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The Use of Bluetooth in the Intelligent Sensor Network

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ABSTRACT- Because they would be running on lesser power but also most likely without the support of a central system, potential ubiquitous computing gadgets would need to interface with other smart devices on an ad hoc basis. However, no one communication technique has yet to emerge as a viable contender in the area of ubiquitous computing: numerous present wireless communication methods seem to be deficient in robustness, use excessive levels of energy, or need the utilization of networks to be competitive. We installed a Smart device into the first iteration of a multi sensor device connected as part of a National Smart-Its research project, which was built to assess the suitability of the newest but also most potential Bluetooth module for particular connection requirements. Despite the reality that Bluetooth allows for reliable and easy ad hoc communication, preliminary research suggests that the Bluetooth system might benefit from better support for asymmetrical communication and, in especially, slave-to-slave transmission.

KEYWORDS- Bluetooth, Sensor Network, Smart-Its, Universal Asynchronous Receiver-Transmitter (UART), Wireless-HART (Highway Addressable Remote Transducer).

I. INTRODUCTION

Objects that we see every day are becoming "smart" by incorporating computational and connection technologies into them, according to the concept of ubiquitous computing. Despite the reality that such things keep their original function of the body, their enhancement will simply boost and broaden their use, allowing for the development of new interaction patterns and application possibilities. The Smart-Its initiative seeks to introduce smartness to the actual world via a variety of means. While a single Smart-It is capable of perceiving background data through its embedded device may gain mutual understanding through the exchange of this knowledge and the exchange of information. Having sufficient networking equipment is essential for sharing information. In order to be consistent with the inconspicuous design of the apps, the networking equipment should preferably be wireless. Even though a Smart-Its sensor node has no legitimate leadership, nodes must be able to chat ad hoc, that is, and without previous knowledge of each other without a assistance of a context framework, in order to function properly (however they may consume services when available). Furthermore, the connection technology must be reliable, scalable, and capable of making efficient use of the limited resources available to the autonomous device. Finally, in order to take use of contemporary environmental communication capabilities, the networking technologies that are utilized should be compliant with a widely accepted standard. These criteria triggered a search for a viable Smart-Its sensor networking connection solution, which was launched in response. After doing a brief review of the available technologies, we decided to take a deeper look at the new Bluetooth standard as a potential option for consideration [1].

Bluetooth is a developing networking protocol that allows for the ad hoc creation of up to eight functional units of master/slave Piconet. Bluetooth is currently in beta testing. It makes it possible to establish random relationships between devices without the requirement for previous knowledge of one another. A Bluetooth connection allows data to be shared between systems that are separated by a notional distance of up to 10 meters. Both Piconet users are able to access data at a rate of 1 megabit per second. Bluetooth operates in the license-free 2.4 GHz ISM band (2.400-2.484 GHz), and it makes use of frequency hopping spread spectrum (FHSS) to alleviate worries about interfering radio signals. The technology is aimed at low energy usage and is targeted at the retail consumer sector with cheap prices and a global supply network in place [2-6]. We constructed a small number of Smart-Its demonstrators using Bluetooth communications to investigate the practical application of Bluetooth computer networks and to assess its suitability for interconnected devices in general and the Savvy project in particular. While the functioning prototype allowed us to get a detailed first look at how Bluetooth is used in custom-built products, the lack of support for some of the key parameters in our from before the Bluetooth modules prohibited us from making conclusive conclusions about its suitability for our needs. Instead, we plan to conduct additional testing in the future, preferably with more sophisticated components from a wider range of suppliers [7].

A. Insights into The Industry

It is projected to reach USD 8,669.8 million by 2025, expanding at a compound annual growth rate (CAGR) of 15.2 percent. The global manufacturing wireless sensor network (WSN) market was estimated to be USD 3,282.2 million during 2018, with a CAGR of 15.2 percent expected from 2019 to 2025. The WSN seems to be a network design that eliminates the need for fiber cables to communicate between sensor network and controllers. It also enables for better communication by using radio nodes strategically arranged in appropriate topologies. As a consequence, there is a spike in sales for IWSN in recent years, and this growth is projected to continue during the forecast period [8].

Because of the growing need for communications infrastructure and also technical breakthroughs involving machine learning (ML), artificial intelligence (AI) and big data, the IWSN market is likely to grow significantly in the coming years. Companies are able to examine massive amounts of data gathered from a variety of sensors, including temperature, movement, pressure, gas, movement, and chemical sensors, thanks to these technologies, to name a few examples. The scale of the industrial wireless sensor network (IWSN) market in the United States is shown in Figure 1.

