.2 Technological features

Bluetooth technology gets around obstacles by using a variety of radio frequencies to send out data to connected devices at low transmit power. The devices agree on the physical way they will communicate - through radio signals - and Bluetooth-connected gadgets all share a common protocol, or a preset agreement on how much data will be sent and received at one time.

Using the specific radio frequencies of 2.45 GHz brought challenges. Baby monitors, garage door openers, and Bluetooth devices all use this band. So how to keep Bluetooth devices from interfering with the baby monitor - or with other Bluetooth devices? The solution: so-called frequency hopping.

Bluetooth enables gadgets to change frequencies within the designated band, 'hopping' around on 79 frequencies and travelling on a different frequency 1,600 times each second. This makes it highly improbable two devices will try to send out a signal on the exact same frequency at any given moment. Devices that are connected via Bluetooth then use the radio frequencies to communicate and decide whether they have data to exchange by 'hopping frequencies.'

In 1994, by using frequency hopping, Dr. Haartsen built the foundation for Bluetooth. By jumping around on frequencies, the link between devices is strengthened by creating more channels to communicate through. Power is preserved by using low transmit powers, and activating the radio only when data needs to be exchanged.

Bluetooth's frequency hopping means the receiving unit is asleep, waking up every one second and listening on one specific frequency. If no device is sending data, the receiver goes back to sleep and re-awakens one second later. When it re-awakens, it listens in. The device repeats this process, hopping through 32 frequencies during standby. In what is called a pairing, two Bluetooth-enabled devices connect with each other.

2. The market

Initially, the development of the bluetooth market was "*...a rather start-stop affair"* when it was first introduced in 1998.2 The technology found its way quickly into higher-end cell phones and computer input devices, but growth slowed significantly by 2002. According to Dr. Haarsten, contributing factors to this slow-down were the fact that many devices were still in development, and that the burst of the internet bubble affected also Bluetooth take-up.

From 2003 on, however, growth accelerated and by 2007, the technology *"...approached real ubiquity"* with around 800 million devices sold that year globally, according to a 2008 IMS Research report. The IMS report – in line with other market research reports and expert opinions – anticipated even further accelerated growth. By 2016, the number of yearly sold Bluetooth-enabled units was expected to surpass the 1,800 million mark. Reality seems to exceed these expectations, as shipments of

[2] Dugand, F. (2008): Bluetooth´s Bright Future, May 2, 2008, http://enterpriseinnovator.com/index.php?articleID=15182&sectionID=5

Bluetooth-enabled devices increased by 23 % between 2009 and 2010.3 An Instat research report predicted last year that 2 billion Bluetooth-enabled units would be shipped in 2013.[4]

Factors explaining the popularity are, amongst others, clear design requirements, strong focus on interoperability, familiarity to consumers, stability and established standards as well as proven Intellectual Property.5 Moreover, growth will be fuelled by integrating Bluetooth with other components on single chips*: "An increasing number of areas where Bluetooth is applicable are large enough to make cost-reduction through integration attractive."* The role of the IP is key as *"…the development of a new Bluetooth core and stack to include in a combination chip at this time would not be a wise use of design resources. For a chip company, the advantages of using proven IP instead of developing their own Bluetooth solution from scratch are lowered development cost with shortened time to market and lower risk*."6

Further factors substantiating growth prospects are technological advances of the Bluetooth technology, particularly with the introduction of Bluetooth 3.0 + High Speed (HS) – which combines classic Bluetooth and WiFi to transmit large data files and was introduced in 2009 – and Bluetooth 4.0 (with lower power consumption than classic Bluetooth, to be used for example in medical and fitness devices from the end of 2011 on).7 The range of main served market segments by 2016 will include cellular handsets, headsets, laptop PCs, gaming equipment, automotive, portable media players and nine other (smaller) fields of application.

3. The role of patents and Intellectual Property Rights (IPR)

3.1 Motives and benefits of patenting and employed IPR strategy

Patents play an important role in the ICT industry, and it comes at no surprise that this holds also true for Bluetooth. What makes this case interesting is the specific way the IP is exploited via a patent pool and via the Bluetooth SIG. It showcases also the close connection between patents/IPR and standards.

According to Peter Nestler, in the mid-1990s responsible for IPR at the Ericsson facility in Lund, the main goal was to create a strong patent portfolio and *"…to make sure that we file as many and good patents."* When the Bluetooth SIG was created, the members agreed to set up a so-called patent pool for Bluetooth, i.e. take all patents that are needed for Bluetooth (and owned by the SIG members) and place them together in a 'pool'. Physically, ownership of the IP was not transferred from the companies to the SIG, but the companies agreed to out-license the basic patents at no costs for the development of Bluetooth-enabled devices. Only non-essential patents for particular solutions would be charged, however at non-discriminatory and fair conditions.

