

Internet of Things: Security Challenges

^[1] Aamir Parvaiz Wagay, ^[2] Dr. Khalid Mohiuddin

^[1] Ph.D. Scholar, Himalayan University, Itanagar, Arunachal Pradesh, India

^[2] Assistant Professor, King Khalid University, Kingdom of Saudi Arabia

Abstract— Internet of factors (moreover IoT) with the aid of definition refers to a networked interconnection of gadgets in regular use which can be often equipped with ubiquitous intelligence. It far based totally on processing of massive portions of statistics to be able to provide useful data/provider and permits a green regulatory coverage within the region of IoT. One of the key challenges for the realization of the IoT includes protection challenges, particularly within the area of privateness and confidentiality among control of heterogeneities and barriers of network capacities. Those demanding situations can be based totally on statistics protection control structures as well as on felony foundations. When considering the criminal framework of security and privateness of the IoT, it needs to be determined which version of law should be implemented. Thereby, no conventional authorities' law is certainly appropriate for an international gadget along with IoT. The maximum essential basis therefore will be the regulatory foundations of EU union (at the territory of European) and, consequently building the model of self-law primarily based in part on country and mostly on regulation worldwide agreements that are to be considered as tools to manipulate the IoT. This paper offers an insight into the most crucial safety demanding situations related to implementation of IoT and constructing appropriate regulatory framework. Adoption of the regulatory framework is essential for the improvement of IoT offerings because of adequate criminal safety businesses will get.

Keywords— Challenges, Confidentiality, Facts, IoT, Privacy, Regulation, Safety.

I. INTRODUCTION

The net, or how we like to refer to it, the arena wide net, is no longer simply a network of computer systems however it also connects distinct gadgets that are capable of ship and get hold of facts about the repute of devices related to the network. The internet of things (hereinafter: IoT) is a concept taking into account the networking of various things and objects from regular life and their ordinary communication over the net, without human interplay, a good way to improving the situations and manner of life. The term internet of things turned into hired for the primary time with the aid of Kevin Ashton, the director of MIT's vehicle-id center, in 1999 in his presentation for Procter & Gamble, but it took some years for the time period to go into extra common use. IoT changed into officially brought as a time period in 2006 by the worldwide Telecommunication Union (ITU) in its internet record [1]. With the development of IoT technology, each device in our environment might be capable of speak with every other device and send statistics to that tool or control it, relying at the collected data. The net of things is a network connecting objects from unique environments into an unmarried big community based totally on the internet Protocol, and it's far a basis for the development of the so-referred to as clever environments, such as smart homes, factories or even towns. As opposed to the former vertical development of character areas and technologies (from technologies for connecting mobile gadgets, Wi-Fi

sensory networks, processing of big portions of facts), the addition of a new middleware permits the conclusion of the concept of the net of things. The middleware enables the connection of exclusive technology and platforms and it is a platform for the improvement of advanced offerings without the want to possess knowledge approximately each generation one after the other so that it will developing new offerings [2]. The networking of a big number of items in our surroundings will result in a larger amount of generated facts that need to be stored, processed and provided in a desirable form. there are many applications for services in the IoT subject, from consumer programs on the way to offer brought value only to the consumer who described them to complete branches of technological know-how which are supplied simplified sharing of assets, accumulating of records from a massive variety of sensors, statistical analysis of such facts and conclusions in relation to information in real time [3]. The potential for monetary exploitation and application of IoT become diagnosed by way of the Economist mag as an end result of a survey performed in June 2013 whilst opinions of 779 enterprise professionals had been accumulated to define the enterprise index of IoT. Consequences have shown that three quarters of businesses have been actively gaining knowledge of or the usage of IoT, and ninety six% said that they could begin the usage of IoT in a single form or some other in the following 3 years. The assessment of ability growth of the IoT marketplace inside the next few years varies relying on wide variety of linked devices and on the financial growth of the marketplace. consequently, for

