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Designing an IoT platform using Wireless Sensor Network

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Abstract: *The Internet of Things (IoT) is not only a well-researched topic but also a growing industry. Although the main idea is to connect devices to the internet, there are many ways to do this since IoT systems are application-oriented. This paper presents a wireless sensor network (WSN)based IoT platform designed for wide are a applications. The platform consists of one or more wireless sensor networks, gateways, web servers, and databases that provide a reliable connection between field sensors and Internet databases. WSN is based on the IEEE 802.15.4e Time Slot Channel Hopping (TSCH) protocol because it has the high performance. Subsequent to the system designed for many subscribers, new synchronization plans and effective transmission functions are also planned to increase network capacity and reduce energy consumption. Therefore, the platform concept can meet the needs of high-end applications and the battery life of low-end applications.*

Keywords: IoT Platform, Wireless Sensor Networks, Application ddevelopment, Time slotted channel hopping protocol

I. INTRODUCTION

The Internet is changing from connecting people to connecting things, leading to the new concept of the Internet of Things (IoT). This innovation brings products or devices to the internet and creates new applications and businesses.From in-house devices to outside environmental sensors, these devices will generate a new source of network data, and together they will provide a better real-world understanding of network environments. This situation increases our quality of life by bringingout new applications or changes in many areas such as transportation, health, house/work/agricultural automation, disaster detection/prevention. Researchers are involved in the development of new technologies for commercial or industrial use. In the literature [1-5], it is possible to see different models, methods and design methods as methods from different perspectives. The diversity of IoT applications makes it difficult to have a unified system for compliance as user needs and technology change over time. In general, the IoT system can be classified into two parts: data transmission and data processing. Data transmission refers to the connection between an object of interest and a data server on the Internet, by which the device can communicate with other entities and vice versa. Data management is the process of performing further analysis or performing specific tasks on the data generated by these products, individually or collectively. From the end user's perspective, an IoT upgrade that connects products from different vendors or platforms should be the preferred way to build your own application. Therefore, this paper introduces the concept of user-oriented, software-defined Internet of Things (UC-SDIoT) as shown in **Figure 1.** Real world sensors will be used by different consumers. By using the network's fake objects (in the real world) as proxies for these sensors, each end user can create a unique IoT system from custom rules that deal with the fake objects. using methods [4-5]. To make it easier to use, we classified the entire system into two independent subsystems. One is used for data transfer and the other is used for data processing. The intelligence of objects is used in these so-called devices, not in devices with limited resources. This article describes our current work on data transfer. The most difficult task of establishing an Internet connection for such devices is that these devices do not have enough resources to manage complex Internet processes. Therefore, the gateway-based approach [8-10] is often adopted by using the gateway as a bridge between the Internet and a private network of various devices. There are two types of gateways. The first type of gateway acts as a translator, converting complex Internet protocols into easy-to-use standards such as IPv6 over Low

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Power WPAN (6LoWPAN) [6], Constrained Recreational Environment (CORE) [7] and Constrained Application. Protocol (CoAP) [8], and so on.The main advantage of this method is that sensor nodes can be accessed directly from the internet, but processing load can be a problem that reduces the capacity of the sensor network. In the second mode, the gateway collects information from all sensor nodes and forwards it to the server, and the sensor network operates independently on the Internet. In practice, sensor networks are often used by organizations for specific applications. Individual sensor networks will be preferred for ease of control. Considering the need for undemanding performance, we believe that the UC-SDIoT architecture is a good solution because the end user needs to communicate with only one server for each sensor from different vendors instead of multiple gateways. Therefore, this article will focus on the second method. In this paper, we design a general wireless sensor network (WSN) based on IEEE 802.15.4e Time-Slotted Channel Hopping (TSCH) [9] protocol with resource-constrained adaptation to heterogeneous structure. TSCH is based on global synchronous clock controlled by synchronization time, but the time error between two nodes increases with the duration of two synchronized times. To increase the efficiency of time synchronization, we propose a new strategy to reducethe clock drift every time. We also integrated the transmission system to increase grid capacity. By carefully designing the program, the planning process can support different applications simultaneously.

II. EMBEDDED SYSTEMS Vs IoT

Every day, our lives become more dependent on 'embedded systems' that is embedded in our environment.

