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Comparitive Study of Hardwares and Softwares in Internet of Things

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Abstract: Internet of Things is a recent trend that has many application fields which enable the benefits for society in the field of automobile, wearable, smart home, connected cars, smart farming and various applications. Internet of Things is a network of interconnected objects uniquely addressable based on communication standard. The vision of Internet of Things is that each object will become the part of the internet. In this paper the various hardware and software tools that can support an entire development of Internet of Things applications is discussed and compared. The key features are created for different hardware and Software tools which are important for Internet of Things

Key words: Internet of Things · Hardware · Software tools

INTRODUCTION

As the number of devices connecting to the internet is increase, Internet of Things [1] plays a vital role in modernizing the society In the aspect of Engineering and technology there are separate vendors for hardware and software tools with respect to Internet of Things. The comparison chart will be useful to finding out the suitable hardware and software tools which makes Internet of Things technology more vibrant. The different hardware taken into consideration for comparison are Pan Stamps, TinyDuino, Adriano Uno, RFduino, Minor, CisecoOpenKontrol Gateway, Pinocchio, Raspberry Pi, Beagle Bone Black and UDOO. The above listed are the popular board and development Platforms which will be helpful for Internet of Things application. To make the Internet of Things application efficient, not only selecting hardware platform but also select good Operating system which is more convenient for the respective hardwares.The operating system for Internet of Things devices to be compared in this paper are RIOT, Contiki, Tiny OS and Linux

Development Boards: There are various development boards for IOT application. Each hardware is developed by different vendor and is best suitable for different application.

Panstamps: Pan Stamps are low-current consumption boards made to last for years from simple batteries. They don't include an on-board USB front-end to save power and costs but they can be connected to Pan Sticks or any other USB-(3.3V) UART converter. Pan Stamp doesn't load Hardware Serial by default so the Serial object used to print (print, printing) our packets through the UART is not available unless include Hardware Serial's. This technique prevents pan Stamps from wasting resources when Serial communications are not needed.

Tiny Dui No: The TinyDuino processor board takes the power of a full size Adriano (the size of a deck of playing cards) and shrinks it down to the size of a quarter.

A TinyDuino system can easily be build by snapping in the necessary Tiny Shields (miniature expansion boards) to perform all sorts of different functions, like reading sensors, communication with mobile phones and even connecting to the Internet.

Adriano Uno: The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the

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microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Rfduino: RFduino is an Adriano compatible microcontroller, with a Bluetooth 4.0 Low Energy built-in module. It provides 7 GPIO lines, which all supports digital I/O, analog input (10 bit ADC), I^2C, SPI, UART and PWM. Some shields are available: RBG Led / push button shield, USB shield (for RFduino programming), prototyping shield, servo shield, CR2032 coin battery shield, single AAA battery shield, dual AAA battery shield and relay shield.

XxinoRF: The XinoRF is an easy to use digital electronics development board which combines the Arduino UNO R3 with Cisco's SRF-U wireless module. The unit can be programmed from the free to download Adriano IDE via the USB connection or over-the-air using the Ciseco wireless serial data connection. It will run all of the sketches already created for wired Arduino Uno R3. Most series 1 XBee serial sketches will also work. Code developed on the XinoRF will transfer easily to the smaller RFu-328 for deployment. The over-the-air programming capabilities simply extend to the RFu-328 and this simplifies the development and management of networks of Arduino controllers.

CisecOopenkontrol Gateway: The OpenKontrol Gateway allow you to bridge from our wireless protocol network to Wife, Bluetooth and Ethernet networks. They also support third party wireless units such as the Zigbee, NRF and RFM units. The OpenKontrol Gateway is based on the AT Mega 328 micro-controller and can be configured with on-board SRAM, an SD card, a real time clock, a coin battery cell and sports an FTDI programming port.

Pinocchio: Each board has an 802.15.4 radio that communicates with any other board on its PAN ID, in a mesh network configuration. It includes a Wi-Fi shield that fits on top of one of the Pinocchio boards. This board and shield combo acts as a bridge between the Pinocchio mesh network and the web. The Atmel 802.15.4 radio in the ATmega256RFR2 chip has a ridiculously low power draw for the range.

