

The Evolution of Bluetooth as a Wireless Communications Technology

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In the communication's industry, [wireless communications](#) are among the fastest growing segment. The development of this technology has had a huge impact on our lives today. Most wired networks today have been replaced or supplemented by wireless local area or GSM networks, such as in business, homes or campuses.

Bluetooth is a form of wireless technology that makes use of UHF short-wavelength radio waves from the 2.4-2.485 GHz ISM band to exchange data over short distances from mobiles and fixed devices, making use of PANs or personal area networks. It is a low-power, low-cost technology operating over wireless, where the devices form ad-hoc short-range networks or piconets to connect with each other. The piconets activate dynamically and automatically once a Bluetooth-enabled device leaves or enters radio proximity (Jin-Shyan Lee, 2007). Bluetooth can handle voice transmission and data simultaneously, which enables users to perform different tasks such as PC synchronization, printing, or accepting or making voice calls through special headsets.

Key Contributors to Development

The development of Bluetooth was started in Sweden by L.M. Ericsson in 1994. The name Bluetooth was borrowed from the king of Denmark in 940 to 981 AD, named Harald Blaatand Bluetooth. The Swedish Telecommunications Company Ericsson is credited with originating its research. In 1989, the actual effort began when Ericsson Mobile's Chief Technology Officer, Nils Rydbeck, and a physician, Johan Ullman, joined in the efforts of two engineers at Ericsson, Sven Mattisson and Jaap Haartsen, to research short-link optimal radio technology standards that can be used to transmit data or signals between wireless headsets and personal computers, that they planned to introduce in the market. The chief inventor, Jaap Haartsen, was a senior engineer and scientist at Ericsson who was given the task of developing technology that could allow wireless communication between a phone and its accessories. Sven Mattison and Jaap Haartsen worked together on a project named MCLink. This was a successful venture that eventually became known as Bluetooth. In a meeting, Jim Kardach, an engineer from Intel, named the technology Bluetooth after the Dutch king a codename for it (Tonner, 2001).

The 'Centre for Business History' located in Norway provides records of 10 patents that protect Bluetooth technology, a majority of which Ericsson holds. Jaap Harartsen is credited for US Patent No. 6590928, which is entitled 'Frequency Hopping Piconets in an Uncoordinated Wireless Multi-User System' (Haartsen, 1997). It discusses a wirelessly connected network involving a slave unit along with a master unit, in which the master and slave units are capable of interacting with each other

using a frequency hopping channel virtually (Brachmann, 2015). It was groundbreaking because it provided a communication method for a cost-effective local wireless network that could support data and voice transmissions, efficiently using the limited available radio spectrum, with self-organization techniques enabled. Over the coming years, Haartsen kept working on the development of piconet networks and eventually played a large part in the establishment of the SIG or 'Special Interest Group' for Bluetooth. He chaired the SIG's air protocol certification section between 1998-2000, working to standardize protocols relating to Bluetooth radio communications.

Early Development

Five companies in 1998, Nokia, Ericsson, IBM, Toshiba, and Intel, joined each other to create a consortium called the SIG or 'Special Interest Group,' in order to encourage the implementation and development of a worldwide solution for wireless communication in the short-range segment that would operate in the unlicensed ISM (scientific, medical, Industrial) band of 2.4 GHz (Bisdikian, 2001). SIG members were market leaders, two leaders in laptop computing, two leaders in the mobile telecommunications market, and a leading DSP 'digital-signal-processor technology' company. It was Ericsson who initially approached these other portable device manufacturers to generate interest in the new technology. They envisioned the new system together, which required portable devices of critical mass levels that would use the new short-range radio technology. The new Bluetooth consortium announced itself in May 1998 to the general public from San Jose, London, Tokyo, and California (Haartsen, 1998). Later on, further names such as Lucent, 3COM, Microsoft, and Motorola joined the group, and today, the SIG has a membership of around 30,000 worldwide companies. The IEEE 802.15 standards working group formed in 1999 to develop together a tree of diverse communication standards for WPANs or 'wireless personal area networks'. The SIG submitted its Bluetooth technology specifications for the IEEE 802.15 standard as a potential candidate. The proposal was chosen, and the Bluetooth specification began to serve as the baseline of 802.15.1 standards.

