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Everything about the Internet of Things (IoT)

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Abstract-In this paper, it is attempted to elaborate on Internet of things (IoT) and first of all, some basic points about IoT, such as Busduct, Konnex (KNX), bus network, wireless, and history of those basic points will be provided and after that, new technologies including artificial intelligence (AI), computer and systems, and some programming languages will be compared with these basic points that consist IoT.

Keywords-*IoT, Busdoct, KNX, Smart Building, AI*

I. INTRODUCTION

Today, we are in technology era, so everybody wants to change world to a better place, exactly like people who lived in the past, and they made and invented things to build this world and reach us to technology era. So, we can use some of this stuff to change and then compose them with technology in order to build Internet of things (IoT) for new world and changing world to a better place for us and people who will live in the future (Figure 1).

Figure 1. IOT [27]

Hence, we will need a lot of stuff, first of all, we will require a number of stuff that we still using them and they are not from technology era, such as electricity, car, refrigerator, and everything like that, and the things that we can add them to that stuff belonging to the technology era are Busduct, Konnex (KNX), network, wireless, energy efficiency, artificial intelligence (AI), 5G technology, and a lot of programming stuff.

II. BUSDUCT

A. What Is a Busduct?

The Busduct system is referred to a new system that can be replaced with cabling in some cases. As the name implies, it consists of two main parts, bus and duct. Bus is the same copper or aluminum conductor conducting electricity, and is responsible for electricity and duct is also a prefabricated electrical channel into which energy buses are placed [9-11].

B. History of Busduct

General electric (GE) Company claims that the first idea for Busduct has come from the request by the General Motors (GM) Company following development of its various production units for transmission and distribution panels of its devices, when it faced with many problems and as a result, it started negotiations with GE Company. After reviewing various designs and theories, for the first time, GE Company designed Busduct consisting of air insulation with a metal body and provided it to GM Company. With introduction of Busduct and replacement of this system with cable system, a large volume of power cables plus cable trays, cable ladders and also, a large number of power distribution panels were removed and prefabricated modular canals with easy and fast portability were replaced, which are able to transmit and distribute electricity at higher capacities (Figure 2) [9-11].

Figure 2. Busduct things[9-11]

III. KNX

A. KNX Smart Platform

In the field of new technology, KNX intelligent platform is one of electrical installations of intelligent systems, which is a standard based on the open systems interconnection (OSI) model and is among electrical installations of smart homes used in construction and hospital projects according to needs and expectations of employer (Figure 3). It is located in project building facilities; as one of the most common and popular electrical installations of intelligent systems and as a solution for automation and control of building systems, air conditioning systems, and light and energy control competitively [1-8], [12-14].

Figure 3. KNX[28]

Complete description on KNX design has been presented in the KNX handbook containing several thousands of pages of documentation. KNX applications play a basic role in converting theoretical knowledge about smart grid into practical awareness. KNX technology provides all necessary functions required for home and building automation. It provides an OSI-based communication environment for nodes connected to the KNX network. KNX allows establishment of different physical transmission media, such as twisted pair (KNX.TP), power line (KNX.PL), radio frequency (KNX.RF), and Ethernet (KNX net/IP), as described in the literature [1-8].

B. History of KNX Smart Platform

In 1999, with merger of three organizations including EIBA (European installation bus association), EHSA (European home systems association), and BCI (BatiBus club international), KNX smart platform was developed that is still under construction and this smart platform is currently managed by the Konnex Association. The association is governed by Belgian law, as a non-profit and spiritual owner of the KNX smart platform, which is based on the EIBA communication system with layers. Physical and business practices of EHSA and BCI have been expanded and managed [1-8], [24].

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D. Bus Network

Bus smart platform is another smart platform built with new technology, which is defined as a set of rules regulating communication and interaction of electrical installations of intelligent systems (Figure 4). In other words, it acts like a communication bridge or common software language between electrical installations of intelligent systems in construction projects and hospitals operating two or more synchronization devices. History of this smart platform goes back to a time when it was necessary to install electrical systems in intelligent constructions and hospital projects to provide coordination and balance between them [9-14].