Raspberry Pi: The Raspberry Pi [2] is a low cost, computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing and playing games.

BeagleBone Black: Beagle Bone Black [3] is a low-cost, community-supported development platform for developers and hobbyists. Boot Linux in under 10 seconds and get started on development in less than 5 minutes with just a single USB cable.

UDOO: UDOO board is equipped with two CPU. The Free scale i.MX 6 is an ARM Cortex A9 processor based on ARM v7 instruction set. Next generation graphics and high-definition video are central in the i.MX 6 series. The i.MX 6 series supports up to 1080p60 video playback, enabling exceptional high-quality videos with low power consumption for devices playing high-definition content. The 3D graphics engine in the top of the line i.MX 6 Quad and i.MX 6 Dual processors are capable of providing up to 200 Mt/s, which enables ultra-vivid, realistic graphics critical for multimedia. These applications combine the power of the main cores with the until-now-untapped potential of the 3D engine to perform computational tasks.

Comparison of Hardware

CPU and Connectivity: The different development boards have different connectivity and those hardwires have built in microcontrollers. The Table I shows the comparative analysis of Microcontroller and Connectivity for different Hardware. In my observation, as Raspberry Pi Development board has Ethernet, SD Card, HDMI, WIFI and GSM, it is best suitable for Internet of Things.

Memory and Power: The different development boards have different size of Memory and the required power supply. The table II shows the comparative analysis of Memory and power for different Hardware. In the view of Memory and Power the development board which are supported with external SD card and required less power are more suitable for Internet of Things.

Table I: Comparative Analysis: CPU and Connectivity

Development Platform	CPU	Connectivity
Pan Stamps	Atmel Atmega328p	RFtranceiver
TinyDuino	Atmel Atmega328p	Bluetooth, Wi-Fi
Arduino Uno	Atmel Atmega328p	Bluetooth, Wi-Fi, Gsm
RFDuino	Nordic 32 bit ARM Cortex M0 Processor	Bluetooth
Xinorf	Atmel Atmega328P	Wireless
Openkontrol gateway	Atmel Atmega328P	Ethernet, Gsm, RF module, Wi-Fi
Pinocchio	Atmel Atmega256	802.15.4, Wi-Fi
Raspberry Pi	ARM1176jzfs	Ethernet, sd card, Hdmi, Wi-Fi, Gsm
Beagle boneblack	AM335x 1ghz ARM® cortex-a8	Ethernet
Udoo	Free scale i.mx 6 ARM Cortex-A9	Ethernet, Wi-Fi

Table II: Comparative Analysis: Memory and Power

Development Platform	Memory	Power
PANSTAMPS	4k RAM	2.5v to 3.6v
TINYDUINO	2K RAM	2.7v
ARDUINO UNO	2K RAM	3.3v
RFDUINO	16K RAM	3.3v
XINORF	2kb RAM	5v
OPENKONTROL GATEWAY	32K RAM	5v
PINOCCIO	32K RAM	3.3v
RASPBERRY PI	512B RAM	3.3v
BEAGLEBONE BLACK	2GB RAM	5v
UDOO	1 GB RAM	5v

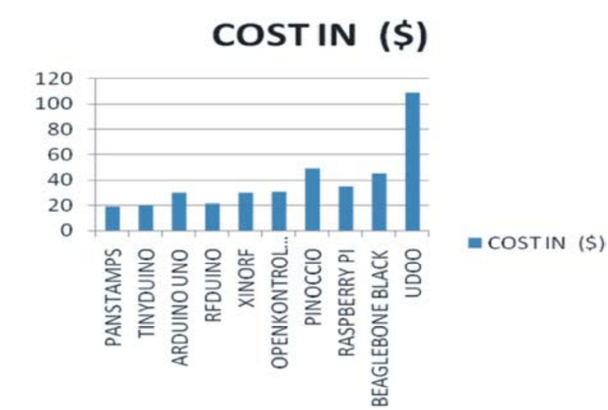

Fig. 1: Comparative Analysis: Development Board and its Cost

Fig. 2. Raspberry Pi Development Board

Cost: The cost of the development boards varies from 18$ to 110$. The Bar Chart clearly shows that Pan stamp hardware cost is lesser than other hardware board. Fig. 1. Illustrates the cost of individual Development board. From the overall analysis of all the hardware it is clearly seen that Raspberry Pi is very much suitable for Internet of Things application. The Fig. 2 shows the Development Board of Raspberry Pi.

