High level design of LAN centric IoT network for supporting health and activity monitoring in the home environment

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1. Background and Aim

Internet of Things (IoT) provides a great concept for automating and supporting health and activity monitoring of older adults (Zhang and Zhang, 2011). IoT are mostly in cloud centric structure, where devices connect to an external server in the "cloud". Problem with this kind of architecture is that if provider suddenly chooses to change service agreement or turn off the server, end user would be left with useless sensors and actuators. Also risks of data security are considerable when sending data through Internet (Aazam, 2014). Moreover, privacy issues for storing health data in the cloud server are often concerned by hospital, nursing home and household users.

In this paper, we propose using an edge server in the home environment for supporting activity and health monitoring of older adults in daily life. Instead of storing user's private data in cloud servers far out of reach of end users, the data is stored in the edge server in their own homes, so that users own the data, can access or process the data when needed. The IoT edge server can also work as a Wi-Fi router, building a "LAN centric IoT" network around it in the home environment.

2. Methods

In this structure, an edge server should provide the same services of a cloud server. User interface can be built on its web service that can be accessed without limitation from local area network and with specific set-up from wide area network. It can connect devices using different protocols such as Wi-Fi and Bluetooth, increasing the possibilities of IoT applications greatly. Capabilities of data analysis and machine learning to detect patterns of activity and abnormalities are also required.

Figure 1 shows the high level design of LAN centric IoT network, where the edge server is at the center point. Data is placed in external storage devices connected via USB which is more portable and easily expanded. The edge server also works as a Wi-Fi router at home. This way external access to the server is easier because its IP address is always known from dynamic domain name system (DNS), and the amount of devices in end users home can be reduced. To achieve external access from outside of LAN, edge server supports dynamic DNS to update the server name automatically in near real time.

Edge server connect to IoT devices via Bluetooth 4.1 and Wi-Fi. Edge server can dynamically pass data information from Bluetooth device to Wi-Fi device and vice versa. Other 2.4GHz frequency protocols can be connected with an external hardware.

In our design, Raspberry Pi 3 is used as an edge server. It has quad core ARM Cortex-A53, 1.2GHz CPU, 1GB LPDDR2 (900 MHz) RAM, 10/100 Ethernet, 2.4GHz 802.11n wireless and Bluetooth 4.1 Classic and Bluetooth Low Energy. To achieve longer-range on Wi-Fi network, the built in Wi-Fi is replaced by RTL8192CU USB Wi-Fi dongle with 5db gain. Like previous models of Raspberry Pi, it has 4 USB ports to extend the storage size and RAM. With these hardware specifications we can run MQTT broker, Wi-Fi AP software, web server and data analysis calculations same time.

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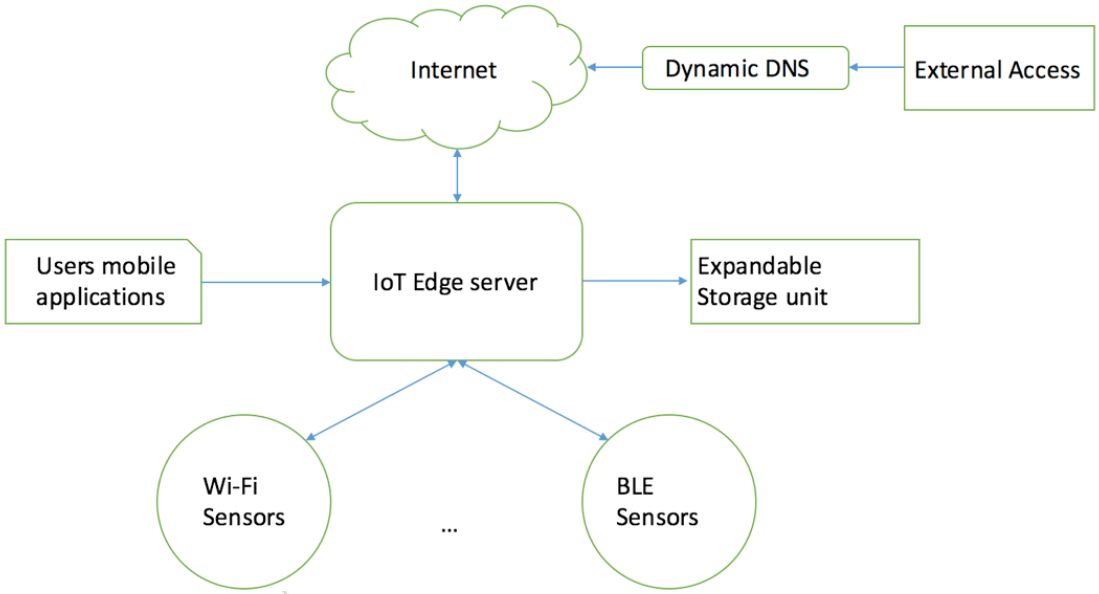

Figure 1. High level design for IoT Edge server

3. Results and Discussion

In this paper we proposed a high level design of LAN centric IoT network using and edge server for health and activity monitoring in the home environment. Its local data storage saves private data only locally, giving the user full control and ownership over it.The edge server also works as a Wi-Fi router for end users and a connection point for IoT devices, as well as connecting Bluetooth devices with Wi-Fi devices and vice versa.

On current state of development of the edge server, we have already covered Wi-Fi router and dynamic DNS and established all technologies for launching IoT edge server on an embedded Linux computer Raspberry Pi 3. On future steps we will build similar data analysis and machine learning services than cloud servers tend to provide and start developing web user interface.

In Gerontechnology Research Center (GRC), Yuan Ze University, we have designed different types of sensors to measure activity and health of older adult, for example, a battery powered PIR sensor to measure coarse location and activity inside of the apartment and an electrical current sensor to detect the usage of applications such as television. We are also looking into connecting some exiting health monitoring appliances such as blood pressure and glucose measurement to edge server. With wide range of sensors and powerful and robust edge server we can develop and ease and secure health and activity monitoring platform for older adults.

References

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