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TOWARDS IOT: INTEGRATION OF WIRELESS SENSOR NETWORK TO INTERNET WITH GATEWAY APPROACH

JAYWANT KAMBLE[1], PROF. MAHESH NAVALE[2]

1. Student, Dept. of E&TC, SKNCOE, Pune, Maharashtra, India.
2. Assistant Professor, Dept. of E&TC, SKNCOE, Pune, Maharashtra, India.

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Abstract: In the Internet of Things (IoT), the everyday objects that surround us will become proactive actors of the Internet, generating and consuming information. By embedding computational capabilities in all kinds of objects and living beings, it will be possible to provide a qualitative and quantitative leap in several sectors: healthcare, logistics, domestics, entertainment and so on. According to analyst and media, in 2008, the number of connected devices surpassed connected people and it has been estimated that by 2020 there will be 50 billion connected devices which is seven times the world population. In fact, one of the most important elements in the IoT paradigm is wireless sensor networks (WSN). WSN behave as a digital skin, providing a virtual layer where the information about the physical world can be accessed by any computational system. There are so many approaches for putting sensor data on Internet. In this project, the Gateway approach will be used. Gateway will act as a translator between WSN network and the Internet network. Gateway will capture or accept sensor data and with by doing necessary operations on the data will put that data on the Internet. In this paper, we will discuss the idea about the project and evaluate the considered system.

Keywords: WSN, Internet of Things, Gateway

Corresponding Author: MR. JAYWANT KAMBLE

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INTRODUCTION

Wireless sensor networks (WSNs) have gained worldwide attention in recent years, particularly with the proliferation in Micro-Electro-Mechanical Systems (MEMS) technology which has facilitated the development of smart sensors. These sensors are small, with limited processing and computing resources, and they are inexpensive compared to traditional sensors. These sensor nodes can sense, measure, and gather information from the environment and, based on some local decision process, they can transmit the sensed data to the user. Smart sensor nodes are low power devices equipped with one or more sensors, a processor, memory, a power supply, a radio, and an actuator .A variety of mechanical, thermal, biological, chemical, optical, and magnetic sensors may be attached to the sensor node to measure properties of the environment [1].

In the upcoming Internet of Things (IoT), the everyday objects that surround us will become proactive actors of the Internet, generating and consuming information. The elements of the IoT comprise not only those devices that are already deeply rooted in the technological world (such as cars or fridges), but also objects foreign to this environment (garments or perishable food), or even living beings (plantations, woods or livestock). By embedding computational capabilities in all kinds of objects and living beings, it will be possible to provide a qualitative and quantitative leap in several sectors: healthcare, logistics, domestics, entertainment, and so on.

The paper is idea paper and divided into five sections, Introduction section gives brief idea about the WSN and IoT and Literature survey explains in detail 'General Architecture of Internet of Things' and

I. LITERATURE SURVEY

There are so many architectures available to be used for the implementation of the IoT System. Here some of the mostly used and standardised architectures are given which are used for particular application scenario as given in [6].

1. Community Health Service Architecture Based on the Internet of Things on Health-Care
2. Three layer architecture for Smart Grids
3. IBM "Strat cast" architecture for Smart Home
4. ITS architecture for connected cars

All the above Architecture listed is very well for respective application but in IoT we need architecture which can accommodate all the application.

The general architecture for the IoT consists of mainly three layer architecture [6] as shown in Figure 1.

The Architecture consists of three tiers:

1. Context-Aware Tier:

This tier consist of the Data Collector and Coordination and Collaboration which are the part of system which makes the data available from the actual environment and send it to the Network Tier to proceed further.

2. Network Support Technology:

This tier gives us the connectivity to the Application layer through the network so that application layer can process the data and make certain suitable decisions using the intelligence.

3. Application Layer:

The application tier itself consists of three layers technology layer, middleware layer, application layer. The application layer consists of applications that export all the systems functionality to the final user.

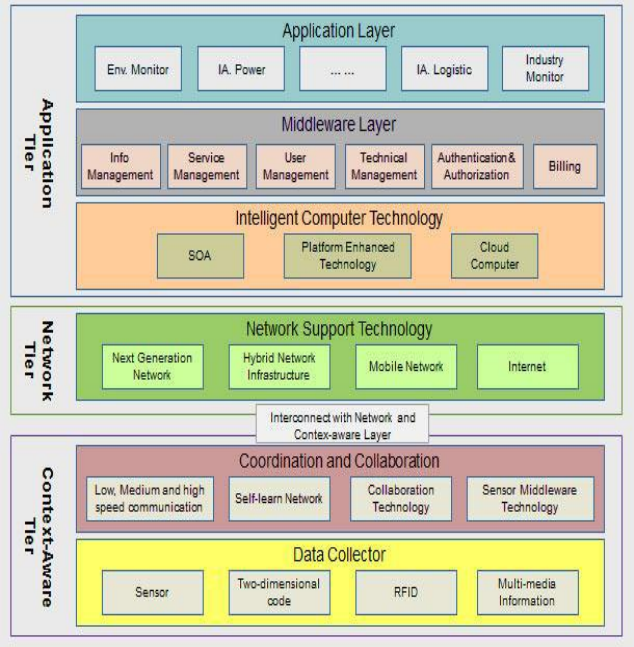


Figure 1 General Architecture of Internet of Things [6]

Internet of Things (IoT) can use the existing infrastructure for communication. But to solve the issues such as scalability, reliability and security we can use the different protocols. There are various architectures proposed and used now days to manage the communication between the IP-speaking devices [5].