Circumstances Leading to Development

Bluetooth technology was designed in order to fulfill the need to connect personal communication and technology devices without the need to have a clutter of cables. The idea came up at Ericsson when they were trying to work with RS-232 cables in a tangle, which was usually used to establish communication between instruments at the time, and they envisioned replacing it with a wireless alternative that would be RF-based. Bluetooth was designed as a short-range communications wireless protocol that would facilitate such data transmission over short distances through PANS. The intent behind the technology was to create a single digital protocol that would wirelessly connect multiple devices and overcome synchronization problems between devices. The new technology used a frequency hopping technique spread in a spectrum, which chopped data and transmitted it into 75 different chunks of frequencies. It was designed to automatically manage its connections at a physical

level, decide when to transfer and what bits to transfer, and also check whether the received and sent messages were the same. Although other companies were also hit with the idea of the wireless linkage between devices, they quickly realized that there is a need for universal interoperability and that technology would require to be standardized, so they became part of the Bluetooth SIG.

Transformation and Societal Impact

Today, Bluetooth communications are considered to be at the forefront of technological innovations. It changed the way people talk on phones and how they interact with it. The product development that followed proved that it was a unique transmission protocol that could have almost limitless implications. Bluetooth technology has changed society and how people interact with their devices. From projection at school to speakers at home, it led to a cordless world where spaces could be kept neater. It is like an iPhone compared to an old telephone with a cord. Bluetooth allows devices to be moved around without having wires to remain plugged in and with no interruptions between the connections. Hands-free headsets that operate using Bluetooth have begun to become more common and allow users to work with their devices at greater range and easier mobility. In businesses, Bluetooth connections allow one to print documents wirelessly, connect keyboards and mice to PCs wirelessly, and allow for the connection of personal hand-held devices to be connected to screens and projectors for presentations during meetings (Waqgas ur Rehman Butt, 2008), all at a very low-power usage, compared to Wi-Fi technology. The technology also led to wirelessly enabled wearables, such as smartwatches and fitness bands. It allowed transferring captured data on those wearable devices to be synchronized with smartphones and save records in real-time without putting a heavy drain on the battery. A Wi-Fi connection limits synchronization between such wearables and drains a greater portion of the battery (Dan, 2016).

As cellphones began to transfer data wirelessly between themselves and computers it led to a range of applications development. From an MP3 player and a PDA to a car's navigational system, today, while driving, people no longer need to hold a phone and talk to someone, as Bluetooth simultaneous voice and data transmission allows people to let the phones stay in their pockets and simply speak in the car. They can speak the name of the contact, and the phone will dial. The microphone system or the earpiece begins to be routed through the car's sound system.

All of these developments led to great changes in how humans interacted with their devices and each other as well.

Future Expectations

Today, there are billions of chips that have integrated Bluetooth wireless technology incorporated into them in order to enable the use of thousands of applications built to utilize it for a number of purposes. The low energy requirement of Bluetooth protocols makes it highly useful in newer devices

that will utilize coin cell batteries for power. In two decades, the total number of Bluetooth-related products and their application-related shipments has surpassed 2.5 billion, whereas its association has stretched to 19000. It is quickly growing into a technology with a very optimistic future (Nordic Semiconductor, 2014).

Bluetooth led to the development of technologies and applications that make seamless use of personal area networks that would never have been possible in a world connected with cables. Today, the Bluetooth SIG works with other standards bodies like the UWB, 'Ultra Wide Band,' to improve existing Bluetooth technology and make it suitable for future requirements. It could extend its coverage to up to 100 meters with a transfer rate of 100Mbps that could allow it to stream high-quality video content to Bluetooth-enabled devices. All major operating systems, such as Windows and Mac OS, provide native Bluetooth compatibility, and it has become an integral part of this (Mohamed, 2009).

Future functions in Bluetooth technology that are being researched include determining location and distance so that devices can work with each other while understanding the distances between each device (Hardawar, 2016). This can provide contextual awareness as an extra parameter that could also lead to the development of interesting and useful applications using the Bluetooth protocol. It can be said that the best uses of Bluetooth technology are still ahead of us.

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