instance, Gartner estimated that 30 billion gadgets will be connected to the net in 2020 with a single IP deal with which could convey additional USD 1.nine billion (1012) for the arena economy [4]. At the identical time, Cisco and Ericsson forecast that this variety would increase to 50 billion [5] [6] objects related to the net, a good way to bring about profits for the world economy amounting to USD 14 billion. For comparison sake, this quantity exceeds overall GDP of 17 EU Member States in 2011 [7]. IDC also envisaged in October 2013 that there will be a total of 212 billion “items” via 2020, which could same to EUR 8.9 billion in line with year with the annual boom fee of 7.9% [8]. This paper gives an outline of the situation in IoT with a unique emphasis on regulatory demanding situations in an effort to emerge in the upcoming years in this area. It offers records of the development of IoT era via special EU and worldwide our bodies and corporations, consisting of ITU and the European studies Cluster with projects associated with IoT. It additionally provides a definition of IoT and related standards, an overview of two reference models for IoT architecture and the most essential protocols for the net of things. In addition to that, an outline is provided of the contemporary scenario in IoT in Europe including state of affairs in Croatia and in the America, along with challenges and possible troubles for the belief of IoT.

II. INTERNET OF THINGS

In the interim there may be no generally popular definition of the net of things. The definition itself is Nonetheless uncertain and it's far frequently a topic of philosophical discussions. Majority of authors on this vicinity use their very own definition which, to a greater or lesser quantity, differs from different definitions. A number of the definitions that maximum regularly occur in literature are supplied under. Often, IoT can be defined as a community of items which might be capable of stumble on and exchange data amongst each other, but it differs from the net in several different elements [1]. A more extensively everyday definition is ITU's definition from 2005, which is very well known and reads as follows: IoT is a worldwide infrastructure for the statistics Society, allowing superior offerings through interconnecting (physical and digital) matters based totally on, existing and evolving, interoperable data and verbal exchange technologies [1]. The RFID organization defines IoT as the global community of interconnected gadgets uniquely addressable based totally on popular conversation protocols [9]. in line with the IoT EU research Cluster (IERC)1 IoT is an integral part of the

future net, and it is defined as a dynamic global infrastructure that has the ability of self-configuration, that is, a community based on trendy and interoperable communications protocols, and a network wherein bodily and virtual “things” have identification, physical characteristics and digital persona and also use shrewd interfaces even as being on the identical time secretly integrated into the records community [10]. IERC also offers its personal definition of “things” as energetic individuals in business, facts and social processes in which they're enabled to interact and talk amongst themselves and with the environment. This interaction and communicate take vicinity in the form of the alternate of facts and information accrued from the surroundings. Whilst reacting autonomously to the real/bodily global occasions and influencing it by means of walking procedures, “things” cause actions and create services without or with direct human intervention [10]. “Matters” can also be described as actual/bodily or digital/virtual topics that exist and circulate in time and area and may be recognized. Things are often diagnosed in accordance with the assigned identity wide variety, name and/or place address.

IoT vs M2M

IoT and M2M structures in large part overlap but, considering their definitions, they'll now not be regarded as same. A shared function of IoT and M2M is far off get admission to gadgets. But, there are a few important variations among them. A conventional M2M refers to verbal exchange among two or more devices via a cell or fixed community. This is vertical point-to-factor communicate. M2M applications usually consist of a hardware module embedded right into a device at the consumer side which communicates via a cellular or constant network with the corresponding utility, frequently on the facet of the provider company. The goal is to reduce control and renovation prices. M2M connects “things” with a laptop. IoT connects a laptop with “matters” (machines, devices, sensors, merchandise etc.), structures (commercial enterprise programs, support structures, analytical structures, data storages, control structures and many others.) and people (consumers, employees, partners and shoppers). IoT is based at the IP community for horizontal connection of items/devices to a cloud or person platform.

