UDC 004.738.5

THE GENERELIZED CLASSIFICATION MODEL OF IoT-PLATFORMS

Tsaryov R., Korovkina K.

O.S. Popov Odessa national academy of telecommunications,
1 Kuznechnaya St., Odessa, 65029, Ukraine.
c4r1980@gmail.com

УЗАГАЛЬНЕНА КЛАСИФІКАЦІЙНА МОДЕЛЬ IoT-ПЛАТФОРМ

Царьов Р. Ю., Коровкіна К. В.

Одеська національна академія зв'язку ім. О.С. Попова,
65029, Україна, м. Одеса, вул. Кузнечна, 1.
c4r1980@gmail.com

ОБОБЩЕННАЯ КЛАССИФИКАЦИОННАЯ МОДЕЛЬ IoT-ПЛАТФОРМ

Царёв Р. Ю., Коровкина К. В.

Одесская национальная академия связи им. А.С. Попова,
65029, Украина, г. Одесса, ул. Кузнечная,1.
c4r1980@gmail.com

Abstract. The relevance of the concept development of the Internet of Things was shown in the article. The generalized classification model of Internet of Thighs (IoT) platforms was proposed. The model is represented by two levels: realization level (type of realization, type of support, type of compatibility with operation systems, type of compatibility with databases, type of supported network protocols, type of development strategy, type of architecture) and operating level (an application area, visualization opportunity, data processing manner, security methods, devices management method). Brief characteristics for each class of IoT platforms included in the proposed model were presented.

Key words: Internet of Things, IoT-platform, classification model.

Анотація. Показано актуальність розвитку концепції Інтернет речей (Internet of Things). Запропонована узагальнена класифікаційна модель Internet of Things (IoT) платформ. Модель надана у вигляді двох рівнів: рівень базових характеристик (тип реалізації; тип супроводу; тип сумісності з операційними системами; тип сумісності з базами даних; тип підтримуваних мережевих протоколів;тип стратегії розвитку; тип архітектури) та рівень специфічних характеристик (галузь застосування; можливість візуалізації; спосіб обробки даних; методи захисту; спосіб управління пристроями). Наведені короткі характеристики кожного з класів IoT-платформ, які входять до складу запропонованої класифікаційної моделі.

Ключові слова: Інтернет речей, IoT-платформа, класифікаційна модель.

Аннотация. Показана актуальность развития концепции Интернет вещей (Internet of Things). Предложена обобщенная классификационная модель Internet of Things (IoT) платформ. Модель представлена в виде двух уровней: уровень базовых характеристик (тип реализации; тип сопровождения; тип совместимости с операционными системами; тип совместимости с базами данных; тип поддерживаемых сетевых протоколов; тип стратегии развития; тип архитектуры) и уровень специфических характеристик (область применения; возможность визуализации; способ обработки данных; методы защиты; способ управления устройствами). Даны краткие характеристики каждого из классов IoT-платформ, входящих в состав предложенной модели.

Ключевые слова: Интернет вещей, IoT-платформа, классификационная модель.

The modern information technologies provide unique opportunities to implement new aspects of human interaction with the environment that are realized in the concept 'Internet of Things'. Internet of Things (IoT) – is an ability to connect any objects (things) to the information network and organize data exchange between them in order to improve an efficient use of these things. The IoT concept is a further development of complex automation concept that was transferred from the industrial sphere for all aspects of human life [1].

Global analytical agency McKinsey based on the results of 2015 estimated that till the 2025 the amount of investments in IoT will be $11 trillion (11% of Global GDP) [2]. The key instrument in Internet of Things development is an IoT platform.

IoT-platform is a central object in the IoT concept that unites real and virtual constituents. IoT-platform consists of five core modules [3]:

- Hardware. The hardware layer includes the physical devices with their in-built microprocessors, sensors, actuators and communication hardware.
- Communication. This part of the technology infrastructure ensures that the hardware is connected to the network via proprietary or open-source communication protocols.
- Software backend. The software backend manages all connected devices and networks and provides the necessary data integration as well as the interface to other systems.
- Applications. In the application layer IoT use cases get presented to the user (B2C or B2B). Most of the applications run on smartphones, tablets, PCs or other devices/things and "do something valuable" with the data.
- Security. Security is a must-have element for all these building blocks. The IoT infrastructure must be holistically designed so that the threat of attacks is minimized on all levels.

The growth of IoT concept popularity leaded to a huge amount of IoT-platforms appearance. All of them differ from each other and in some cases even are not complete IoT-platforms [4].

The emergence of a significant IoT-platforms number designed for different applications and devices development within the IoT concept sets a new task before users – the task of the most suitable from the technical and economical views IoT-platform selection for a particular situation.

