A Review on Open source tools for Internet of Things

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Abstract— Internet of Things is the recent research area which has abundant applications and usage in almost all areas. Many applications are developed and monitored day to day. Many open source tools are available for Internet of Things. This work analyse those tools as a basic research for the area of Internet of Things.

Keywords— IoT Architecture, Arduino, DeviceHive, CupCarbon

I. Introduction

The Internet of Things refers to the ability of everyday objects to connect to the Internet and to send and receive data. Experts estimated that there will be 25 billion connected devices, and by 2020, 50 billion. Technology is quickly changing the way we interact with the world around us. Today, companies are developing products for the consumer market that would have been unimaginable a decade ago. Internet-connected cameras that allow us to post pictures online with a single click, home automation systems that turn on our front porch light when we leave work, and bracelets that share with our friends how far we have biked on run during the day. These are all examples of the Internet of Things, an interconnected environment where all manner of objects have a digital presence and the ability to communicate with other objects and people. The IoT explosion is already around us, in the form of wearable computers, smart health trackers, connected smoke detectors and light bulbs, and essentially any other Internet-connected device that is not a mobile phone, tablet, or traditional computer [1].

Open source technologies support rapid innovation through several advantageous characteristics, allowing for more natural adoption approach within the enterprise. It is free and generally easy to download, install and launch. This allows easy exploration and experimentation with new technologies and enables enterprises to get comfortable with the software on smaller, non-mission-critical projects before any financial commitment is required.

II. Architecture of IoT

A six-layered architecture was proposed based on the network hierarchical structure [2] for IoT. The six layers of IoT are described below [3]:

A. Coding layer

It is the foundation of IoT which provides identification to the objects of interest. In this layer, each object is assigned a unique ID which makes it easy to discern objects.

B. Perception layer

This is the device layer of IoT which gives a physical meaning to each object. It consists of data sensors in different forms like RFID tags, IR sensors or other sensor networks which could sense the temperature, humidity, speed and location etc of the objects. This layer gathers the useful information of the objects from the sensor devices linked with them and converts the information into digital signals which is then passed onto the network layer for further action.

C. Network layer

The purpose of this layer is receive the useful information in the form of digital signals from the perception layer and transmit it to the processing systems in the middleware layer through the transmission mediums like WiFi, Bluetooth, WiMaX, Zigbee, GSM, 3G, etc with protocols like IPv4, IPv6, MQTT, DDS, etc.

D. Middleware layer

This layer processes the information received from the sensor devices. It includes the technologies like cloud computing, ubiquitous computing which ensures a direct access to the database to store all the necessary information in it. Using some Intelligent Processing Equipment, the information is processed and a fully automated action is taken based on the processed results of the information.

E. Application layer

This layer realizes the applications of IoT for all kinds of industry, based on the processed data. Because applications promote the development of IoT so this layer is very helpful in the large scale development of IoT network. The IoT related applications could be smart homes, smart transportation, smart planet, etc.

F. Business layer

This layer manages the applications and services of IoT and is responsible for all the research related to IoT. It generates different business models for effective business strategies.

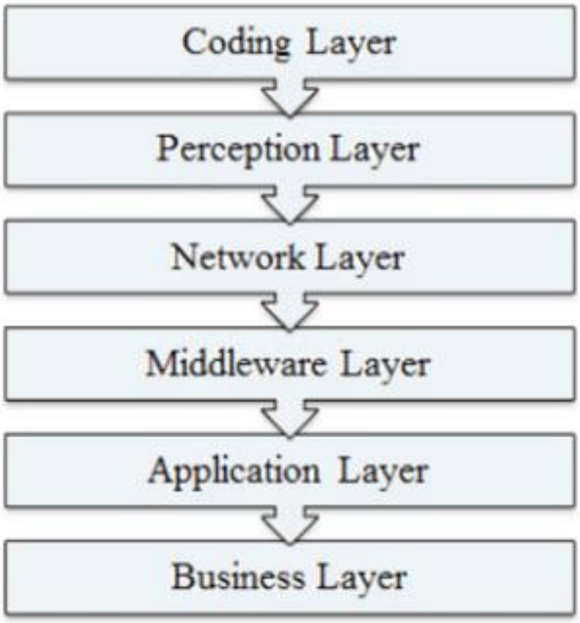

Fig. 1. Six layered architecture of IoT

III. IoT Development Tools

There are various open source IoT development tools available. The list is given as follows [4]:

A. Arduino

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. It is both a hardware specification for interactive electronics and a set of software that includes an IDE and the Arduino programming language.

Fig. 2. Sample Image for Arduino Processor

B. Eclipse IoT project

Eclipse is sponsoring several projects related to IoT. It includes application frameworks and services, open source implementations of IoT protocols and tools for working with Lua, which Eclipse is promoting as an ideal IoT programming language.