IoT normally combines sensory facts with “massive facts”, analytic or employer packages for the improvement of productivity, growth of manufacturing and percentage available on the market, improvement of offerings, offer of SaaS (software program as a provider)

etc. in preference to M2M which simplest helps gadgets, IoT answers aid passive sensors as nicely, small strength sensors and reasonably-priced gadgets that may not be adjusted to M2M hardware modules. IoT gadgets communicate through popular IP networks. IoT is commonly linked to a cloud which makes it a scalable and flexible solution as opposed to M2M communications which can be frequently orientated towards installation of SIM playing cards or drawing a set line. IoT is extra orientated closer to software program solution or IP network even as M2M conversation is in the main orientated in the direction of an embedded hardware and mobile community. It must be mentioned that M2M with internet Protocol is a part of IoT. IoT is a broader idea that M2M due to the fact it is able to be included into the overall enterprise commercial enterprise solution whilst M2M is greater orientated toward renovation.

strength performance, micro manufacturing of energy, electric cars and focus of users approximately strength consumption. The scope of utility of IoT can be divided into the following regions: private and family use, economic system, carrier programmes and mobile area. The above mentioned department is provided in determine 2.

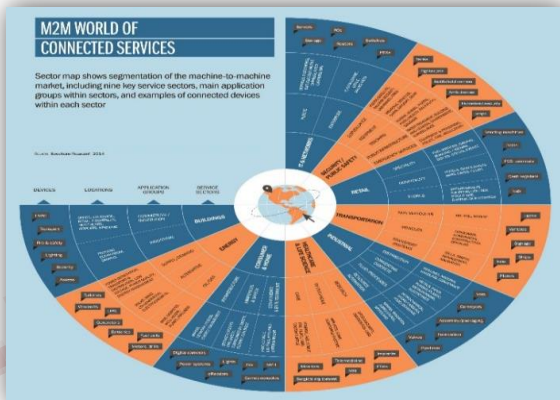


Fig 1: M2M World of Connected Services

SCOPE OF IoT

Although IoT permits an extensive spectrum of applications in normal existence, its current software is restrained and vast adjustments are anticipated within the destiny. Key enabling technologies encompass ubiquitous connectivity, clever gadgets and opportunity for integration of smart objects into one-of-a-kind programs. There are numerous distinctive connected matters ranging from machines to vehicles, devices, mild furniture and buildings. they're no longer restricted best to material items, for example, smart locations and sensing of the surroundings are very essential for plenty applications. The scope of software may be very extensive, such as upgraded traffic protection and traffic control, transformation of the power grid closer to advanced grids on the premise of latest requirements which includes

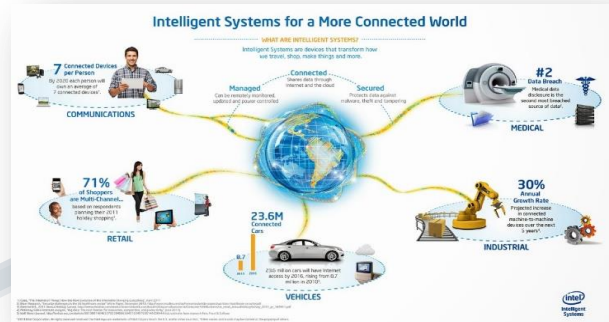


Fig 2: IoT End Users and Areas of Applications PERSONAL AND HOUSEHOLD IoT

Records accrued by sensors is used only by means of the man or woman who owns the network. Wireless is frequently used as the middle community enabling excessive permeability and assisting the transmission of video sign and excessive frequency of sampling which favour the transmission of audio sign. One of the high-quality examples of software of IoT in this location is e-health care. Records gathered by way of sensors located on frame are sent to one of the clever gadgets in the residence which similarly transmits them to a server. A clever telephone is an awesome example of an information-gathering tool because it carries numerous interfaces the most suitable of which for this reason is Bluetooth. The accumulated records can be used by docs to supervise patients even when they're at domestic, which contributes to the reduction of hospitalization costs. Manipulate of family gadgets, including air-conditioning gadgets, refrigerators, washing machines etc. will enable higher control of the house (clever residence) and extra green electricity use [9].

ECONOMIC IoT

The financial application within the paintings surroundings refers back to the "network of things". Statistics amassed by such community are used only via the network user and they may be selectively published. Sensors have always been a constituent part of factories

with regards to safety, automation and different techniques important for continuous operation. Sensors might be replaced in the future by using wireless structures that allows you to make certain flexible adjustments of settings, that is, simpler modifications of settings whenever important. The brand new device is simply an IoT sub network that is constrained to at least one manufacturing unit.