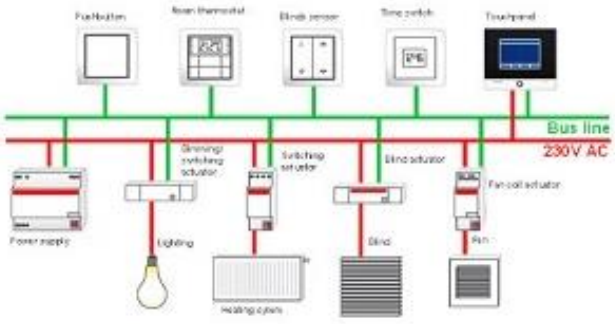

Figure 4. Bus network [9-11]

The two types of bus coupling unit are completely compatible. If we want to take advantage of new topology and need to have a combination of TP1-64 and TP1-256 devices, then we can use the following formula:

$(4*M*TP1–64)+(N*TP1–256)<257$

Where, M and N are the number of each device type, respectively. This allows for development of a maximum of 64 x TP1-64 or 256 x TP1-256 devices [15-16].

IV. Wireless

A. *Wireless Smart Platform*

Another intelligent electrical system facility built with the new Z-Wave and Zigbee technology and is applied instead of wiring or cabling of construction and hospital projects for communication and interaction of electrical installations of intelligent systems is a smart wireless platform whose signals are transmitted by radio frequency (RF) signals, with which it controls the desired device (Fig. 5) [1-8], [12-14].

Figure 5. Smart platform [1-8]

V. Smart House or Smart Building

A smart building is referred to any building that uses the automated processes to automatically control its operations using sensors, actuators, and microchips to collect and manage data (Figure 6). With acceleration of fifth-generation network (5G) rollouts, 5G-enabled IoT applications are being introduced, offering new opportunities for building managers and real estate firms to improve efficiencies in building operations [25].

Greg Corlis, managing director of the KPMG Company considers that building managers and building owners still have to learn about the full potential of technologies ,such as 5G, IoT, or AI and how these can be used to improve building operations [25].

The combination of these three technologies still faces technical implementation challenges, and building owners and managers have yet to learn more about the advantages offered by these technologies in design of smart buildings [25]

Figure 6. Smart house [29]

A. *The Effect of IOT on Smart Buildings*

"From the IoT perspective, you are not going to have smart buildings without IoT. IoT is really going to enable the entire ecosystem to create actual smart building, so if you think about all the IoT-type sensors that we deploy, the building management system (BMS) is technically an extension of IoT capabilities," said Greg Corlis, managing director for emerging technologies, and national IoT leader at KPMG US [21], [25]: "We are about to witness a significant uptick in clients requests to move forward with smart building initiatives (Figure 7).

Figure 7. Smart home [30]

Definitely, any new building that is being constructed needs to be built as a smart building fundamentally. It does not make sense not to leverage IoT-type technologies for that facility. Just trying to continue traditional route and not embedding these types of technologies does not make a lot of sense," Corlis said: "Integration of legacy infrastructure with IoT sensors and applications, newer networks, and cloud services is the key for making buildings truly smart", said Apurba Pradhan, vice president(VP) of product marketing, systems ,and software at Adesto Technologies Corporation, a California-based provider of application-specific semiconductors and embedded systems for the IoT. Through this integration, building managers can extract meaningful data that will enable them to benefit from other technologies, such as AI and achieve return on investment [25].

VI. Computer and Systems

Home automation is adoption of a system to control lighting, atmospheric conditions, entertainment systems, surveillance systems, and home appliances. It allows the devices applied in the home to be connected to a remotely controllable network.

Developing smart devices to work with all home automation systems would be a difficult task as it would require assistance of smartphone companies to properly set up these devices in order to communicate with home automation systems [17-18].

With the recent technological developments, there has been an ongoing debate on the need to switch from traditional home settings to secure automated homes. Most homeowners in developing countries would consider this new initiative as an unwarranted luxury. They would point out to cost of installations and the lack of an enabling environment as a significant hindrance. However, it should be noted that improvements in home automation systems would improve productivity and security in households at affordable costs [19].