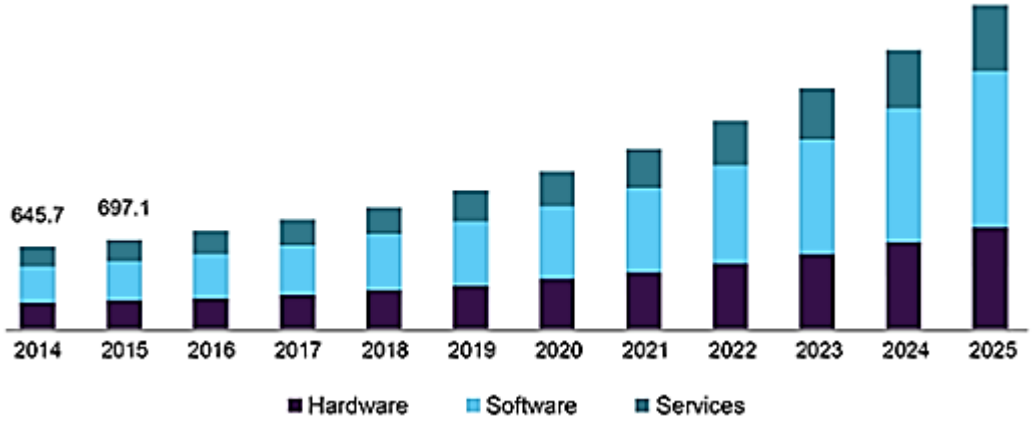

Figure. 1: U.S industrial wireless sensor network (IWSN) market size, by component, 2014-2025 (USD Million) [GRANDVIEWRESEARCH]

In order to guarantee smooth communication between industrial equipment, emerging economies across the globe are placing a strong emphasis on strengthening communication connections between industrial devices via the use of wireless technologies. Industry sectors such as oil and gas, as well as utility companies, are adopting wireless sensor networks because they have the capacity to function smoothly in hostile remote environments [9-13].
Growth is anticipated to be fueled by an increase in demand for Wireless-HART and ISA-100.11a technologies, as well as their fast acceptance in the industry. Wireless networks are widely used for environmental monitoring, as well as their small footprint, are anticipated to have a favorable impact on the industry's growth during the forecast time period. For participants in the industry, however, in recent years, factors like as limited bandwidth as well as battery life have been a subject of discontent [14].
The US Department of Energy predicted in 2016 that electric vehicles will replace gasoline vehicles by 2040, motor-driven systems account for 23.0 percent of total energy consumption in the United States. The integration of a WSN with sophisticated energy management systems resulted in a reduction of 18.0 percent in power usage. Eaton Corporation has created a system that can connect with a range of open Wi-Fi and be coupled to innovation and environmental management system and use a self-configuring WSN. Various governments are implementing a variety of initiatives to improve connection and introduce system mobility, as well as to make data more easily accessible to citizens. For example, in the United States, El Paso launched the Digital El Paso initiative to enhance the usage of WSNs across the city. Manufacturers in the IWSN market are benefiting from such initiatives, which are generating growth possibilities [15].

B. Insights into Components

Based on the product, the market has been segmented into three main categories: hardware, software, as well as services. In 2018, the software industry is predicted to rise through the ranks of the market due to increased demand for client software applications and self-organizing systems. During the projected period, the software category is likewise predicted to grow at the fastest pace. According to industry experts, the use of Software Defined Architecture (SDN) within IWSN to improve reliability and efficiency has further boosted the demand in the industrial sector.
In addition, the hardware sector accounts for a substantial portion of the IWNS market share. The increased use of sensor nodes, gateways, and portals to create network infrastructure is a crucial driver driving the hardware industry forward. The growing usage of an Internet of Things (IoT) as well as connected devices in industrial uses is expected to contribute to the electronics sector's growth. Furthermore, the IWSN can be easily established in locations that are technically unreachable, giving them an edge over their wired counterparts in this region of the globe. The hardware installation also makes it simple to integrate data, which allows for the centralization of monitoring programmes once they have been implemented [16].

C. Insights about Type

Sensor networks are classified into several categories, including temperature measurement networks, force sensor networks, level wireless sensors, flow sensor networks, moisture content sensor networks, body movement and position wireless sensors, gas sensor infrastructures, light sensor networks, cannabinoid sensor systems, and others. As a consequence of high of implementations in the oil / gas, preservative, and supermarket industry for inferentially assessing the flow of beverages or body fluid, as well as the rising prevalence of flow sensor nodes on the market, the flow environmental sensing segment accounted for the largest share of the market in 2018. As a result, a huge number of companies are developing piezoelectric flow sensors, which will be used in combination with

wireless sensors to reduce power usage in the oil and gas industry [17-21].

Because of the ubiquitous usage of chemical sensors networks in production plants, it is important to understand how they function, the sector is projected to expand at the highest rate during the projection period, according to the forecast. When used in conjunction with other sensors. Furthermore, since gas sensors are both cost-effective and small, they are becoming increasingly popular in sectors such as pharmaceuticals, petroleum and chemical, oil and gas, building automation, and food and beverage processing and packaging [22].