SERVICE PROGRAMMES

Information collected from the community are most often used for the optimization of procedures. Examples of such use encompass clever meters. Statistics amassed by means of clever meters permit companies of software offerings to manipulate their resources on the way to achieve greater optimization of charges and earnings. Such systems encompass very luxurious networks used for the supervision of key infrastructure and green resource management. Mobile community, Wi-Fi network or satellite or for pc communication may be used as a key network. Concrete application of achievements in this area will considerably improve the present monitoring systems to be able to be more efficient inside the monitoring of certain objectives, noticing of suspicious hobby and monitoring of unauthorized access. Making sure the great of water or tracking of agricultural land are only some of the regions in which IoT has already had many benefits, and it is sure that advantages from use of IoT era may be even extra inside the future [9].

MOBILE IoT

Noise pollutants is in general as a result of city visitors. Moreover, traffic additionally contributes to the reduction of air satisfactory and to emission of greenhouse gases. Visitors' jams make contributions to increased costs of financial and social activities in majority of cities. All of the above-mentioned issues can be decreased through continuous gathering and processing of traffic information. In relation to traffic through lengthy distance Wi-Fi sensors networks, IoT permits regular tracking of time of travel, from points of foundation to destination points, of air pollutants and noise pollutants. This sort of an IoT system will maximum possibly update present day structures for gathering site visitors data and support the improvement of algorithms for traffic management, consisting of better object manipulate systems. The outcomes of processing of amassed records could be supplied to passengers who will have a non-stop insight into situation in site visitors [9].

III. BUILDING THE SECURITY AND REGULATORY FRAMEWORK OF THE INTERNET OF THINGS

IoT is a complex system that could result in several innovations and new guidelines of behavior. Scientists, politicians, CEOs of huge organizations in Europe and the USA are presently discussing capability rules of behavior. Law ought to don't forget the complexity of the IoT gadget which is why the problem ought to be taken into consideration from several forward-looking tiers. Unique interest need to be paid to results of marketplace regulation, this is, to its effect on improvements and adjustment and speed of spreading of the IoT in society and business environments. Beneath is a top level view of discussions within the private region and within the public about key IoT issues that encompass privacy, safety, ethics, statistics confidentiality, competition, economic improvement and freedom of innovation.

EUROPE

Because of its worrying goals, Europe has completed the best development within the IoT section and its improvement is similarly supported by using guidelines in several sectors. Guidelines crucial for the for the IoT region are defined within the following files:

1. "The electricity services Directive" – Directive 2006/32/ECon energy quit-use performance of diverse gadgets and electricity offerings according with this Directive, it's far predicted that 80% of households will have hooked up clever strength meters by way of 2020.

2. "eCall Directive"– by using 2015 the eCall service have to be available in all EU Member States. till then all new cars need to have hooked up devices in an effort to robotically dial 112 in case of an coincidence and provide key information, including GPS coordinates, statistics approximately the driving force and the similar.

3. "The EU 531/2012 Roaming law" – the Roaming Directive introduces crucial modifications that may additionally help EU market, inclusive of the introduction of an aggregator as a wholesale provider. The dialogue at the significance of IoT in Europe started out in 2006 and endured in 2007 when the idea of IoT turned into officially well-known within the commission communique on RFID [15]. Within the report on "future Networks and net" from November 2008, it changed into recognized that IoT has high capacity for the improvement of latest services however on the equal time affords threat in phrases of protection of privateness of