There are basically two approaches used while implementing the IoT:

1. Using 'Smart End Nodes' which can directly communicate with Web Application using Internet protocol stack residing on it.

2. Using Gateway approach, in which end nodes in WSN can communicate with the Web Application through the gateway and vice versa.

Obviously in the Gateway approach the hardware required at the end nodes to connect it to internet will be much lesser than the directly connected end node. And the load on the end node will also be less as most of the data processing work will be done at the Gateway. In this paper, we will consider the gateway approach of implementation.

There are some alliances formed to make standardize the protocols that can be used for the implementation of the IoT worldwide and the challenge of the Interoperability can be solved. The alliances are:

1. **AllSeen Alliance:** The AllSeen Alliance is a non-profit consortium dedicated to enabling and driving the widespread adoption of products, systems and services that support the Internet of Everything with an open, universal development framework supported by a vibrant ecosystem and thriving technical community.

2. **IPSO:** The Alliance is a global non-profit organization serving the various communities seeking to establish the Internet Protocol as the network for the connection of Smart Objects by providing coordinated marketing efforts available to the general public.

3. **Wi-SUN Alliance:** The Wi-SUN Alliance seeks to "advance seamless connectivity by promoting IEEE 802.15.4g standard based interoperability for global regional markets.

4. **OMA (Open Mobile Alliance):** OMA is the Leading Industry Forum for Developing Market Driven, Interoperable Mobile Service Enablers.

These are the organizations in IoT for validation of the different proposed architectures and protocols for IoT, some of them are as mentioned below:

1. **ETSI** (European Telecommunications Standards Institute)

2. **IETF** (Internet Engineering Task Force)

3. **IEEE** (Institute of Electrical and Electronics Engineers)

4. **OMG** (Object Management Group)

5. **OASIS** (Organization for the Advancement of Structured Information Standards)

6. **OGC** (Open Geospatial Consortium)

II. PROPOSED METHODOLOGY

The proposed system can be given in block diagram as shown in Figure 2. As said in literature survey section, we will use the gateway approach.

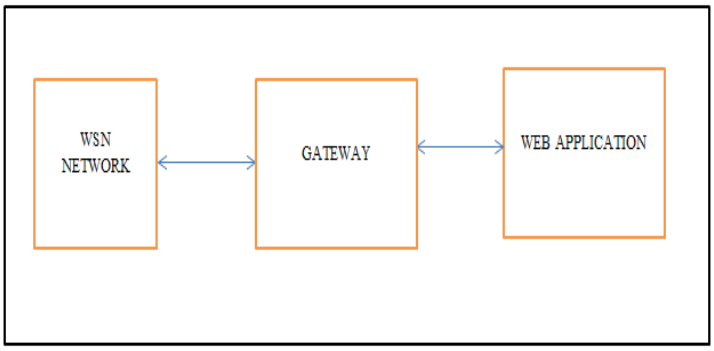


Figure 2 Basic Block Diagram of the Proposed System

A. WSN NETWORK

WSN network is the network of different sensors nodes connected wirelessly and forming a digital layer in the environment so that the real time events in the environment can be converted into the digital data and can be processed further. In WSN network there are basically three types of devices End Nodes, Router and Coordinator node. Among these end nodes have the sensors and actuators connected to them and routers are the devices which have the extra functionality of routing the data and coordinator device act as a sink of the network data[].

Sensor nodes have a triple role in most networks; they act as data collectors, processors and as traffic forwarders for other objects in the network.

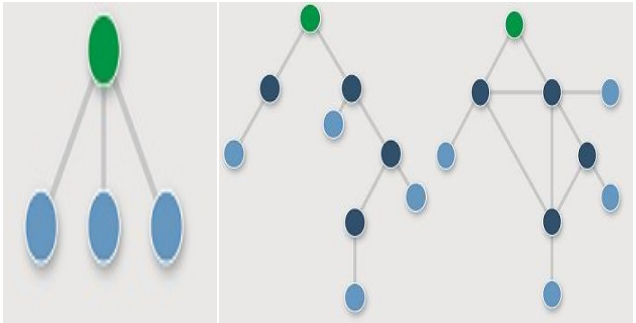


Figure 3 WSN Network Topologies(a) Star (b) Tree (c) Mesh

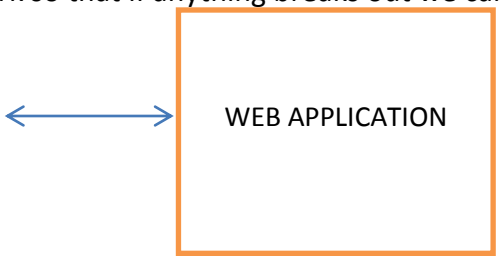
B. GATEWAY

It's the module in device which will take care of the connectivity of the WSN network nodes to the internet. It mainly does the function of connecting the two different protocol having networks on the one side WSN network which will be of the wireless protocols such as Zigbee, BLE, WiFi, etc. and on the other hand the internet network.