D. Insights into Applications

The market has been segmented into four categories depending on the applications they are used for: machine monitor, process monitoring, remote monitoring, protection and surveillance, and others. As a consequence of several advantages, the led to the change sector dominated the market in 2018, including the removal of wiring restrictions, ease of maintenance, and lower prices as compared to wired solutions, which were previously available. Furthermore, the capacity of IWSNs to activate and operate moving components and equipment has been one of the most important reasons in the widespread adoption of these networks.

Enhanced operational efficiency, as well as lower deployment and maintenance costs, are anticipated to propel asset tracking to the top of the market growth charts during the projection period. The availability of trustworthy solution with longer battery life as well as a wireless connection range that is quite long has also helped to the widespread adoption of asset surveillance systems in a variety of industries, including the manufacturing and distribution sectors, among others [23].

E. Insights into Technology

A further division has been made based on technology, with the following categories: ZigBee, Bluetooth, Near-Field Communication (NFC), Wi-Fi, Wireless-HART, cellular network, and ISA 101.1a. As a result of its advantages, providing a user-friendly experience by maintaining compatibility with current devices, applications, and systems are examples of this, the Wireless-HART segment led the market in 2018. Wireless-HART is indeed a wireless communication technology that is widely used in open wireless connectivity, which is subsequently used in value is related and monitoring purposes. Wireless-HART is indeed a modern communications protocol that is widely used in open wireless technology. As a result, it is extensively used in a variety of industries including oil and gas, utility, and manufacturing due to its cost-effectiveness as well as improvement in efficiency, among other benefits.

Increasing use of cellular networks for gateway communications is anticipated to propel this sector to the top of the fastest-growing segments list during the forecast period. cellular networks The information on cloud servers is updated via the usage of a cellular network, and the information may be viewed from any place through the internet. Increasing demand for the Internet of Things (IoT) and smart manufacturing is expected to propel the expansion of cellular technology inside the commercial wireless sensor network marketplace during the forecast period. As such, the widespread adoption of specialized wireless cellular technologies for Internet of Things connection, including such LTE-M and NB-IoT, around the world is projected help to the sector's growth and development [24].

F. Insights into The Region

In 2018, the North American regional market had a commanding position on the worldwide market. the presence of a substantial manufacturing sector is a contributing factor The firms in the region, in addition to being tech savvy technologies for performance improvement and the development of relevant legislation, are also champions in their respective industries. The rising usage of IWSN the oil and gas companies for offshore installations is also one of the main major factors driving growth in this region's regional market in North America, as are a number of other factors. Significant increases in expenditure in Wi-Fi router by major technology providers may also be associated with the growth of the market.

In light of the rising implementation of smart manufacturing technology in countries like as Chinese, India, and Taiwan, it is projected that the Accounted for a major share market would overtake North America as the speediest regional market in the not too distant future. It is anticipated that Latin American regions would see considerable growth over the forecasted period, owing to the increased usage of WSN inside the oil, gas, and mining industries.

G. End-User Perspectives

Using end-use as a guide, the market is divided into the categories listed: autos, oil & gas extraction and processing, utilities, miner, food & beverage production, and others. Tpm, quality control, and intelligent automated management services were also expected to drive the implementation of industrial wireless sensor networks (IWSN) in the industrial sector, resulting in the segment sprouting as the quick segment in terms of revenue growth in the future.

In addition, the growing need for energy-efficient and environmentally friendly production is encouraging firms in the electronics industry to invest in more complex plant control methods, which is aiding the growth of the IWSN industry. In addition, the utility sector accounts for a substantial portion of the IWSN market share. Because of the fast increase in the implementation of smart grid infrastructure across the globe, the utility sector has seen significant growth. Smart grid technology includes features such as automated metering technology, full-duplex connectivity, distribution mechanization, usage of renewable sources, and extensive monitoring and administration of the whole power system, to name a few. The scale of the industrial wireless sensor network (IWSN) market in Europe is shown in Figure 2.