The rationale for this approach was to allow the standard to establish. On the one hand, firms interested in the technology would have rather cheap access to Bluetooth. According to Dr. Haartsen, the costs for a full solution Bluetooth addition/chip to a

[3] Research and Markets: Bluetooth 2011: Rapid Growth for Established Interface, http://www.researchandmarkets.com/research/11da13/bluetooth_2011_ra

[4] http://www.instat.com/press.asp?ID=3238&sku=IN1104968MI

[5] Dugand, F. (2008): Bluetooth´s Bright Future, May 2, 2008, http://enterpriseinnovator.com/index.php?articleID=15182&sectionID=5

[6] Dugand, F. (2008): Bluetooth´s Bright Future, May 2, 2008, http://enterpriseinnovator.com/index.php?articleID=15182&sectionID=5

[7] Bluetooth Smart device information for manufacturers and developers, http://www.bluetooth.com/Pages/Smart-Logos-Manufacturers.aspx

device would only be US$ 5, a price tag, which would be difficult to hold if royalties were charged. On the other hand, the patent pool had a blocking function, i.e. if someone were to use Bluetooth technologies for it's own, proprietary radio communication solution there would be a means to stop them. Also, if such a company would want to halt the introduction of the Bluetooth standard, *"….the SIG would have the weapons to refrain them from doing so."* (Dr. Haartsen). In order to fulfil this protective function, it is clear that the quality, strength and size of the patent portfolio are of utmost importance.

A further element of the IPR strategy is the usage of a trademark (i.e., the name 'Bluetooth' and the Bluetooth logo). Required to have the devices checked for compliance by the SIG, the Bluetooth trademark guarantees compliance to the standards, high brand recognition and quality.

Both Dr. Nestler and Dr. Haarsten agree that the patent system has worked quite well in the field of Bluetooth. The strong patent portfolio and low/zero-cost access to the technology have not only helped to establish the standard, but have also kept patent litigation among companies at a minimum, if compared to other ICT areas.

3.2 Patent statistics and patenting trends

There are some five patents, which were filed by Dr. Haartsen and which can be considered fundamental for the Bluetooth standard (Dr. Haarsten filed much more patents, around 200). The five patents are presented in the table below. These patents have a priority date ranging from September 1997 to October 1998, which is well beyond when the core inventions have been initially made (commonly, the invention of Bluetooth is dated to 1994). The reason for this discrepancy is that before 1997 the project was an internal research project at Ericsson. Only once the firm started to reach out to other companies, the need for protection with IPR became apparent, and the ideas were put down in patent filings.

Filing number	Title	Priority date
EP1016242 (B1)	Contemporaneous connectivity to multiple piconets	Sep 1997
EP1016241 (A2)	Frequency hopping piconets in an uncoordinated wireless multi-user system	Sep 1997
EP1025651 (B1)	Method and apparatus for the generation of frequency hopping sequences	Oct 98
EP1119991 (B1)	Access techniques of channel hopping communications system	Dec 96
EP1080547 (A1)	Frequency-hopping radio system with hybrid direct-sequence/frequency-hopping mode during startup	May 98

The international significance and the up-take of the Bluetooth standard are also reflected in the word-wide number of patent applications referring to 'Bluetooth'. Since the year 2000, there have been more than 1,000 patent application making reference to Bluetooth each year; since 2005, this figure has increased to over 2,000 per year. Most patent applications were filed in 2007 (2,396 patent applications, including 915 patent families with EP or world application).

It comes at no surprise that the founding members of the Bluetooth SIG are among the most active patent applicants. Other major applicants are large mobile phone technology and computer manufacturers: Siemens (263),

Motorola (218), Philips (208), Samsung (178), Qualcomm (178) have filed EP or world patents on the subject of 'Bluetooth' since 2000. Most patents have a priority filing in the U.S., indicating the particular importance of the U.S. market.

4. Conclusions

The invented technology and its underlying patents are of high value, as evidenced by the market success and the up-take of the Bluetooth standard.

Success factors for the invention were:

- According to Dr. Nestler, the personality and expertise of Dr. Haarsten and the other researchers at Ericsson.
- The creation of strong patents.
- Also, the decision to set up the Bluetooth SIG and the no/low-cost licensing approach chosen, for establishing the standard. Without the drive for a standard, Bluetooth would not have become, according to Dr. Nestler, a success.
- The establishment of the SIG group needs a lot of understanding and collaboration among the involved firms, which need to collaborate at least in the early phases very well with each other. There are other examples where the creation of a standard suffered from dispute in the early phases of the creation of the standard-defining bodies.
- And, finally, *"…there is also an element of luck. Nine out ten research projects fail. You have to be at the right time at the right place with the right people….for researchers my main message would nonetheless still be: keep an open mind, think outside textbooks, do not make decisions too quickly"* (Dr. Haarsten)