Operating System: There are various operating system used for IOT applications. Different vendor create different operating system suitable for IOT Development boards.

RIOT: RIOT is an operating system designed for the particular requirements of Internet of Things (IoT) scenarios. These requirements comprise a low memory footprint, high energy efficiency, real-time capabilities, a modular and configurable communication stack and support for a wide range of low-power devices. RIOT provides a microkernel, utilities like cryptographic libraries, data structures (bloom filters, hash tables, priority queues), or a shell, different network stacks and support for various microcontrollers, radio drivers, sensors and configurations for entire platforms, e.g. TelosB or STM32 Discovery Boards. The microkernel itself comprises thread management [4], a priority-based scheduler, a powerful API for inter-process communication (IPC), a system timer and murexes. In order to build an application or library with RIOT, you need first to download the source code (Getting the source code). This contains-besides the before mentioned features-also some example applications (located in the examples subdirectory) and a sample Make file you may use for your own application. This Make file template shows you how to compile and link your application against RIOT (Compiling RIOT). If you want to use RIOT directly with your embedded platform,

Table III: Comparative Analysis: Operating System

OS	C Support	C++ Support	Multi-Threading	Modularity	Real-Time
Contiki	Y	N	P	P	P
Tiny OS	N	N	P	N	N
Linux	Y	Y	Y	P	P
RIOT	Y	Y	Y	Y	Y

P –Partial Y – Yes N - No

you need to install the corresponding tool chain for the deployed microcontroller (ARM based platforms, TI MSP430 based platforms).

Contiki: Contac is implemented in the C language and has been ported to a number of microcontroller architectures, including the Texas Instruments MSP430 and the Atmel AVR. We are currently running it on the ESB platform [5]. The ESB uses the MSP430 microcontroller with 2 kilobytes of RAM and 60 kilobytes of ROM running at 1 MHz. The microcontroller has the ability to selectively reprogram parts of the on-chip flash memory.

Tiny OS: TinyOS applications are written in the programming language nesC, a dialect of the C language optimized for the memory limits of sensor networks. Its supplementary tools are mainly in the form of Java and shell script front-ends. Associated libraries and tools, such as the nesC compiler and Atmel AVR binutilstoolchains, are mostly written in C. TinyOS programs are built of software components, some of which present hardware abstractions. Components are connected to each other using interfaces. TinyOS provides interfaces and components for common abstractions such as packet communication, routing, sensing, actuation and storage.

Linux: Linux is, in simplest terms, an operating system. It is the software on a computer that enables applications and the computer operator to access the devices on the computer to perform desired functions. The operating system (OS) relays instructions from an application to, for instance, the computer's processor. The processor performs the instructed task, then sends the results back to the application via the operating system. Linux is very similar to other operating systems, such as Windows and OS X.

Comparision of Operating System: RIOT operating system supports C, C++, Multi threading and Real time. From the Table III it is clearly seen that RIOT OS will help for many IoT applications.

Applications: The Internet of Things (IoT) allows us to use technology to enhance our comfort, improve our energy efficiency and simplify the tasks that consume our home and work life and give us greater control over our lives.

- A Connected Home can mean different things to different people, but it's essentially a home with one or more (or many) devices connected together in a way that allows the homeowner to control, customize and monitor their environment.
- Wearable technology is a blanket term that covers a vast array of devices that monitor, record and provide feedback on you or your environment. Broadly speaking, you can divide wearable into Fitness and Health
- The Internet of Things has profound implications for industrial automation and the industrial internet of things. With wireless connectivity, advanced sensor networks, machine-to-machine communications, traditional industrial automation will become more informed and more efficient than ever before.
- A smart meter is an internet-capable device that measures energy, water or natural gas consumption of a building or home.

CONCLUSION

A comparative study has made on different hardware and software platforms needed to build an IOT device. There is no clear winner because each has its own advantage and disadvantage. Choosing a platform depends mainly on the application and the total cost required implementing it.

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