The choice of the most suitable for a particular situation IoT-platform, as a rule, is based on a variety of factors complex analysis, such as: application area (industry, domestic sector, military sector, universal), presence of specialists who work with the platform, supported methods of data processing, desired security level etc. Obviously, carrying out of such analysis requires the involvement of highly qualified specialists' development solutions in the field of IoT who know the capabilities of various IoT-platforms. This quite often is not possible especially considering the quantity of such platforms presented in the market. It is possible to simplify the solution of this problem by using the classification model of IoT-platforms. However, today the universal classification model of IoT-platforms is absent. There are present classification models only by the separate features, for example the classification of the application sphere [4,5]. Considering that it is quite difficult to assess the IoT market, there are obstacles to effective interaction between suppliers and potential consumers of IoT technologies, and time spent on a platform selection significantly increases a cost of developing solutions.

The goal of this work is to develop a generalized classification model of IoT-platform as a base that allows reducing time in order to solve a selection task of the most suitable IoT platform for a particular situation.

The specified task can be presented in the following general form:

$$T_S = f(N, \overline{t_{ES}}) \to \min, \tag{1}$$

where T_S – is time spent on selection of the most suitable IoT-platform for a particular situation; $N = \{SP(i)\}$, $i = \overline{1,n}$ – is a set of available for choice IoT-platform; $\overline{t_{ES}}$ – is the average time spent on assessment of *i*-th IoT-platform characteristics that is defined as:

$$\overline{t_{ES\,i}} = \sum_{k} t_{ESk} \cdot m_k, \quad i = \overline{1,n},\ k = \overline{1,p} \tag{2}$$

where t_{ESk} – time spent on assessment of *k*-th characteristic of *i*-th IoT-platform; m_k – an element of set $M = \{m_{(k)}\}$, $k = \overline{1,p}$ that describes characteristics of *i*-th IoT-platform.

It is obviously that creation of generalized classification model will allow decreasing a size of set $M = \{m_{(k)}\}$ by reducing a number of IoT-platform characteristics, which specialists need to evaluate independently.

To develop a classification model we will rely on the technical and functional features of the IoT-platform. The proposed classification model (Table 1) is presented in two levels – a level of basic characteristics and a level of specific characteristics. The following classification features are used at the level of basic characteristics for IoT platforms classification: type of realization, type of support, type of compatibility with operation systems, type of compatibility with databases, type of supported network protocols, type of development strategy, type of architecture.

Table 1 – The classification model of IoT-platforms

Level	Classification feature	Class of IoT-platform
Of basic characteristics	Type of realization	Unidirectional
		Universal
	Type of support	Fully supported
		Partly supported
		Non-supported
	Type of compatibility with operation systems	Mobile
		Stationary
		Cross-platformed
	Type of compatibility with databases	Relational
		Non-relational
	Type of architecture	Open
		Closed
	Type of supported network protocols	Basic
		Specialized
		Combined
	Type of development strategy	Vertically integrated up
		Vertically integrated down
		Affiliate
	Application area	Industrial
		Consumer
		Medical
		Multi-purpose
	Visualization opportunity	Without visualization
		With visualization
	Data processing method	Real time
		Serial
		Projected
	Devices management method	Centralized
		Decentralized
	Security methods	Authorization platforms
		Encryption platforms

The following criteria are used at the level of specific characteristics: application area, visualization opportunity, data processing method, security methods, devices management method.

Type of realization (level of basic characteristics):

– Unidirectional platforms – platforms oriented on work only with a determined set of specific manufacturer hardware.

– Universal platforms – platforms oriented on work with any hardware of any manufacturer.

Type of support (level of basic characteristics):

– Fully supported – platforms which functionality permanently updates, expands and improves. A function of technical support is realized. It provides operative solution of the problems identified in the work of platform.

– Partly supported – platforms which functionality updates and expands. Technical support is not envisaged, a problem identifying users solves independently.

– Non-supported – developing and updating of platform functionality is not implemented centrally. Users can independently develop platforms functionality.

Type of compatibility with operation systems (level of basic characteristics):

– Mobile platforms – are oriented on work with OS of mobile devices Apple iOS, Windows Phone and Google Android.

– Stationary – are oriented on work with OS of stationary devices Microsoft Windows, Apple Mac OS X and Linux.

– Cross-platformed – are oriented on work with any OS.

Type of compatibility with databases (level of basic characteristics):

– Relational platforms – support work with relational database management systems (RDBMSs) or SQL - Microsoft SQL Server, Oracle Database, MySQL and IBM DB2.

– Non-relational platforms – support work with non-relational databases, so called NoSQL databases - MongoDB, DocumentDB, HBase, Neo4j, Cassandra, Coachbase, Redis and Neo4j.

Type of architecture (level of basic characteristics):

– Open platform – open-source platforms. Platforms are opened for development, improving and modernization to third-party communities, organizations.

– Closed platforms – platforms are developed, improved and modernized only by the platform developer.

