Volume 8, No. 5, May-June 2017

ISSN No. 0976-5697

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

A Comparative Study of Arduino, Raspberry Pi and ESP8266 as IoT Development Board

Dinkar R Patnaik Patnaikuni
Department of Electronics and Telecommunications
Walchand Institute of Technology, Solapur, MH, India

Abstract: Internet of Things is a striding platform where every day devices are transformed into an automated informative system with intelligent means of communicating protocols. The available development boards for deploying elementary Internet of Things systems and programming them pave conformation of related fields. The lack of overall functional knowledge and the capabilities of the available means of development boards is presently resisting the engineers to get through the scope of Internet of Things centric approaches. This paper provides Internet of Things oriented comparison of various boards with suitable selection of the hardware development platforms that are capable enough to improve the understanding technology, and methodology to facilitate developer's requirements. This paper also summarizes various capabilities of available hardware development platforms for IoT and provides a method to solve real-life problems by building and deployment of powerful Internet of Things notions.

***Keywords* :** Internet of Things (IoT); Architecture; Capabilities, IoT Development Boards

1. INTRODUCTION

Internet of Things (IoT) refers to a platform where a smart space network with interoperable protocols form physical and virtual identities for addressing them with ease over the internet intended for social environmental communication. This involves a smart plan of operations of a variety of sensors, controllers etc. The key factor in building the IoT network starts with the proper selection of hardware and software platforms and then defining the architecture complexity on the basis of application under development.

As per [1], billions of devices will be connected to the internet by 2020 and those connections will facilitate the used data to examine, pre plan, organize, and make unattended intelligent decisions. The US National Intelligence Council (NIC) has entitled IoT as one of the six ''Disruptive Civil Technologies". In this perspective, we can see that several service sectors in the fields of transportation, smart city, smart domotics, smart health, e-governance, e-commerce, e-education, retail, logistics, agriculture, automation, industrial manufacturing, and business/process management etc., are already getting benefited from various architectural forms of IoT.

IoT architecture may be treated as a system which can be physical, virtual, or a hybrid of the two.This hybrid system consists of a collection of numerous active physical things, sensors, actuators, cloud services, specific IoT protocols, communication layers, users, developers, and enterprise layer. Particular architectures specific to a use case do act as a pivot component of IoT specific infrastructure while facilitating the systematic approach toward dissimilar components resulting solutions to related issues. A well-defined form of IoTboard capabilities is a must for implementing any IoT prototype with ease and strong security.

1.1. Basic IoT blocks

A system intended to be an IoT server or system is comprised of a number of basic functional blocks to promote various functionalities of the system such as sensing, identification, automation, communication, and management like any other automated industrial robot. **Fig. 1**. represents these functional blocks as described below.

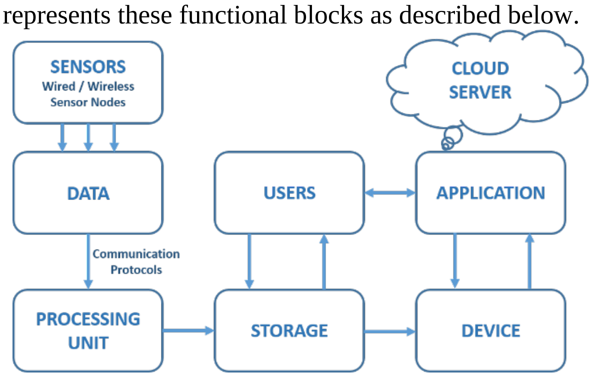

Figure 1 Basic IoT Functional Blocks

Device: An IoT system relies on device that provide sensing, actuation, control, and monitoring activities. IoT devices can exchange data with other paired devices and application, or fetch data from other nodes and process the data either locally or send the data to centralized servers like Raspberry Pi or cloud based applications for processing the data, or perform some tasks locally and other tasks within IoT infrastructure based on the device constraints like memory, processing capabilities, communication latencies, and speeds.

Communication Protocols: The communication block of an IoT architecture performs the communication between devices and remote servers. IoT communication protocols generally work in data link layer, network layer, transport layer, and application layer. The inter-device .must have a wide range of hardware protocol suite support including SPI, I2C, ModBus, etc.

Ease of Programming: An IoT system serves various functions such as device control, monitoring, data publishing, data fetching and a numerous other similar functions based on the application. This puts an additional constraint for the IoT devices to be much easily programmable for rapid prototyping and testing purposes.

Management: Management block provides different functions to regulate an IoT system to seek the underlying administration of IoT system. This follows that an IoT system must possess a means of providing some feedback for every action taken against a cause.

Security: This functional block secures the entire IoT system by providing activities such as, authentication, authorization, privacy, message integrity, secure data storage, and data security.

Application: Application layer plays a crucial role in terms of user interactions that provides necessary triggers to control, and monitor various aspects of the IoT system. This layer facilitates the user to visualize, and analyze the system status at present moment of action and even prediction of futuristic prospects.

2. The Comparison

Based on the availability of usable I/O interfaces for sensors, interfaces for Internet connectivity, memory and storage interfaces, and audio/video interfaces the following boards are evaluated. IoT devices can also be used to a variety of other purposes, for instance, wearable sensors, smart watches, LED lights, automobiles and industrial machines.