Aspect	Embedded Systems	IoT (Internet of Things)
Definition	Specialized computer systems for specific tasks/functions	Network of interconnected devices, sensors, and objects
Scope	Task-specific, operates within closed environment	Interconnected devices with external network connectivity
Connectivity	Limited or no connectivity to external networks	Connectivity via Wi-Fi, Bluetooth, cellular, RFID, etc.
Data Handling	Real-time processing and control within the device	Centralized/cloud-based data handling and analytics
Applications	Consumer electronics, automotive systems, industrial automation, medical devices	Smart homes, wearables, industrial IoT (IIoT), smart cities, healthcare, agriculture, environmental monitoring

Table 1 Embedded Systems Versus Internet of Things (IoT)

More than 98% of processors in use today are in embedded systems and are not considered "computers" in the ordinary sense by customers. An embedded system is a special-purpose computer that isdedicated to the device or system it controls. Unlike general-purpose computers such as personal computers, embedded systems perform one or more pre-programmed tasks, usually with specific codes. Since the system is dedicated to a specific task, the design engineer can make it better and reduce product size and cost. Embedded systems are often built in bulk and benefit from economies of scale. Embedded systems are specialized computers designed to perform specific tasks within a device. These systems often include a micro controller or microprocessor embedded in the hardware to control various functions. Embedded systems are often used in everyday products such as home appliances, automobiles, medical equipment and business machines. The Internet of Things refers to a network of interconnected devices, sensors and devices that communicate with each other via the internet or other networks. IoT introduces the concept of embedded systems to enable these devices to collect, share and analyze data, thereby increasing business efficiency, productivity and automation. IoT applications range from smart home appliances and technology to business automation and smart city infrastructure.

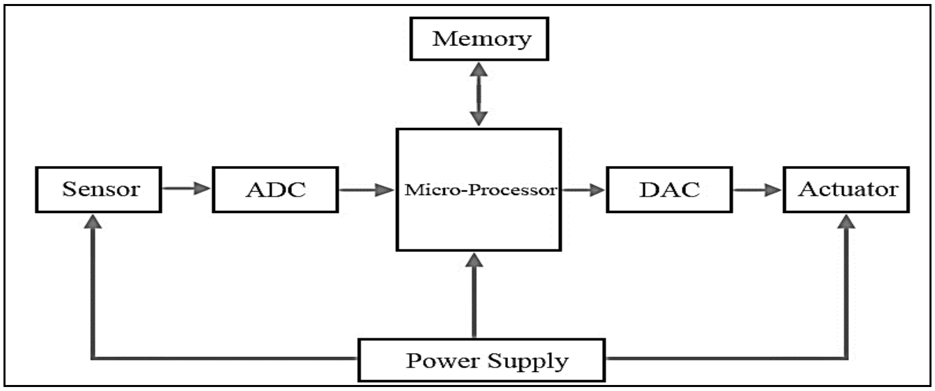

Figure 1 Block diagram of an embedded system

In an embedded system, the main component is a microcontroller (or microprocessor) that acts as the CPU. Responsible for following instructions and maintaining the functioning of the system. Microcontrollers are connected to various peripheral devices such as sensors and actuators that interact with the external environment. The system also includes memory devices (ROM, RAM, flash memory, etc.) to store program code and data.