Type of supported network protocols (level of basic characteristics):

– Basic platforms – platforms which use TCP/IP protocols for interaction.

– Specialized platforms – platforms which use specific protocols such as MQTT, CoAP, MPM, AggreGate Protocol, BACnet, DMX, KNX, Modbus etc.

– Combined – platforms which can work both with TCP/IP protocols and specific protocols.

Type of development strategy (level of basic characteristics):

– Vertically integrated up platforms – platforms oriented on hardware device (thing) creation with following development of functional component.

– Vertically integrated down platforms – platforms oriented on functional component creation with following development of hardware device (thing) for this functional component.

– Affiliate platforms – platforms which are developing by uniting functional component of one developer and hardware solutions of other developer.

Application area (level of specific characteristics):

– Industrial platforms – platforms for developing projects in industrial, grid, transport spheres – projects “smart enterprise”, “smart port” etc.

– Medical platforms – platforms for development projects in eHealth concept.

– Consumer platforms – platforms for development projects in the field of households – projects “smart citizen”, “smart appliances”, “smart house” etc.

– Multi-purpose platforms – allow developing projects for any sphere of human activity.

Visualization opportunity (level of specific characteristics):

– Platforms without visualization – platforms do not provide a visualization opportunity (to reflect in graphs, schemes, diagrams view) devices functionality.

– Platforms with visualization – platforms provide opportunity of reports generating and editing, graphs and diagrams which in graphical view reflect results of device functioning.

Data processing manner (level of specific characteristics):

– Real time platforms – processing of data collected by devices is implemented online.

– Serial platforms – data processing is carried out by series, devices collect determined amount of data and then send them for processing in scheduled time periods.

– Projected platforms – are used different methods of forecasting based on diverse types of machine learning and statistical sampling.

Devices management manner (level of specific characteristics):

– Centralized platforms – platforms which realize centralized management of all devices.

– Decentralized platforms – centralized function management is not realized, each device is independent.

Security methods (level of specific characteristics):

– Authorization platforms – diverse authorization mechanisms, identification, authentication (through certificates, tokens, identifiers etc.) are used for providing a security of platform.

– Encryption platforms – encrypted data transfer channels creation mechanisms (encrypted channel SSL/TLS, encrypted channel MQTT) are used for providing security of platform.

Conclusions and results:

Proposed classification model reflects both basic (which characterize any platform) and specific for IoT-platforms characteristics. The model can be used for the database creation with information about existing IoT-platforms, it will allow to simplify and speed up decision making in the sphere of selecting an optimal one for solving a specific problem of IoT-platform.

REFERENCE:

1. Nosov N. Internet veshhej: otstaem i budem otstavat' sil'nee / N. Nosov. – Access mode: https://www.itweek.ru/iot/article/detail.php?ID=182550.
2. McKinsey report: “Unlocking the potential of the Internet of Things”. – Access mode: http://www.mckinsey.com/insights/business_technology/the_internet_of_things_the_value_of_ digitizing_the_physical_world.
3. IoT-analytics White paper: “IOT PLATFORMS The central backbone for the Internet of Things”, November 2015 / Access mode: https://iot-analytics.com/product/whitepaper-iot-basics-getting-started-with-the-internet-of-things/
4. IoT-analytics The IoT Platform Company List 2017. – Access mode: https://iot-analytics.com/product/list-of-450-iot-platform-companies/
5. J’son & Partners Consulting report: «Analiz tehnologicheskih platform M2M/IoT i provajderov specializirovannogo PO». – Access mode: https://iot.ru/monitoring/json_partners_predstavili_ analiz_tehnologicheskih_platform_m2miot_i_provajderov_specializirovannogo_po.

ЛІТЕРАТУРА:

1. Носов Н. Интернет вещей: отстаем и будем отставать сильнее / Носов Н. – Режим доступу: https://www.itweek.ru/iot/article/detail.php?ID=182550.
2. McKinsey report: “Unlocking the potential of the Internet of Things”. – Режим доступу: http://www.mckinsey.com/insights/business_technology/the_internet_of_things_the_value_of_ digitizing_ the_physical_world.
3. IoT-analytics White paper: “IOT PLATFORMS The central backbone for the Internet of Things”, November 2015. – Режим доступу: https://iot-analytics.com/product/whitepaper-iot-basics-getting-started-with-the-internet-of-things/
4. IoT-analytics The IoT Platform Company List 2017. – Access mode: https://iot-analytics.com/ product/list-of-450-iot-platform-companies/
5. J’son & Partners Consulting report: «Анализ технологических платформ M2M/IoT и провайдеров специализированного ПО». – Режим доступу: https://iot.ru/monitoring/json_partners_predstavili_ analiz_tehnologicheskih_platform_m2miot_i_provajderov_specializirovannogo_po.