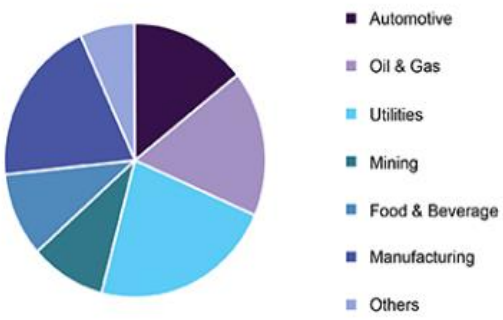

Figure 2: Europe industrial wireless sensor network (IWSN) market size, by end use, 2018 (%) [GRANDVIEWRESEARCH]

H. The Smart-Its Prototype

The Smart- is an acronym that stands for "smart" and "intelligent." As a result of the necessity to incorporate "smartness" into current systems, the project was conceived and developed. Through the incorporation of lightweight, unobtrusive, and autonomous computer equipment into its designs, it strives to incorporate computing into real-world items. Intelligent Connection (Smart-Its) products integrate technology for sensing, encoding, and connectivity that may be used in conjunction with other devices that are linked to the Smart-Its. However, although an individual smart it may sense background data from embedded sensors, it is only via exchange of information that a group of smart it can come to comprehend one another on a more general level of comprehension. For example, a network of Smart-Its augmented products might be used to build a shared context that could be accessed by apps and services that were installed in the environment at the time of creation. If you're seeking for methods to use Smart-Its to prevent credit card fraud, for instance, operational scenarios of Smart-Its sharing mutual information have been found and may be used to your advantage. These circumstances need the usage of a high number of Smart-It-enabled private topics such as clothing or vehicle keys in order for a Smart-It-enabled cardholder to function properly, making the card ineffective if the card is misplaced or stolen. Our Smart-It node specs will be detailed in detail in the following sections, including the components that were used in our initial prototype [25].

II. DISCUSSION

Commercial Bluetooth solutions come as self-contained transceiver modules. Protected subsystems intended to be added-on peripherals. They feature a built-in CPU, memory, baseband and radio circuitry. While the lowest levels of the Bluetooth protocol must be implemented on the host device, the upper layers of the protocol, as well as software, must be implemented on the modules. This is because the in-system CPU and RAM are not available for downloading user-specific implementations. The transport layers for Bluetooth modules and host devices are standardized for UART, RS232, and USB. Only Ericsson ROK 101 007 tech tests were available at the time (January 2001). Our host CPU for higher Bluetooth protocol layers and applications is an Atmel ATMega103L microcontroller. The device has an 8-bit RISC core with up to 4 MIPS @ 4 MHz, a serial UART, and various control modes. The embedded memory is made up of 128 KB Flash and 4 KB internal SRAM. The SRAM and an address latch may be used to expand data memory up to 64 Kbytes. The 16-bit data-memory address bus may directly access external memory without paging. Instead of sending sensor data to the Bluetooth module, we used a more capable CPU to allow for more sophisticated pre-processing on-board.

A simple scheduler (which allows incident-driven application activity organization) and the Bluetooth protocol stack host component are presented in C. There are system drivers for UART ports, ADCs, general purpose IO, RNG, system clock, and sensors. At the time of project debut, the Bluetooth stack's host component was available in open source and commercial versions (January 2001). The commercial software stacks had extremely high system requirements, both in terms of needed operating system capabilities (especially multi-threading) and programme and data capacity. Open source was introduced for Linux environments, and microcontroller requirements were ignored. For limited deployment, 2 Kbytes of storage memory is sufficient, with most of it being utilized as buffer space. We selected open source since it was readily available and all other choices were as acceptable (or unsuitable). We converted the host part of the Bluetooth protocol stack from open-source Linux to our microcontroller environment. The foundation layers are HCI and LLCP (L2CAP). The Bluetooth stack for Linux supports multi-threading and serial port access. In our design, the scheduler and low-level drivers handle this. The microcontroller's limited memory space was the main porting barrier.

The Ad Hoc Networking Capability of Bluetooth Today Bluetooth is the first de-facto ad hoc networking interface, developed by many separate groups. It was designed to replace cables and works well in that context. Its unique design makes it unsuitable for other ad hoc networking solutions. Moreover, the sector continues to struggle to meet customer demand for quantity and consistency. The initial items were out in late 1999 and late 2000. When we started our research in early 2001, manufacturers were still offering pre-release Bluetooth chips that didn't fully conform to the standard.

III. CONCLUSION

The considerable exposure that Bluetooth has received in recent months may be attributed to a variety of things. The Piconet connection paradigm, which was one of the first international standards to be developed, considerably streamlines ad hoc networking by adopting the Piconet connection conceptual framework. Bluetooth equipment may be used everywhere in the globe without requiring any modifications since they are operating on the publicly accessible ISM band. The frequency hopping technology improves communications by protecting them from interference with restricted bands. However, although Bluetooth components are now exceedingly costly, prices will drop to around USD 5 per gadget when mass production is implemented in its entirety. Initially, future Bluetooth components are meant to be used as a cable replacement system, and they would be better suited to situations in which a powerful master computer (often a

laptop, a PDA, or a cellular telephone) can readily connect to a variety of peripheral devices. Bluetooth, with transmission speeds of up to 1 Mbps, provides more than enough capacity for ubiquitous computing systems, such as basic sensor networks, to function well.

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