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Comparisons Between Different Protocols for Home Automation

A COMPARATIVE ANALYSIS REPORT FOR CP5307

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Introduction

This paper is a comparative analysis about different home automation protocols which relates to mobile technology. Mobile technology is essential in home automation as people nowadays use their mobile phones and tablets as a user interface to control many variables at home automation like lighting, music, temperature, security using smart devices and appliances that are able to connect and communicate with the server and with each other using wireless connection such as the internet. However, in order for these devices with different manufacturers to connect and communicate with each other, a home automation protocol should be considered by every manufacturer before making their product.

There are many home automation protocols today that are used for home automation. The most common and affordable protocols are the Ethernet, Bluetooth and WIFI. Each of them are widely used nowadays but each of them have their own advantages and disadvantages. This paper will discuss the different aspects of comparison and contrasts of the home automation protocols mentioned above . Some comparison charts are also provided to help in visual understanding each protocols pros and cons. Furthermore, the latest technology and innovations for each protocol are also discussed to overcome each weaknesses.

Discussion

I. Ethernet

Ethernet is a local area network (LAN) technology and uses wired technology that allows you to connect a variety of computers together with a low-cost and extremely flexible network system, Spurgeon, C. (2000). Ethernet is widely used that almost all computer manufacturer today supports Ethernet. It evolves from the original 10Mbps to 100Mbps Ethernet up to the traditional Gigabit(1G) Ethernet and the new 2.5 and 5G Ethernet standard that brings 5X the speed without disruptive cable changes set by the IEEE or the Institute for Electrical and Electronics Engineers, Cooney, M (2016). Ethernet communication uses a physical cable made up of twisted pairs of wires. The maximum distance of a cable is limited to 100 meters and data transfer speeds of up to 1Gbps or 1,000 Mbps. Ethernet is further developed by The Ethernet Alliance, a global non-profit, industry consortium of member organizations that are dedicated to the continued success and advancement of Ethernet technologies. Moreover, Cat 7 cables are the latest to hit in the networking market and enable speeds of up to 10 Gbps

The benefits of Ethernet are the speed of data transmission and the distance of communication.
Basing on the Figure 1. graph below taken from the 2020 Ethernet Roadmap of The Ethernet Alliance, the current speed that Bluetooth supports is 100GbE while a projected 400GbE is underway.

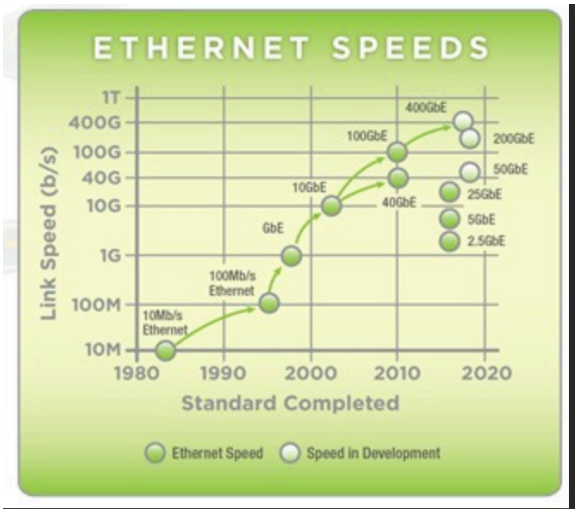

Figure 1. Ethernet Speeds taken from 2020 Roadmap of The Ethernet Alliance.

In addition, cables are more secure since they are buried in the walls and is hard to access. Although, this is also a disadvantage because the cost of installing the cables is quite expensive since you need to open a wall and install the cables. You also need a space for your central data closet that house your Ethernet switches.

II. Bluetooth

Bluetooth is a wireless technology was created when five major companies(Ericsson, Nokia, IBM, Toshiba and Intel) formed a group to create a license-free technology for universal wireless connectivity in the handheld market, Bhagwat, P. (2001). It is a wireless radio protocol that uses the 2.4 Ghz band. Bluetooth 1 provides bandwidths of around 1 Mbps, while Bluetooth 3.0 and 4.0 provides a data rate of around 24Mbps. The protocol uses a relatively low amount of power to operate, which means accessories can run on battery, but it has a limited range. According to figure 2 below taken from the Bluetooth SIG website(https://www.bluetooth.com), the total shipment is currently 4.2 billion and expected to rise to 6.0 billion in 2024.