Gateway will do the function of protocol mediator for two different networks and also will act as a local server for the local data storage and connectivity point for the Web Application.

C. WEB APPLICATION

WEB application will be the user interaction tool with the WSN network. It will also act independently as a data display tool. It will also give the manual control of the output nodes in the WSN network so that if anything breaks out we can control the things manually.



Then imagination is the limit for the idea and functions perform by the WEB application.

III. EVALUATION

In this section of the paper, we will evaluate the proposed system with different parameters taking into consideration for different components in the system.

A. Physical Layer Technology

Here we are considering the gateway approach that's why there will be two hardware components End Node and Gateway.

1. End Node Communication Technology:

There are so many options available to be used for end node wireless connectivity but here we will compare the mostly used among them [3] as given below:

i. Zigbee

ii. WiFi

iii. Bluetooth Low Energy (BLE)

These three can be comparing on the parameters that are most important when we use them in the IoT. All three technologies have built-in link layer authentication and encryption which sometimes needs to be completed with end-to-end security from the sensor to the Web application.

802.15.4 has a main advantage in its range since many 802.15.4 based technologies (e.g. ZigBee) support mesh whereby coverage can be extended by using routers. 802.15.4 also has the advantage looking at power consumed and cost point of view.

We can't say only one technology as best because in different use cases the suitability of them changes.

Table 1 Comparison of Communication Technology for End Device communication

Parameter	Zigbee	Bluetooth low Energy	WLAN
Cost	Low	Low	High
Security	Moderate	Moderate	High
Power Consumption	Very Low	Moderate	High
Range	Less than 100m	Less than 100m	More than 100m
Nodes Capacity	1024 to 65532	Upto 10	Depends on Router Capacity
Data Rate	Moderate	Moderate	High

2. Gateway Hardware

i. Laptop/Computer

ii. RaspberryPi

iii. Arduino

Here we can see that mostly these three options can be considered for the gateway.

The Arduino and Laptop are the hardware used in the implementation earlier due to their respective advantages and ease of use. But the Raspberry Pi is much advantageous than both of them and can be observed from Table 2.

And one more important thing it has ARM as CPU or brain and it has its own features of speed , efficiency and small size Computer and this is what we need now a days speed and more features with small size.

Comparison of these three can be summarized as shown in the Table 2.

Table 2 Comparison of hardware to be used as Gateway

Parameter	Laptop/ PC	RaspberryPi	Arduino
Processing Capacity	Very High	High	Moderate
Cost	Very High	Moderate	Moderate
Physical Size	Larger	Very Small	Moderate
Power Consumption	High	Low	Moderate
TCP Protocol	Present	Present	Absent(Need Extra Hardware)

From the above comparison we can see that the Raspberry Pi can be used as a gateway which will act as a mediator between the internet and the WSN network on the other side because of its advantages on size, cost and power consumption mostly.

B. Web Technologies

In Web Technologies the following Application layer protocols [4], [7] are mostly used:

1. **CoAP**: Constrained Application Protocol.
2. **MQTT**: Message Queue Telemetry Transport.
3. **XMPP**: Extensible Messaging and Presence Protocol.
4. **RESTFUL Services**: Representational State Transfer.
5. **AMQP**: Advanced Message Queuing Protocol
6. **Web sockets**

It so much depends on the application need which protocol to be used. For Asynchronous communication we will use the XMPP protocol and for Synchronous we will use the HTTP based RESTFUL Services.

C. Software Technology

We will be using "JAVA" designed specifically for RaspberryPi by the ORACLE [8]. And the ORACLE also inventing much for research in this area, which we will definitely can utilise in future for much seamless and efficient IoT Applications deployment in the world.

There are others options also available such as using PYTHON which is mostly used for RaspberryPi till now, but when we say the IoT System there are so many work we need to do towards establishment of it and for that we will need more number of brains which are very well in it. And it's the known fact that there are so many developers available in Java to do this work and can make it much stronger implementation as the same is used in many industrially embedded device programming.

IV. CONCLUSION

From this paper, we can conclude that with Gateway approach the load on the sensor node is reduced significantly and hence the cost to establish the sensor network and to get sensor data and make it available on the Internet for further use in web application. And the power consumed by the nodes will also reduce which makes the maintenance need for the sensor network which mostly be using battery powers nodes will reduced at large scale. From the comparison of different wireless technologies available, for IoT 'Zigbee' (802.15.4) is best suitable due to its many suitable features as per IoT is concerned. From different available hardware's available to be used as gateway, Raspberry Pi is considered for its own advantages and by taking in case for the fixed position gateway, the JAVA language will be used for programming of the Raspberry Pi as it is most suitable as per IoT and it is new approach in this field.

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