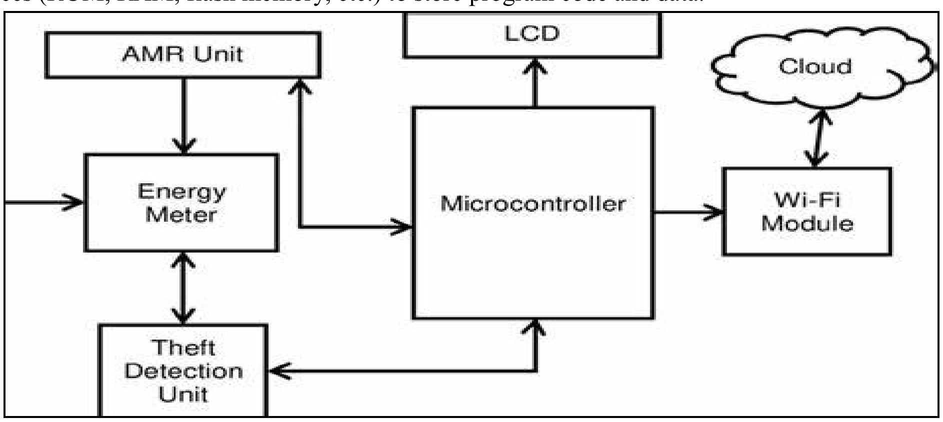

Figure 2 Block diagram of an IoT energy meter system

In IoT systems, edge devices (which may also include embedded systems) act as endpoints to collect data from the physical environment. These universes are equipped with sensors and actuators to interact with their environments. They communicate with the central cloud platform via communication modules such as Wi-Fi or Bluetooth. The cloud platform is responsible for data processing, storage and analysis and enables remote monitoring, control and automation of the IoT ecosystem. In recent times, the use of PC hardware has played a significant role in making IoT technologies the most advanced and easy to use. As PC hardware prices have fallen, manufacturing high-tech machines has become more affordable. This means that projects that were too expensive to complete in the past are now possible. However, while the hardware is getting better, the software options of these systems are not that good either. Embedded systems and IoT devices are everywhere today, from simple things like clocks and microwave ovens to complex things like lighting and power plants. Some of these machines have proprietary operating systems, but some are so specialized that they only need one program. We call the program firmware. These machines vary in size and complexity, from small devices to large installations. Embedded systems consist of hardware and software. It is designed to work closely with specific hardware and software to perform different tasks. Hardware such as processor and memory are very important for systems to work well. So, an embedded system is actually a special computer designed to perform a specific task. Similarly, IoT devices are part of a network where different devices communicate with each other to work intelligently. Embedded systems and IoT devices are designed to use software and hardware to perform specific tasks.

Item	Uses
Automatic Teller Machines	Cash withdrawal, balance inquiry, fund transfer
Cellular telephone	Voice calls, text messaging, internet access
Telephone switches	Routing calls, managing telecommunications
Computer network equipment	Data transmission, network connectivity
Computer printers	Printing documents and images
Disk drives	Storing and retrieving digital data
Home automation products	Controlling lighting, temperature, security
Handheld calculators	Performing mathematical calculations
Household appliances	Cooking, cleaning, heating, cooling
Medical equipment	Diagnosis, monitoring, treatment
Measurement equipment	Taking measurements for scientific purposes
Multifunction wristwatches	Timekeeping, fitness tracking, notifications
Multifunction printers	Printing, scanning, copying

Table 2 Applications of Everyday Technologies using IoT

Embedded systems are found in wide range of application areas can be seen in table above. Originally, they were used only for expensive industrial control applications, but as technology brought down the cost of dedicated processors, they were used in moderately expensive applications such as automobiles, communication and office equipment and television Today's embedded systems are so inexpensive that they are used in almost every electronic product in our life. Embedded systems are often designed for wide scale production.

III. IMPLEMENTATION

A program that simulates an IoT platform using wireless sensor networks. This program creates virtual sensors and a central hub to collect data from these sensors.

```
import time
NUM_SENSORS = 5
SIMULATION_TIME = 60
class Sensor:
    def __init__(self, name):
        self.name = name
    def generate_data(self):
        while True:
            data = random.randint(0, 100)
            print(f"{self.name} - Sending data: {data}")
            time.sleep(1)
            yield data
class CentralHub:
    def __init__(self):
        self.sensors = {}
    def register_sensor(self, sensor):
        self.sensors[sensor.name] = sensor.generate_data()
    def collect_data(self):
        print("Central Hub - Starting data collection...")
        start_time = time.time()
        while time.time() - start_time < SIMULATION_TIME:
            for sensor_name, data_generator in self.sensors.items():
                try:
                    data = next(data_generator)
```

```
                print(f"Central Hub - Received data from {sensor_name}: {data}")
            except StopIteration:
                print(f"Data collection from {sensor_name} stopped.")
                del self.sensors[sensor_name]
        time.sleep(0.5)
sensors = [Sensor(f"Sensor-{i}") for i in range(NUM_SENSORS)]
hub = CentralHub()
for sensor in sensors:
    hub.register_sensor(sensor)
hub.collect_data()
```

'Sensor' class represents a virtual sensor. It generates random data every second. 'CentralHub' class represents the central hub of the IoT platform. It collects data from registered sensors. Sensors are created and registered with the central hub. The central hub collects data from all registered sensors for a specified simulation time. This program is a simple simulation to demonstrate the concept of an IoT platform using wireless sensor networks. In a real-world scenario, you would replace the simulated sensor data generation with actual sensor readings from physical devices and implement more sophisticated data processing and analysis logic in the central hub.

IV. CONCLUSION

This paper presents the complete design of a WSN based IoT system for general and versatile applications. EFB plan can effectively manage failure time. It allows us to further relax the synchronization time to reduce the waste of electricity in the battery by using sensor nodes. Transmission efficiency can improve the technical performance of TSCH. With greater sensitivity, WSN can accommodate more high-speed sensor nodes. Test results show that we have completed the recommended tasks and established an efficient connection to storage facilities on the Internet. We believe that after creating a physical world for everything, this will be the foundation of the success of UC-SD IoT which will allow users to create their own IoT systems using products from different sources. To complete the UC-SD IoT process, we now focus on software architecture design based on the agent-centric approach concept. All of these software modules, including middleware, applications, and user interfaces, will be implemented in the web server in Figure 2. This approach is cross-platform and simple to integrate with existing open-source packages. In the future, we also plan to extend the proposed TSCH software for self-organizing networks for automotive or robot applications, where it is necessary to create the network management protocol that dynamically adjusts the node transmission time.

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