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A Comprehensive study of the role of Open Source Technologies in IoT

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Abstract
The Internet of Things (IoT) describes the network of physical objects things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. The challenges in IoT are to manage, maintain and deal with a lot of heterogeneous devices, security for the data generated by them, interoperability of different data formats, various protocols used for data communication, architecture that will include all the heterogeneous devices. To build a better IoT ecosystem, the open IoT platform has become a popular term in recent years. OpenIoT is a simple-to-use open source application, which connects all the sensors that use cloud technologies to make them an extension of your IoT application. [1] More and more IoT developers are motivated to use open systems like open source software, open source hardware, open data due to the associated benefits such as convenience and fast development resulting in major cost savings for the industry. The focus of this paper is to discuss about the architecture of OpenIoT and other open source tools that are used in OpenIoT.
Keywords: *IoT, Open source, OpenIoT, architecture, IoT platforms, IoT tools*

I. Introduction

According to the Minerauda et al. [2] an "IoT platform is defined as the middleware and the infrastructure that enables the end users to interact with smart objects". The IoT devices range from ordinary household objects to sophisticated industrial tools [3]. Internet of Things (IoT) is mainly associated with vertically integrated systems that often are closed and fragmented in their applicability. There are different types of platforms available that often are referred to as IoT platforms, such as device-to-device, cloud-based and device-to-cloud platforms (enterprise platforms)[4–6]). Apart from using many of the open systems, they contribute a lot to the field of open source projects.

Open source projects have led to innovation, development and consumption communities run completely by and for users. Open source software development communities consist of people who contribute to the public good of open source software by writing code for the project.[7] Open source software development communities consist of people who contribute to the public good of open source software by writing code for the project.

II. Open Source for Developers

Even though there are a large number of software related to the field of IoT, developers show their interest towards using mostly open source software due to the following reasons:[8]

- It is available at a nominal cost or free of cost.
- It is the best technology as it is undergoing frequent updates / improvements,
- It highlights the quality of the IoT projects done by the developers due to the availability of a community of volunteer developers where multiple solutions will be given.
- It is a new cutting edge technology.
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III. OpenIoT Platform Overview

The OpenIoT architecture comprises seven main elements: [9]

1. **The Sensor Middleware** (Extended Global Sensor Networks, X-GSN) collects, filters and combines data streams from virtual sensors or physical devices. A mobile broker (publish/subscribe middleware) is also used for the integration of mobile sensors.

2. **The Cloud Data Storage** (Linked Stream Middleware Light, LSM-Light) acts as a cloud database which enables storage of data streams stemming from the sensor middleware. The cloud infrastructure also stores metadata required for the operation of OpenIoT.
3. **The Scheduler** processes requests for on-demand deployment of services and ensures their proper access to the resources (e.g. data streams) that they require. It discovers sensors and associated data streams that can contribute to a given service. It also manages a service and activates the resources involved in its provision.
4. **The Service Delivery & Utility Manager (SD&UM)** combines data streams as indicated by service workflows within the OpenIoT system in order to deliver the requested service (typically expressed as an SPARQL query). The SD&UM acts also as a service metering facility which keeps track of utility metrics for each service.
5. **The Request Definition component** enables on-the-fly specification of service requests to the OpenIoT platform. It comprises a set of services for specifying and formulating such requests, while also submitting them to the Scheduler. This component is supported by a GUI (Graphical User Interface).
6. **The Request Presentation component** is in charge of the visualization of the outputs of a service. This component selects mash-ups from an appropriate library in order to facilitate service presentation.
7. **The Configuration and Monitoring component** enables visual management and configuration of functionalities over sensors and services that are deployed within the OpenIoT platform.

OpenIoT has provided an innovative platform for IoT and cloud convergence, which enables:

- Integration of IoT data and applications with cloud computing infrastructure
- Deployment of and secure access to semantically interoperable applications
- Handling of mobile sensors and associated QoS parameters

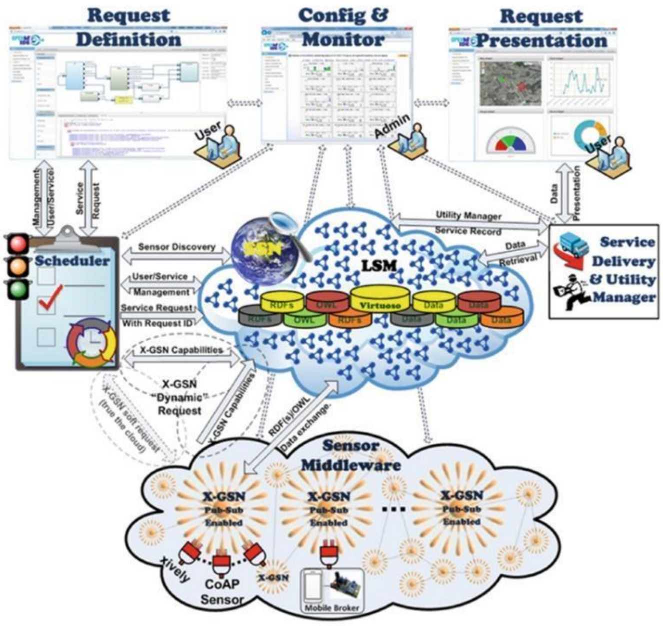

Figure 1 : OpenIoT Architecture

IV. List of IoT Platforms and related open source tools

The following table provides some of the open source tools used in IoT in various platforms [10]