people [16]. The want for discussion about structure and management of the IOT has been identified, and all the Member States have been invited to sell decentralized management so that you can make certain confidentiality, protection, privacy and moral control of statistics exchanged in the IoT [16]. The EU fee ordinary the strategic movement plan for IoT in 14 factors [17] in 2009 which represented a series of ideas for management of the IoT, the assessment of feasible risks, the financing of joint investments, participation in international speak, and integration of IoT into four studies and improvement tasks of a public-private partnership. In June of 2010 the EC mounted a multi-stakeholder working group inclusive of people of various profiles along with scientists, technicians, representatives of the enterprise, prison and social sciences as an advisory body of the EU commission managing fundamental issues consisting of control mechanisms, ownership of records, privateness, protection, requirements and international cooperation. The EC carried out a public session in IoT control in 2012. The questionnaire accumulated reviews on the proper approach to control in order to stimulate faster improvement of IOT, at the same time as on the same time making sure adequate safety of European residents. The results have validated a joint position that IoT will make a contribution to huge monetary and social development, especially inside the regions of health, unbiased lifestyles and assist for disabled persons. In all different regions, it illustrated variations in reviews between citizens and institutions of residents that choice a stricter law as compared to the industry. In step with the effects, 77% of respondents supported the improvement of indicators for effect assessment within the field of records safety, such as necessities related to the consent of users to collect facts, facts anonymization, confined use and statistics retention and privateness. An thrilling truth is that the majority of replies indicated that IoT will result in many ethical troubles associated with the accumulated statistics however also that the improvement of IoT need to not bring about social injustice. the European Union expert institution concluded in December 2012 that there's a giant war of words among the commercial enterprise network (inside the first area the industry) and the general public on most of the people of issues, in unique privateness, security and want for faster development of competitiveness in an IoT surroundings [18]. On the idea of this end, the EC entrusted an EU organization named RAND with the improvement of pointers for IoT management. Its report became posted in August of 2013 pointing out that IoT is developing fast and represents a assignment for traditional business, market, control and

social models. Economic, social, political, prison and technological internet control is primarily based on a presumption of rational selection, market strength and green self-corporation adjusted to structures beneath human manipulate. Considering interactive self-sufficient IT structures are substantially exclusive from this paradigm [19], RAND recommends the software of a "smooth regulation" technique a good way to include standards, supervision and ethical individual and will at the equal time ensure freedom for the industry to modify to necessities in an easier way. This should make sure area for the development of IoT within the EU.

THE UNITED STATES OF AMERICA

Rather than Europe which stimulates the development of IoT with is regulatory sports, discussions on IoT in the USA are sporadic and scattered. The majority of debates take vicinity inside character federal organizations fascinated only in a few segments of IoT. Therefore, for instance, in 2012, the countrywide Institute of requirements and generation published the Framework and Roadmap for smart Grid Interoperability requirements [20] which blanketed handiest one section of IoT. The country department investigated in 2013 the possibilities for using the IoT for monitoring weapons of mass destruction, and the department of fatherland safety has been continuously installing sensory structures for detection of chemical and organic threats [21].

The first critical discussion turned into initiated in April 2013 through the Federal alternate commission through asking for feedback on the influence of IoT on privateness and protection [22]. Best 27 replies have been acquired, out of which more than 60% from the enterprise or their institutions. Consequently, remarks were in opposition to law. Most people of

Remarks had been targeted on self-regulation and the removal of presidency impact on the improvement of standards of privacy and safety that would endanger the improvement and improvements for IoT. The industry believes that the improvement of certificate for safety and privateness could ensure enough protection of customers. In November of 2013 the FTC held a public workshop on IoT in order to investigate issues related to security and privacy due to increasing numbers of linked gadgets [23]. At this workshop, the President of the FTC pointed out the important thing demanding situations, one of the principal being the lack of collected and saved non-public data. The 3 fundamental principles he singled out covered records transparency, simple selection of control of personal data and the privacy version [29]. The round table further opened a dialogue on extra manipulate

problems which includes the usage of IoT for authorities supervision of residents. Several options for the protection of privacy and safety of customers were proposed, consisting of self-law, the instruction of licensed approval certificate, implementation of moral codes, the implementation of the present law on users and the development of latest law of IoT. The conclusion of the work institution was that law will depend on whether organizations earn sales solely from IoT products and services or they plan to take advantage of user facts by supplying records analysis offerings.

