Challenges and Opportunities in Designing Internet of Things

Trio Adiono

School of Electrical Engineering and Informatics
Institut Teknologi Bandung
Bandung, Indonesia
tadiono@stei.itb.ac.id

Abstract— **User experience becomes an important feature for the success of many products. It is not only about fulfilling the user's requirement, but also increasing user productivities and the product efficiency. Therefore, one of the ways to create a product with high user experience is to connect it to the internet. Therefore user can access it anywhere, any time with many things. The connected product are not limited to electronics, but including the everyday products such as *rice cooker, coffee-maker, refrigerator, water heater, microwave oven,* etc. The *enabler* of this technology is called the *Internet of Things* (IoT). Accenture predicts through 3rd party sources that until 2020, the IoT business will reach around $500 billion[5]. Currently many researches still focus on looking for the IoT suitable platform. Several requirements and constraints have to be considered in designing IoT device, such as interoperability, flexibility, power consumption and re-configurability, as well as the cost. The rapid growth of smartphone application also makes the connection to smartphone a necessity.**

Keywords—Internet of Things (IoT), Machine to Machine (M2M);

I. BACKGROUND

IoT is the networking of everyday objects which interact to each other and also connected to the internet. Many smart applications which support and simplify everyday life can be enabled by the IoT. ABI Research forecasts that there will be more than 40 billion connected IoT devices in 2020[6]. Due to special requirements, the design of IoT module becomes a great challenge in research. The IoT system is required to connect large amount of things to the cloud system. Therefore an open API should also be provided for easy data access and interoperability. As a result, IoT system can be accessed and controlled from anywhere and anytime using any device, one of which is smartphone. Rich futuristic applications can be easily developed based on smartphone using nice GUI design in IoT system. Server design also an important thing in IoT Cloud system both to collect and to distribute data to many IoT modules.

Basic functionality of IoT system is remote monitoring and controlling. Based on this basic functions, many types of smart application can be implemented, such as smart house, smart energy, intelligent traffic system, as well as eHealth application. For example in eHealth application, IoT system can monitor user blood pressure and heart rate, additionally it also tracks user's behavior and activities. Based on those data, IoT smart system can suggest doctor's treatment plan, prescription etc.

The IoT system is required to be very flexible, easy for deployment, having low cost and demanding little maintenance. Therefore, IoT modules need to have low power consumption, included as mass production product and has self reconfiguration system. Using IoT system, many new services can be introduced to new customers with new customer segments by the operators.
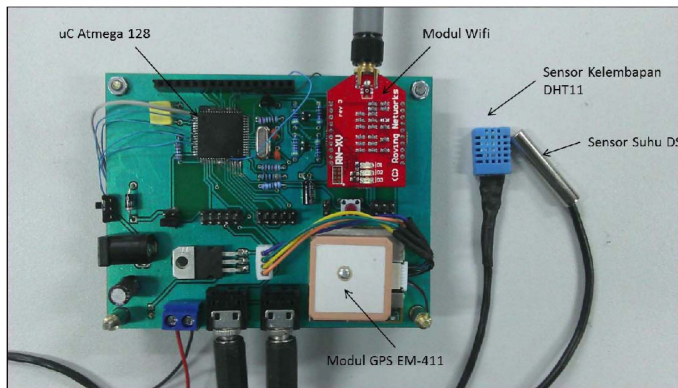
II. IOT SYSTEM

A. System Architecture

The IoT system consists of cloud system and IoT module. The IoT module consists of connectivity, data processing unit and sensing or actuating module. The connectivity has a function to connect all IoT module to the internet and cloud server. It consists of communication and networking module. For the communication several wireless standard can be addopted, such as bluetooth, bluetooth low energy, ZigBee, WiFi and Near Field Communication (NFC). The selection of wireless standard depends on range, power consumption, throughput, working frequency and reconfigurability of protocol. The connectivity is also required to support many different type of network configurations. The network should also can connect many different types of IoT configuration modules. Self configuring network architecture feature is required to easy system deployment. Scalibility of networking is also important to adapt with different scenario of deployment. The connection into the internet should also be managed with special designed protocol to maintain low power consumption.

Small operating system can ease application development and system implementation. The important features of IoT OS modules are module addressing and web interface that enable easy data access to IoT module. Therefore, the trade of between OS complexity and easiness of implementation become an important thing in designing IoT system.

Sensing devices can be connected to many type of sensors such as temperature, humidity, GPS, movement etc. On the other hand, it also can be connected to actuating device such as motor, switch etc. Good system may support multiple devices communication at the same time.

Additionaly power source also becomes important, becouse the application usually far from power source and low maintenance requirements. Rechargable battery is one of solution for long time maintenance. The recharge system can use energy harvesting technology or renewable energy such as solar power.

Figure 1 IoT module with sensor and wireless connection.

In system level, the IoT system needs a server that manage the connection of all IoT modules. The server has gateway and router module to connect the IoT module to the internet. It also has a data server and data processing unit that provide cloud service for all IoT modules and the device that want to access the IoT module data. Since the server usually close to source of power, in the system level, most of data processing can be move to the cloud server instead of in IoT module. The system has to support large amount of IoT module deployment. Beside handling the IoT module, the server should also capable to handle large amount of data from IoT modules while maintain low power communication. Therefore, several data access methods, such as periodic, on event and on demmand could also be adopted in this system.

III.   CONCLUSION

IoT is a system that integrates every day objects to the internet. Therefore those objects can be accessed anytime, anywhere, and to anything. The communication in IoT is performed between machine to machine (M2M). IoT open new applications that may increase user experience, efficiency and confort. IoT module has capability of transfer, store, analyze, sensing and actuating. Several new services are also enabled by this technology. The connection to Cloud system and smartphone becomes key features. The designs of IoT platform still have a lot of challenge to achieve optimum solutions.

BIOGRAPHY

T. Adiano is faculty member of the School of Electrical Engineering and Informatics of Institut Teknologi Bandung (ITB) and the head of IC Design Laboratory of Microelectronics Center ITB. He obtained his Ph.D. degree in VLSI Design from Tokyo Institute of Technology (Titech), Japan. From 2002 to 2004 he was a research fellow of the Japan Society for the Promotion of Science (JSPS) in Titech. In 2005, he was a visiting scholar at MESA+, Twente University, Netherlands. He has developed several microchips for video processing, smart card, NFC, and WiMax Baseband Chip. He received the "Second Japan Intellectual Property (IP) Award" in 2000 from Nikkei BP for his research on "Low Bit-rate Video Communication LSI Design".

REFERENCES

[1]   Buttrich, Sebastian, Basic Wireless Infrastructure and Topologies, [Online], Available: www.itrainonline.org , 17 September, 10.00

[2]   Tarkoma, Sasu Prof., Rauss, Wilhelm. TiViT Internet of Things (IoT) Program Overview Presentation. 2011. [Online]. Available: http://www.slideshare.net/tivit/tivit-interactive-internet-of-things?qid=4cab1640-b5bb-41b5-9ff8-39ceb85b9a17&v=qf1&b=&from_search=2 [October 21, 2014].

[3]   Accenture News Releases. 2014. *Industrial Internet of Things Offers Significant Opportunity for Growth of Digital Services, Says Accenture Report* [Online]. Available:

http://newsroom.accenture.com/news/industrial-internet-of-things-offers-significant-opportunity-for-growth-of-digital-services-says-accenture-report.htm

[4]   ABIresearch News. 2014. *The Internet of Things Will Drive Wireless Connected Devices to 40.9 Billion in 2020* [Online]. Available:

https://www.abiresearch.com/press/the-internet-of-things-will-drive-wireless-connect