The benefits of Bluetooth is that it is wireless and don't need to spend money for cable installation. Aside from that, Bluetooth is very affordable since the technology of Bluetooth in using Bluetooth is cost-effective as enumerated in the article by Articlepro (2020). In addition, it is highly compatible as Bluetooth devices can connect with each other even though they have different model. Furthermore, Bluetooth uses low power signals and require very little energy, thus it uses less battery or electrical power to run. This is an excellent benefit for mobile devices because Bluetooth won't consume a lot of the phones battery,

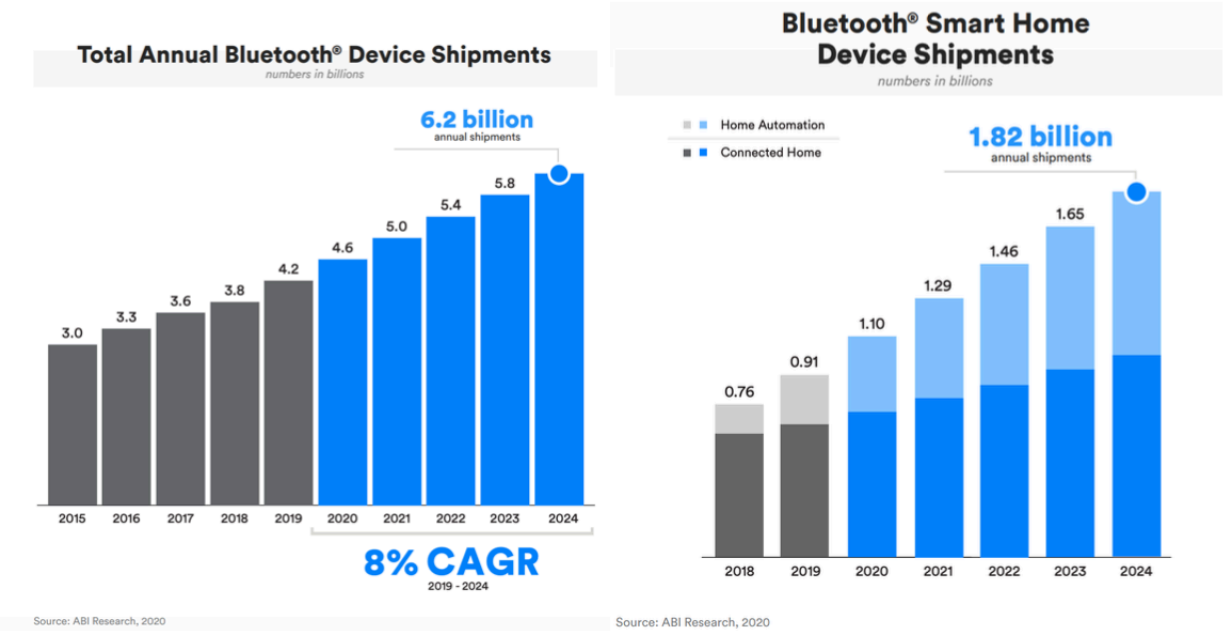

Figure 2: Total Annual Bluetooth Device Shipments and Bluetooth Smart Home Device Shipments from the Bluetooth Market Update 2020.

The major limitation of Bluetooth is that it is only a short range communication thus, making it hard to cover an entire home. Another limitation of Bluetooth is that as it operates in a 2.4 GHz, it is susceptible to interference from other wireless devices since there are a lot of them uses 2.4 GHz frequency range. Aside from that, Bluetooth doesn't allow video transmissions so it is only used for audio streaming or issuing commands among different accessories. Nonetheless, a latest version of Bluetooth that was released by the Organization Bluetooth Sig called Bluetooth 5. This new Bluetooth technology increases the range of the Bluetooth by using higher transmitting power, Woolley, M (2017).

III. WIFI

WIFI is a wireless technology that connects devices to the Internet without using a cable or physical wired connection. It is a wireless networking technology that is commercially used at least as early as August 1999. It was coined and invented by Interbrand as a pun on the word hi-fi (high fidelity), a term for high-quality audio technology. It is currently standardized and a trademark of The Wi-Fi alliance. According to the figure 3 below taken from the Wi-Fi Alliance website (https://www.wi-fi.org), a total of 30 Billion Wi-Fi Device were already in the market.