Part of the IoT development stack	Examples of open source technology
Embedded operating systems 64% of IoT developers uses open source for this	Raspbian, Ubuntu Core (a.k.a. Snappy), Google Brillo, Contiki, FreeRTOS, RIOT OS, TinyOS, ARM mbed
Frameworks, software components, and libraries 71% of IoT developers uses open source for this	Open source business rule engines: Node-RED (made by a team at IBM), Siddhi, bip.io, The Thingbox Project Communication stacks: IoTSyS, VerneMQ, RHIOT, or the Eclipse IoT Project. Miscellaneous: KinomaJS, Zetta, Yaler, prpl Foundation

Device-side IoT platforms 61% of IoT developers uses open source for this	OpenHab and Eclipse SmartHome (share a common technology base), Nimbits, IoT Toolkit, Chimera IoT platform
Cloud-based IoT platforms 64% of IoT developers uses open source for this	DeviceHive, DeviceHub, OpenRemote, ThingSpeak, SiteWhere, Kaa
Open hardware 77% of IoT developers uses open source for this	Arduino and derivatives, Texas Instruments' BeagleBoard, networking equipment and gateways like The Things Network, Flutter, sensor platforms like eHealth in biometrics, AirBeam in environmental monitoring, processors like PULPino
Open data 68% of IoT developers uses open source for this	The governments of the G8 countries (Canada, France, Germany, Italy, Japan, Russia, UK, and USA) have published over 540,000 datasets on their combined national data portals so far.

Table 1 – List of open source tools

V. Operating Systems for the IoT environment

Like any new software, an OS has to be integrated with the existing IoT environment. To keep the complex IoT environment running, a new OS has to be customised to meet specific requirements. Owing to some constraints that exist in many traditional OSs, they are impractical to be used in IoT as IoT devices are designed with limited resources [11, 12]. The adoption process of an OS requires that the OS should be able to operate IoT devices efficiently.

Types of OSs in IoT

Based on their programming features and their capability open source Oss are classified as follows:[13]

1. OSs for low-end IoT devices – Examples: TinyOS, RIOT OS, LiteOS, Contiki OS, Apache Mynewt OS, etc., All these OS are non Linux based operating systems
2. OSs for high-end IoT devices – Examples: uClinux OS, Raspbian OS, Android Things OS, etc., All these OS are Linux based operating systems

OS	Kernel	Scheduler	Programming model	Language Support	Real time
TinyOS	monolithic	non-preemptive FIFO	event driven	NesC	no support
Contiki OS	modular	preemptive FIFO	event driven, protothreads	C	partial support
RIOT	Microkernel	preemptive, priority, tickless	Multithreading	C, C++	Supports
LiteOS	modular	preemptive priority (RR)	Multithreading	LiteC++	no support
FreeRTOS	microkernel	preemptive, optional tickless	Multithreading	C	Supports
Mynewt	modular	preemptive	Multithreading	Go (golang), C	Supports
Mbed	monolithic	non-preemptive	single thread	C, C++	Supports
uClinux	monolithic	preemptive	Multithreading	C	partial support
Raspbian	modular, monolithic	preemptive	Multithreading	Python, C, Ruby, Java, PhP, C++, Node.js	supports
Android Things	modular	preemptive	Multithreading	Weave using C, C++	Supports

Table 2 – Summary of features of Open Source Oss

VI. An insight into open source tools:

Some of the Opensource tools used for data collection, processing, visualization and device management in IoT are mentioned below:

1. Zetta – It is API based IoT platform based on Node.js. It is considered as a complete toolkit to make HTTP APIs for devices. Zetta combines REST APIs, WebSockets to make data-intensive and real-time applications. [14]

2. Arduino - Arduino is a simple-to-use IoT platform. It operates through an array of hardware specifications that can be given to interactive electronics. The software of Arduino comes in the plan of the Arduino programming language and Integrated Development Environment (IDE).[15]

***3. OpenRemote* -** OpenRemote has introduced a new open-source IoT platform to create professional energy management, crowd management, or more generic asset management applications.[16]

***4. Node-Red* -** Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.[17]

VII. Challenges and Open Research problems

The Open IoT platform has the following challenges and problems:[18, 19]