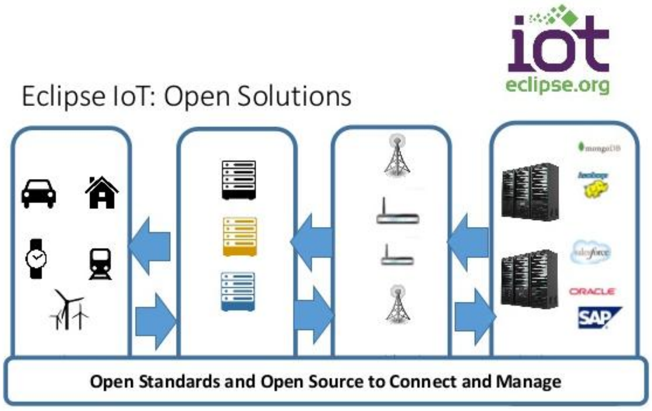

Fig. 3. Eclipse IoT Project

C. M2MLabs Mainspring

M2MLabs Mainspring is an open source application framework for building machine to machine applications such as remote monitoring, fleet management or smart grid. Its capabilities include flexible modelling of devices, device configuration, communication between devices and applications, validation and normalization of data, long-term data storage, and data retrieval functions. It is based on Java and the Apache Cassandra NoSQL database. M2M applications can be prototyped in hours rather than weeks and finally transferred to a high performance execution environment built on top of a standard J2EE server and the highly scaleable Apache Cassandra database.

D. Node-RED

Node-RED is a visual tool for wiring the Internet of Things i.e. wiring together hardware devices, APIs and online services in new and interesting ways. Node-RED describes itself as a visual tool for wiring the Internet of Things. It allows developers to connect devices, services and APIs together using a browser-based flow editor. It can run on Raspberry Pi, and more than 60,000 modules are available to extend its capabilities.

E. DeviceHive

It is a machine-to-machine communication framework for smart energy, home automation, remote sensing, telemetry, remote control and monitoring software and other IoT applications. It supports Java, C++, .NET, Python, Javascript, and other platforms.

F. IoTivity

It is sponsored by the Open Interconnect Consortium, the IoTivity software allows for device-to-device connectivity. It is an implementation of the OIC's standard specification. Linux, Arduino and Tizen are the operating systems used for this software.

G. The Thing System

The Thing System is an open source. It supports a huge list of IoT devices, including those made by Cube Sensors, Parrot, Next, Oregon Scientific, Samsung, Telldus, Aeon Labs, Insteon, Roku, Google, Apple and other manufacturers.

Windows, Linux and OS X are the operating systems used for this system.

H. Sapphire OS

It is a full stack, open source, low power wireless platform from the hardware pin up to the web and beyond. Sapphire combines flexible low cost hardware, a lightweight but powerful embedded operating system, and network connectivity tools to help us connect anything to everything.

I. RIOT

RIOT OS is an operating system for Internet of Things (IoT) devices. It is based on a microkernel and designed for energy efficiency, hardware independent development, a high degree of modularity.

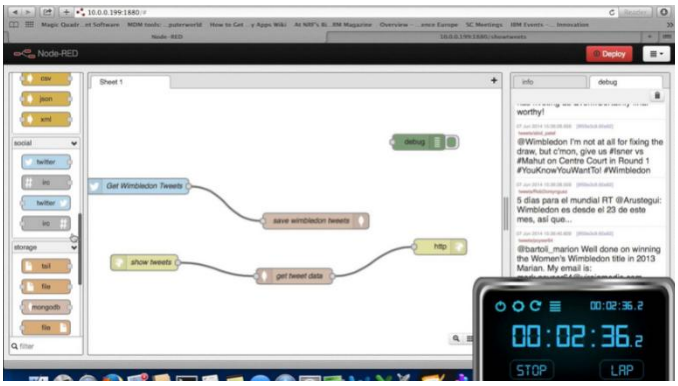

Fig. 4. Sample Screen while running Node-RED

IV. Simulation Tools

In a computer simulation, a process models the behavior of some other system over time. In some cases, the simulated system is real but more often it has yet to be designed or implemented. In practice, simulation is about methodologies and techniques that are needed for the performance evaluation of complex systems.

The motivations behind the use of simulation are: i) cost reasons, ii) testing on the real system is too dangerous, iii) many different solutions must to be evaluated to support the system design. Due to the increasing complexity in the systems to be built, simulation is used more and more often. Some of the simulation tools are given below for IoT [5].

A. Cooja

The Cooja simulator is a network simulator specifically designed for wireless sensor networks. The simulation parameters such as number of nodes, types of nodes, firmware used, location of nodes, etc can be stored in a file for future simulations [6].

This simulator is an extensible toolkit which enables the simulation, modeling and experimentation of cloud system its infrastructures and application environments of single and internetworked clouds. This software helps researchers to concentrate on particular design issues without considering the low level details of cloud infrastructures and services.