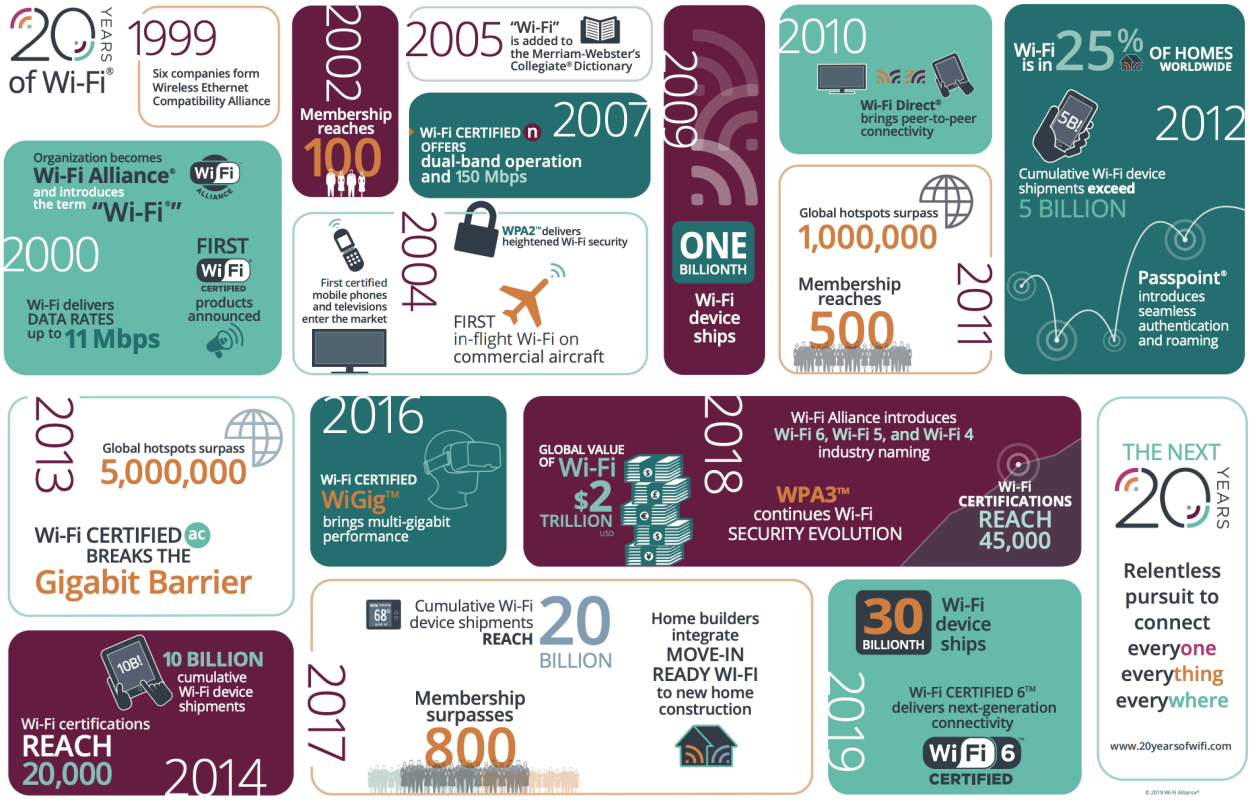

Figure 3. 2020 Wi-FI Timeline taken from The Wi-Fi Alliance.

As enumerated by ElShafee, A. and Hamed, A.K. (2012), the benefits of WIFI includes; Reduced installation costs since there is no need for cabling where materials are expensive and the labor in the cable installation; Easy deployment, installation and coverage since wireless nodes can be mounted almost anywhere; System scalability and easy extension since additional nodes do not require additional cabling and; Integration of mobile devices such as smartphones where a device's exact physical location is no longer crucial for a connection as long as the devices is in range of the network. Furthermore, The maximum range of a WIFI is around 60-feet and it can be affected by many things like physical barriers, interference, transmitter power and antenna quality. It has also a high speed ranging from 10Mbps to 100Mbps allowing high-definition audio and video streaming. The latest WIFI standard is 802.11ac that offers speeds of up to 3,200Mbps. In addition, theoretical limit of Wi-Fi is 256 connected devices.

There are few drawbacks in Wi-Fi network. First, since there are many devices using and competing for bandwidth they will interfere with each other. For example, as many users stream hi definition videos at the same time, the Wi-Fi connection will become slow as the bandwidth is congested. Another problem is that Wi-Fi devices consumes a lot of power because high speed rate requires a lot of power to operate therefore a need to plug-in all the time. In regards to range, it is limited to larger homes where there are a lot of concrete blocks and WIFI signals cannot penetrate it. Therefore, you need to install additional WIFI repeaters or routers. Finally, security, although Wi-Fi itself is not a security risk, sometimes people fail to enable proper security measures like passwords and software updates. Noll, M. (2019).

Comparison

Ethernet, Bluetooth and WIFI have different strengths and weaknesses. Each aspects is discussed and compared further in this paper. First we need to see some comparison charts that are provided below.

	WiFi	Ethernet
Speed	Slow data transfer speed	Faster data transfer speed
Reliability	Suffers from signal interference due to many environmental factors	Delivers a consistent speed
Security	Data flow needs to be encrypted	Data doesn't require to be encrypted
Latency	Higher	Lower
Deployment	Easy to install and deploy	Cable installation infrastructure is required

Figure 4. Comparison Chart between WIFI and Ethernet taken from ubidots.com – Wi-Fi vs. Ethernet: Which Connection to use.