2.1 Arduino:

The arduino board [2] is a freely available open source development microcontroller capable to cope up with a variety of communication protocols that is a must to be usable for any kind of IoT device. This board is cheap and feature rich with availability of a variety of daughter boards that have an amazing stacking feature to the main mother board. The availability of wifi and ethernet shield along with the low power BLE-4 arduino shield makes it suitable for rapid prototyping and programming with ease. The

Figure 2Arduino UNO

easy to use and abundant example programs in the arduino IDE makes it simple for the user to get started pretty quickly in the process of making IoT device work seamlessly in all kind of environments.

2.2 Raspberry Pi:

The Raspberry pi Development Board [3] is small sized Broadcom BCM 2835 SoC based ARM11 power minicomputer. The raspberry pi can be easily plugged into monitor because of its inbuilt GPU and audio-visual capabilities. Also it uses standard mouse and keyboard. This is easily programmable by powerful languages like C, python etc, giving it a capability to store and analyze the data. The inbuilt wifi, BLE, storage capability of this board and the available RAM being very huge in comparison to other boards enables it to act as an IoT server in most of the IoT network configurations.

Figure 3 Raspberry Pi-3

2.3 ESP-8266:

The ESP-8266 module [4] little beast is an extremely capable wireless programmable microcontroller board. The ESP8266 WiFi board is a SOC with integrated TCP/IP protocol stack that can give any secondary microcontroller access to your WiFi network.The ESP8266 board is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor and therefore this is more suitable to be used as a sensing node that is capable to sense the data from various wirelessly connected IoT sensor nodes and send data to the central server like

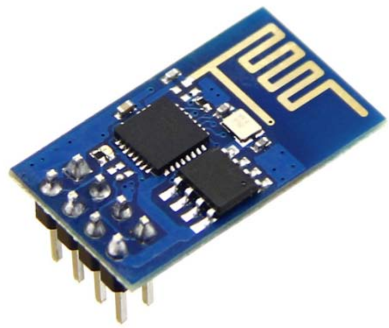

Figure 4 ESP 8266-01 wifiIoT module Raspberry-Pi.

Table 1 Comparison of Arduino, Raspberry Pi-3 and ESP 8266-01 wifi module

Parameters	Arduino Uno	Raspberry Pi B+	ESP-8266
Processor	ATMega328P	Quad-core ARM Cortex A53	-
GPU	-	Broadcom VideoCore IV with 400 MHz	-

Operating voltage	5V	5V	3.3V
Clock speed	16 MHz	1.2GHz	26 MHz – 52 MHz
System memory	2kB	1 GB	<45kB
Flash memory	32 kB	-	up to 128MB
EEPROM	1 kB	-	-
Communication supported	IEEE 802.11 b/g/n IEEE 802.15.4 433RF BLE 4.0 via Shield	IEEE 802.11 b/g/n IEEE 802.15.4 433RF BLE 4.0Ethernet Serial	IEEE 802.11 b/g/n
Development environments	Arduino IDE	Any linux compatible IDE	Arduino IDE, Lua Loader
Programming language	Wiring	Python C C++ Java Scratch Ruby	Wiring, C, C++
I/O Connectivity	SPI I2C UART GPIO	SPI DSI UART SDIOCSI GPIO	UART, GPIO

CONCLUSION

There have several initiatives to realize IoT applications using Arduino [5]. The comparative study shows how these platforms are promoting the growth of IoT by utilizing the specific board as per the intended application. The detailed analysis show that higher end development boards such as Raspberry Pi-3 have higher performance in comparison with other boards like arduino and ESP8266 in terms of its storage and computing speeds but at the cost of higher price. Raspberry Pi equipped with inbuilt wifi and Bluetooth serves as an easy means to connect to internet and push the data to the cloud servers if required for further processing. Whereas it is clearly visible from the comparison that boards like Arduino being equipped with inbuilt analog to digital conversion has a better means of sensing the analog data readily when there is a need to sense some continuous analog signals coming out of analog sensors.Based on the specs and performance analysis Raspberry Pi definitely emerges as a winner when it comes to satisfying most of functional requirements of an IoTsystems' basic blocks[6]. ESP-8266 on the other hand stands out strongly when it comes to device level sensor networking abilities due to its small form factor and wireless connectivity. ESP-8266 being a low cost device is a first choice for implementing sensor networks in an IoTscenario[7]

REFERENCES

[1] Ray, P. P. "A survey on Internet of Things architectures." Journal of King Saud University-Computer and Information Sciences (2016).

[2] https://www.farnell.com/datasheets/1682209.pdf

[3] https://www.raspberrypi.org/documentation/ hardware/computemodule/RPI-CM-DATASHEET-V1_0.pdf

[4] http://espressif.com/sites/default/files/documentation/0a-esp8266ex_datasheet_en.pdf

[5] Waher, Peter, et al. IoT: Building Arduino-Based Projects. Packt Publishing Ltd, 2016.

[6] Maksimović, Mirjana, et al. "Raspberry Pi as Internet of things hardware: performances and constraints." design issues 3 (2014).

[7] Di Nisio, A., et al. "Design of a low cost multipurpose wireless sensor network." Measurements & Networking (M&N), 2015 IEEE International Workshop on. IEEE, 2015.