Most homeowners in developing countries lack complete and total control over their homes. They are not able to have access to vital home automation features, such as control and monitoring of home appliances, low-cost security, and efficient energy usage implicitly. Therefore, herein, it is tried to find a way in order to replace traditional home systems with secure wireless automated systems [20], [25].

In-depth research was done on existing works and systems that had been implemented in scope of the research work defined in this paper, namely, to design secure wireless home automation based on privacy by design.

The literature was reviewed with a focus on acknowledging the works that have been done, establishing their strengths and gaps, and investigating how different ecosystems influence outcomes [20].

VII. Review of the Related and Existing Systems

A significant drawback of this system is the absence of a mobile or web application interface to control home appliances. Reliance of the short message service (SMS) system alone for communication means that if the global system for mobile communications (GSM) device is misplaced, access control will no longer be valid [26].

The gap in this system is that it is highly intrusive and requires a rewiring of electrical appliances for configuration purposes. The system is also limited to the use of only a GSM, and a SIM card is needed to control the home remotely, and if the GSM or SIM is misplaced, the system ceases to function. Additionally, no security standards were put in place to secure the system against intruders and hackers [26].

However, the lack of an Internet connection is a significant drawback of the system as computation and control of home appliances cannot be made remotely. The lack of remote access to the system poses several problems; the most significant one is that the system is less efficient in cases where emergency access is needed.

The limitation of this work is that the new OpenHAB distributed multiuser (DM) is not compatible with existing mobile OpenHAB apps. However, this is mainly because mobile apps do not currently supply implementation of users credential functionality as well as providing authentication tokens to the representational state transfer (REST) application programming interface (API) [26].

However, a closer look at the systems revealed some gaps. Some of systems failed to provide access control levels for users, making it easy for intruders to be granted with access

permissions. Other systems were found to lack support for multiple devices from different vendors due to compatibility issues. Some of the reviewed systems lacked remote control functionalities, and a few of them did not implement any security mechanism for wireless communication protocols.

These gaps identified from the literature review helped us in our problem statement and finding possible solution approach in developing a secure wireless home automation system with an open home automation bus (OpenHAB) framework by leveraging and improving upon security features of the default server architecture to enable privacy by design and control home appliances via mobile and web apps [26].

VIII. System Design and Implementation

In the system design and implementation phases of the proposed solution regarding the identified gaps in the reviewed literature, both software and hardware tools were utilized. These tools are well suited for achieving our desired goal of building a secure wireless home automation system. In building the designed prototype, readily available circuit components were employed. Cost, efficiency, implication, and suitability of each of the components used in the prototype design were carefully weighed.

The development tools used in this research paper were effective in delivering of setting objectives using the OpenHAB framework.

The circuit design and simulation were carried out first using Proteus software to ascertain behavior of the various hardware modules when they are integrated.

It included the power supply unit with the relays connected. The current and voltage sensor units are also displayed in Figure 8. Switching operation for energy management utilizes a single channel relay.

Figure 8. Iot network [31]

On the other hand, a current sensor is a device that detects electric current flow and generates a signal proportional to that current flow. The generated signal may be analog voltage or current, which can be utilized to display the measured current in an ammeter or can be stored for further processing and analysis in a data acquisition system or even can be used for control of home appliances.

IX. Programming Stuff

Every part of the system has some levels of programming to enable flexibility and adaptable control in order to achieve a complete home automation system. The design software environments used in this paper for hardware and application programming included the Arduino integrated development environment (IDE), Android Studio, Visual Studio Code, Proteus Simulation Software, Fritzing, Etcher, PuTTY, and Vim (Fig. 9). All coding process on any Arduino component was done using the Arduino IDE; the Android application was built by Android Studio, the web view was prepared by Visual Studio Code, and configuration on our OpenHAB instance on the Raspberry Pi was done over secure shell (SSH) using PuTTY by the Vim editor.

Different sections of the whole developed secure home automation system are as follows [22-23], [25].

Figure 9. Programming IoT [32]

According to Schneider Electric Company, the IoT helps to create dynamic and intelligent cloud-based interoperable networks by connecting electrical, mechanical, and electro-mechanical systems and platforms. These systems can help to monitor themselves and act when necessary (e.g., turning down air-conditioning or heating needs in a little-used area)by communicating with each other to provide the data and analytics needed for facility managers in order to intelligently optimize performance and create smarter buildings [22-23], [25].