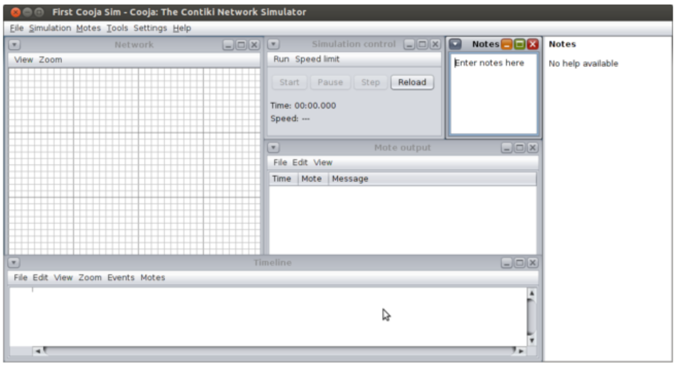

Fig. 5. Sample Screen for Cooja simulator

B. DPWSim

DPWSim is a simulation toolkit that supports the modeling of the OASIS standard ‘Devices Profile for Web Services’. Its main goal is to provide a cross-platform and easy-to-use assessment of DPWS devices and protocols [7]. DPWSim provides simulation tools to help researchers and developers to build IoT applications consuming DPWS services. DPWSim can support users to create virtual environments from a simple to a complex one, even a geographically rich interface with the aid of external computer graphics software and design skills.

C. CupCarbon

It is a smart city and Internet of Things Wireless Sensor Network simulator. Its objective is to design, visualize, debug and validate distributed algorithms for monitoring, environmental data collection, etc and to create environmental scenarios such as fires, gas, mobiles and generally within educational and scientific projects. It employs the OpenStreetMap framework to deploy sensors directly on the map. The main goal of this tool is to help trainers to explain the basic concepts and how sensor networks work and it can help scientists to test their wireless topologies, protocols, etc [8].

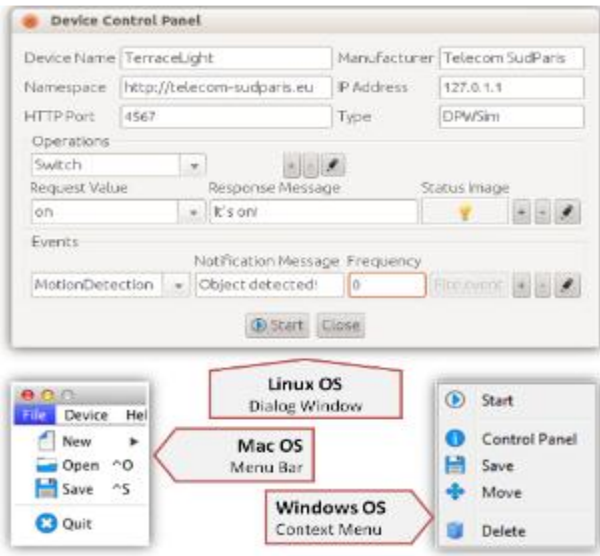

Fig. 6. DPWSim GUI components: a dialog window (Linux OS), a menu bar (Mac OS) and a context menu (Windows OS)

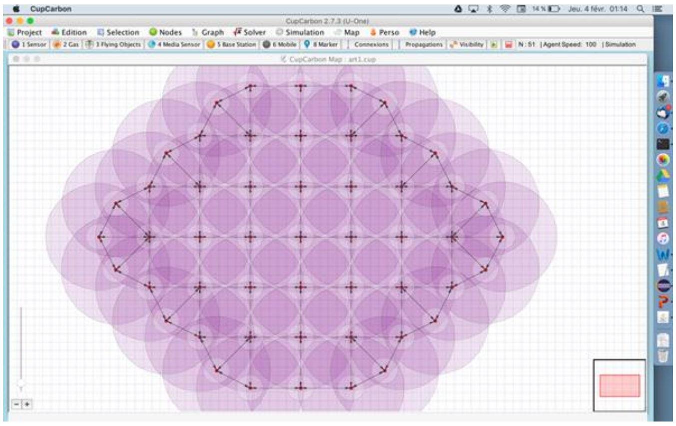

Fig. 7. Sample Snapshot for CupCarbon

D. UrbanSim

It is a software based simulation for urban areas with tools for examining the interplay between land use, transportation and policy. It is intended for use by Metropolitan Planning Organizations and others needing to interface existing travel models with new land use forecasting and analysis capabilities. UrbanSim does not focus on scenario development, as most of these tools do, but rather on understanding the consequences of certain scenarios on urban communities [9]. n extension of cloudsim and supports high performance computing applications.

V. Conclusion

The Internet gave us the opportunity to connect in ways we could never have dreamed possible. The Internet of Things will take us beyond connection to become part of a living, moving, global nervous system. Knowing the tools and techniques involved in IoT is an essential in todays' technological world.

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