IV. SECURITY CHALLENGES RELATED TO IMPLEMENTATION IOT

IoT is an area wherein studies is in full swing. Following the primary research on technologies used inside the region of IoT, it is necessary to introduce standards for architecture, systems and communicate among individual components. The development of requirements and structures for IoT is a basis for the improvement of superior services. There are many viable directions for research due to the fact the mature section of improvement of IT brings new demanding situations related to marketplace regulation, price, security and development of performances and performance of work of platforms. Thus far, studies targeted on the established order of purposeful structures on the way to permit the provision of increasingly services, but, with the boom of the wide variety of customers, it'll essential to provide guide to the excellent of carrier. The open issues in the region of statistics processing encompass standardization of question language, definition of key assessment (and comparison) parameters for diverse components and adjustment of algorithms for processing statistics float in cloud computing and variable characteristics of access records. Power efficiency will constitute an extensive venture in the improvement of communicate protocols and devices. Strength assets and autonomous operation can be of superb significance, particularly for sensory modules with a view to for the most element be battery-powered. The pleasant indicators are cutting-edge sensors which might be in most cases battery powered and continuously broadcast information by the usage of Wi-Fi or Bluetooth technology. Key challenges and viable issues [26] that want to be taken into consideration and solved earlier than mass application of the IoT include the following:

1. Security privateness and confidentiality – the security domain has the subsequent demanding situations: (a) securing IoT structure, (b) proactive identification and safety of IoT from arbitrary attacks (e.g. DoS and DDoS

attacks) and abuse and (c) proactive identity and safety of IoT from malware. Within the area of user privateness, special demanding situations include the following: (a) control of personal facts (privacy of records), (b) need to enhance privacy technologies and the applicable legal guidelines [28].and (c) standards [27]. Techniques and equipment for dealing with the identity of customers and objects. In the area of confidentiality, a number of the particular demanding situations consist of the following: (a) the need for easier trade of essential, protected and exclusive records and (b) confidentiality ought to be a constituent a part of IoT design.

2. Standardization: management of heterogeneity - control of heterogeneous applications, environments and gadgets represents an outstanding undertaking in addition to the standardization of heterogeneous technologies, devices, programs and interfaces. The shortage of a single connection trendy (a big choice of stressed out and wireless and "proprietary" answers) will represent a massive task to connectivity at the worldwide stage.

3. In safety demanding situations super position play obstacles of network capability – the convergence of gadgets that

Arises from the IoT stimulates extra demand for a sure diploma of expected QoS of the related community infrastructure. New cellular packages that offer sure offerings may additionally call for greater common sending of small blocks of records (periods) essential for upgrading and synchronizing. The frequency of the abovementioned classes may have a brilliant effect on postpone and permeability of the community itself. This a part of infrastructure have to be securely brought with the intention to ensure relaxed records flow.

4. And remaining however now not least: the management of a big portions of records and processing of huge quantities of records to make certain useful records/carrier as well as to make certain confidentiality and integrity of data as part of

Information/carrier (IoT except for "raw" facts from the source may additionally generate a large amount of metadata or brief facts vital for the conclusion of services (e.g. sensory reading can be saved in a relational and semantics database). characteristics are the subsequent: quantity (size of records), variety (heterogeneity of processed information, e.g. tables, pics, electronic mail) and dynamics (traits of statistics, depth and frequency of arrivals, way of processing). structures for IoT have to allow green processing of records in real time ensuing from person demands due to the fact the user needs to be instantly knowledgeable of exciting occasions (e.g. selection of the maximum beneficial travel direction).

similarly to the above-mentioned foremost demanding situations, there also are a few other demanding situations such as: (a) marketplace regulation, (b) designing of an extra green architecture for networking of sensors and garage of gathered statistics, (c) development of mechanisms for the processing of the go with the flow of information accrued in sensory networks, (d) transition to IPv6 (large number of addresses, possibility for vehicle configuration and advanced security parameters), (e) energy assets of devices/sensors (devices are powered by means of electricity made from the environment inclusive of vibrations, mild and air float) and (f) reduced fee of IoT components.

V. CONCLUSION

IoT represents a new, thrilling path inside the improvement of the internet. It refers to precise identity of gadgets and their digital representation in the structure of the internet. Such objects might also speak with every other, provide records approximately itself and accept statistics accumulated by other objects. The improvement of IoT depends at the dynamics of improvements in several technical fields, from Wi-Fi sensors to nanotechnology. Capacities, such as the tracking of modifications in the environment or communication between devices, represent excessive precedence within the improvement of IoT. one of the key demanding situations for the realization of the IoT consist of security, privateness and confidentiality, control of heterogeneities, barriers of network capacities, control and processing of large quantities of information in order to provide beneficial statistics /service and allow an efficient regulatory coverage inside the region of IoT. due to the fact, safety of privateness is one of the key constitutional rights of residents' it's far very important to observe that IoT will must be in compliance with the brand new European regulatory frameworks for statistics and privateness protection, as nicely as with all prison requirements right into a single group of guidelines inside the EU and including also revised measures for information transparency and protection problems.