Also, in a white paper, Schneider Electric Company noted that advanced smart-energy sensors can play a critical role in building energy management systems (BEMS).

These devices contain “sensing” technology that captures and sends digital data to a BEMS to enable analysis and support of actionable insight.

These devices, systems, and platforms connect to a central, open intellectual property (IP) backbone to provide a holistic view of building performance. This backbone not only

integrates all the data generated by the devices, but also presents them via user-friendly interface displays (desktop, tablet, and mobile) that use graphics, data-rich reports, and trend visualizations [22-23], [25].

X. AI

A. AI in Smart Buildings

A clear example of how AI is already being used in smart buildings is a solution developed by Canadian Firm, BrainBox AI, which specializes in autonomous building technology (Figure 10).

BrainBox AI offers a technology combining deep learning, cloud-based computing, and autonomous decision-making to support a 24/7 self-operating building [25].

Figure 10. AI [33]

XI. 5G Technology

There is no doubt that 5G technology is billed as the connectivity fabric that will support a new era of consumer and enterprise experiences. But, in the context of smart buildings, 5G is part of a larger equation that also encompasses AI and IoT (Fig. 11) [25].

Figure 11. 5G technology [34]

Being capable of near real-time data transfer speeds, 5G technology does wonders in reducing latency and improving connection speed and reliability and is expected to facilitate more and better IoT applications for intelligent building technologies in the coming years [25].

A. 5G Is Already Enabling Smart Building

According to the Coretrust Capital Partners, a real estate investment firm focusing on acquisition and operation of large office properties across the U.S., 5G will be the key technology that will enable full implementation of IoT in smart buildings.

Commenting on what specific 5G services or applications have already been implemented in the field of smart building, Ricci said that some smart building applications and usage cases include digital signage, wayfinding, augmented reality (AR) and virtual reality (VR) systems, heating, ventilation and air conditioning (HVAC), and energy control applications, as well as security tools including HD video security [25].

B. 5G for Connecting Building Sensors

Gregory Dial, executive VP of corporate and market strategy, in JMA Wireless Company, believes that 5G, along with the ability to support things like private wireless networks, is going to be extremely important to enable smart buildings, but also it will be a key factor in many other critical infrastructure areas like manufacturing, transportation and large- venue management, among other related factors (Fig. 12).

Figure 12. 5G [35]

Dial also stressed that 5G technology accompanied with private network capability and the added value of putting more compute power at edge of the network will start to automate critical operations [25].

Commenting on how 5G can interact with other emerging technologies, such as IoT and AI to further improve smart buildings, Dial believes that this is the critical link. “5G speeds and low latency to things like smartphones are important, but those technologies pairings will really drive major breakthroughs. Computing them allows high-end functions like AI to run. 5G is simply a standard that allows data to move faster over the air, architecture of the networks supporting 5G

is truly the thing that will make it unique. Software-based platforms and having resources as close to the user as possible are critical."

Commercial buildings in the future will require many types of service including HD video, edge computing, and service association on basic networks. The HD video requirement of the basic network refers to HD (4K and 8K) video streaming and real-time HD communication [25].

However, deployment of 5G in smart buildings has some challenges or obstacles that should be considered by building owners or managers. "These networks need to be something that is understandable by a standard information technology (IT) workforce in order to maximize usability and minimize learning curve. In other words, these networks need to be targeted to a different audience rather than the past. This makes wireless engineers to set up and maintain needs in order to simplify them to the point where data can be viewed and controlled through very simple dashboards," Dial said.

XII. How Aware Are Building Owners of This Technology Opportunity?

Despite the increasing interest in 5G and other technologies, such as IoT, Ricci, at the Coretrust Capital Partners Company, opined that the real estate community still needs some additional evangelization about advantages of 5G technologies in the field of smart building.

Conclusion

In conclusion, it can be said that IoT acts like an umbrella covering all the stuff discussed in this paper and makes this world better than ever so, the life will be easier than the past and talent of people grows up as fast as ever.

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