BASIS FOR COMPARI	BLUETOOTH	WIFI
Bandwidth	Low	High
Hardware requirement	Bluetooth adapter on all the devices connecting with each other.	Wireless adapter on all the devices of the network and a wireless router.
Ease of Use	Fairly simple to use and switching between devices is easier.	It is more complex and requires configuration of hardware and software.
Range	10 meters	100 meters
Security	Less secure comparatively	Security features are better. Still, there are some risks.
Power consumption	Low	High
Frequency range	2.400 GHz and 2.483 GHz	2.4 GHz and 5 GHz
Flexibility	Supports limited number of user	It provides support for a large number of users
Modulation techniques	GFSK (Gaussian frequency shift keying)	OFDM (Orthogonal frequency division multiplexing) and QAM (Quadrature Amplitude Modulation)

Figure 5. Comparison Chart between Bluetooth and WIFI taken from techdifferences.com – Difference Between Bluetooth and WIFI.

I. Technology and Uses

Ethernet uses twisted paired cables for connection while Bluetooth adapter is used in every Bluetooth devices to connect with each other. On the other hand, WIFI uses wireless adapter for every devices as well as a wireless router to connect to the Internet as shown in figure 5.

Bluetooth is a wireless technology that is used to connect short-range devices for sharing data while WIFI is also a wireless technology that provides high-speed internet access. On the contrary, Ethernet is used for wired internet connection.

II. Distance

Basing on the figure 5 above, the range of Bluetooth is approximately 10 meters while WIFI usually 100 meters but it still depends on the WIFI standard that is used. With 802.11 b/g, the typical range is 32 meters indoor and 95 meters outdoor furthermore, latest WIFI standard has longer range. Ethernet on the other hand is limited to the available connected cables. However, a new Bluetooth 5 was introduced by the Bluetooth SIG last 2016 that has doubled the distance of the previous Bluetooth versions, thus covering most area in home and building, Woolley, M (2017).

III. Availability and Costs.

WIFI is easy to install and deploy while Ethernet requires cable installation infrastructure. However the cheapest installation and easy deployment is the Bluetooth since there is no need for any cables or WIFI routers for the devices to be connected. Although WIFI installation is cheaper than Ethernet, upgrading an existing Ethernet is lesser than installing new WIFI network.

IV. Speed

In terms of speed, Bluetooth lags behind Ethernet and WIFI since Bluetooth only has a bit-rate of 2.1Mbps. Since Ethernet is wired technology, it is slightly faster than WIFI. Initially, the maximum theoretical speed of WIFI based on the 802.11g standard is 54Mbps according to Jame, A. (2018) and mobile phones could be connected to the internet with this connection but it is much slower compared to Ethernet which could easily provide 100-1000Mbps. However, with the latest 802.11ac WIFI standard that offers speeds of up to 3,200Mbps, WIFI is much faster than the Ethernet.

V. Power Consumption.

Since Bluetooth has the lowest speed or transfer rate, it consumes less power compared to Ethernet and WIFI. Wi-Fi devices consumes a lot of power because high speed rate requires a lot of power to operate therefore a need to plug-in all the time. While this is the same as ethernet, most ethernet devices are plug in the outlet for continuous power.

VI. Security

Bluetooth is the least secure compared to WIFI and Ethernet as it only uses authentication keys for connection. WIFI data on the other hand needs to be encrypted while Ethernet don't need to be encrypted since it uses cables and are buried in the walls. The data in Ethernet connection can only accessed by the devices that are physically attached to the network therefore there are no or less chance of data loss and hacking. Although WIFI data is susceptible for hacking, WIFI uses the encryption method called WPA2-PSK which is most secure encryption method

VII. Reliability and Interference.

In terms of connection, Ethernet delivers consistent spend and offers more stable connection than the wireless WIFI and Bluetooth. WIFI suffers from signal interference due to many environmental factors while Bluetooth suffers in longer distances.

Conclusion

The Ethernet, WIFI and Bluetooth are different home automation protocols and they have their own advantages and disadvantages depending on the devices needs and configuration. Bluetooth is a wireless technology standard for exchanging data over short distance. It is ideal to use in in small devices like speakers, smartphones and etc. Ethernet is wired technology that connects the devices to the internet like computers, printers, security cameras, smart TV's etc. while WIFI is a wireless technology that connect portable devices to the internet like tablet, smartphones and others to connect to the internet easily. Even though these protocols are old and that there are new technologies that are promising to the home automation industry, Ethernet, WIFI and Bluetooth are still devices are still massively used in the market basing on the figure 2 and 3.

Implications

Although there are other home automation protocols that are in the market. Bluetooth, Ethernet and WIFI are still the widely used home automation protocols because of its simplicity and its capabilities that can be used in smart home devices and appliances. With each strengths and weakness discussed above, each of the protocols mentioned are still being improved and upgraded by each Organizations that are managing them. In result, they became more and more popular and still widely used protocols for home automation.

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