1. Need for improved and more accurate models for resource discovery.
2. Need for more efficient resource scheduling and management policies.
3. More focus on support for data filtering is required.
4. Support for data compression is needed to reduce the amount of required storage.
5. Need to address syntactic and semantic interoperability.
6. Support for changing business logic or IoT environment is expected.
7. Support for hard real time processing is required.
8. Seamless replacement of modules to provide reliability in case of faults and failures is still not addresses.
9. Human intervention is required for deployment of devices on IoT platform.
10. Need for more dynamic rules and policies for making deployed system adaptable to run time environment.
11. Proper data compression solutions can be deployed to reduce the amount of storage required

VIII. CONCLUSION

In this comprehensive study, we discussed about IoT, challenges faced in IoT that can be solved with the introduction of open source hardware, software, database systems, etc., open source operating systems, tools that are currently used in Open IoT architecture in various levels. Also, the challenges and problems that the industry is facing to implement the Open IoT architecture are also addressed. Further our research can be extended to address the challenges and problems by providing right solutions in those areas. Open IoT extends the IoT applications to be available in various sectors and areas because of the cost feasibility, availability to all and everywhere and the freedom to modify and update the technologies used in IoT.

REFERENCES

[1]. https://www.opensourceforu.com/2019/03/openiot-enabling-the-convergence-of-iot-and-cloud-computing/

[2]. Mineraud, J.; Mazhelis, O.; Su, X.; Tarkoma, S. A gap analysis of Internet-of-Things platforms. Comput. Commun. 2016, 89, 5–16. [CrossRef]

[3]. https://www.oracle.com/in/internet-of-things/what-is-iot/

[4]. Derhamy, H.; Eliasson, J.; Delsing, J.; Priller, P. A survey of commercial frameworks for the internet of things. In Proceedings of the 2015 IEEE 20th Conference on Emerging Technologies & Factory Automation (ETFA), Luxembourg, Luxembourg, 8–11 September 2015; pp. 1–8.

[5]. 14. Hammi, B.; Khatoun, R.; Zeadally, S.; Fayad, A.; Khoukhi, L. IoT technologies for smart cities. IET Netw. 2017, 7, 1–13. [CrossRef]

[6]. 15. Kuila, S.; Dhanda, N.; Joardar, S.; Neogy, S. Analytical Survey on Standards of Internet of Things Framework and Platforms. In Emerging Technologies in Data Mining and Information Security; Springer: Berlin/Heidelberg, Germany, 2019; pp. 33–44.

[7]. Georg von Krogh, Department of Management, Technology, and Economics, ETH Zurich, Kreuzplatz 5, 8000 Zürich, Switzerland, and Eric von Hippel, Sloan School of Management, Massachusetts Institute of Technology, 50 Memorial Drive, Cambridge, Massachusetts, The Promise of Research on Open Source Software, MANAGEMENT SCIENCE, Vol. 52, No. 7, July 2006, pp. 975–983, issn 0025-1909 eissn 1526-5501|06|5207|0975

[8]. https://www.w3.org/WoT/IG/wiki/images/9/95/The_essential_guide_to_Open_Source_in_IoT_-_White_Paper.pdf

[9]. John K.Soldatos, Nikos Kefalakis, Manfred Hauswirth and Martin Serrano, **OpenIoT: Open Source Internet-of-Things in the Cloud,** Article in Lecture Notes in Computer Science · March 2015, DOI: 10.1007/978-3-319-16546-2_3

[10]. https://www.w3.org/WoT/IG/wiki/images/9/95/The_essential_guide_to_Open_Source_in_IoT_-_White_Paper.pdf

[11]. Al-Fuqaha, A., Guizani, M., Mohammadi, M., et al.: 'Internet of things: a survey on enabling technologies, protocols, and applications', IEEE Commun.Surv. Tutor., 2015, 17, (4), pp. 2347–2376

[12]. Mahmoud H. Qutqut, Aya Al-Sakran, Fadi Almasalha, Hossam S. Hassanein " Comprehensive Survey of the IoT open source Oss", Article in IET Wireless Sensor Systems · October 2018.
[13]. Hahm, O., Baccelli, E., Petersen, H., et al.: 'Operating systems for low-end devices in the Internet of things: a survey', IEEE Internet Things J., 2016, 3, (5), pp. 720–734
[14]. https://www.zettajs.org/
[15]. https://www.arduino.cc/en/Guide/Introduction
[16]. https://openremote.io/get-started-iot-platform/
[17]. https://nodered.org/
[18]. Bahtijar Vogel, Yuji Dong, Blerim Emruli, Paul Davidsson and Romina Spalazzese: "What Is an Open IoT Platform?Insights from a Systematic Mapping Study", Article in future internet, MDPI, April 18, 2020.
[19]. Preeti Agarwal and Mansaf Alam from Jamia Millia Islamia, Article :" Open Service Platforms for IoT", May 2020, https://www.researchgate.net/publication/341634843