VI. ACKNOWLEDGEMENT

The authors would love to impart the anonymous reviewers for his or her valuable comments and suggestions that have greatly improved the standard of the paper.

REFERENCES

Journal Papers:

- [1] ITU Internet Reports 2005: The Internet of Things“, International Telecommunication Union.
- [2] Antonić, „Platforme za obradu podataka u stvarnom vremenu u području Internet objekata“, Report for doctoral qualification exam, 2013.
- [3] John Soldatos, Nikos Kefalakis, Manfred Hauswirth, Martin Serrano, Jean-Paul Calbimonte, Mehdi Riahi, Karl Aberer, Prem Prakash Jayaraman, Arkady Zaslavsky, Ivana Podnar Žarko, Lea Skorin-Kapov and Reinhard Herzog. Open IoT: Open Source Internet-of-Things in the Cloud, Invited paper, to appear in Lecture Notes in Computer Science, vol. 9001, 2015.
- [4] Forecast: The Internet of Things, Worldwide, 2013. “, Gartner, 2013.
- [5] D.Evans, “The Internet of Things How the Next Evolution of the Internet Is Changing Everything”, White Paper, Cisco, April 2011.
- [6] Miguel Block strand, Tomas Holm, Lars-Örjan Kling, Robert Skog and Berndt Wallin, „Operator opportunities in the internet of things“, Ericsson review, 2011
- [7] Rooney, B. “Internet of Things Poses Big Questions.” Wall Street Journal Online, July 3, 2013.
- [8] International Data Corporation (IDC) Press Release. “The Internet of Things Is Poised to Change Everything, Says IDC.” October, 2013,
- [9] Jayavardhana Gubbi, Rajkumar Buyya, Slaven Marusic, Marimuthu Palaniswami, „Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions“, Future Generation Computer Systems, 2013.
- [10] CERP-IoT, Vision and Challenges for Realising the Internet of Things, March 2010
- [11] Toby Jaffey, „MQTT and COAP, IoT Protocols“, Eclipse Newsletter, February 2014.
- [12] Paul Duffy, „Beyond MQTT: A Cisco view on IoT Protocols“, Cisco Blog, April 2013.
- [13] XMPP Standards Foundation, <http://xmpp.org/aboutxmpp/technology-overview/>

- [14] Stan Schneider, „Understanding the Protocols Behind the Internet of Things“, Electronic Design, October 2013.
- [15] G. Santucci, “1.1 the Internet of Things: Between the Revolution of the Internet and the Metamorphosis of Objects”, Vision and Challenges for Realising the Internet of Things, March 2010.
- [16] European Commission. “Communication on future networks and the internet.” Brussels, September, 2008.
- [17] European Commission, „Internet of Things: A 14-point Action Plan“, Brisel, lipanj 2009.
- [18] T. Wachtel, “10th Meeting of the Internet of Things Expert Group Meeting Minutes” Brussels, November 2012.
- [19] RAND Europe, “Europe’s policy options for a dynamic and trustworthy development of the Internet of Things.”, SMART 2012/0053, August 2013
- [20] National Institute for Standards and Technology (NIST), “NIST Releases Final Smart Grid Framework 2.0’ Document”, February 2012.
- [21] Department of Homeland Security, <http://www.dhs.gov/stsnapshot-detect-protect>, rujanj 2013
- [22] Federal Trade Commission, “Public Comments: #484; FTC Seeks Input on Privacy and Security Implications of the Internet of Things; FTC Project No. P135405; Commission Staff to Conduct Workshop on November 21, 2013 in Washington, DC“, July 2013
- [23] Federal Trade Commission, Internet of Things Workshop, Washington DC, <http://ftc.gov/bcp/workshops/internet-of-things/>, November, 2013
- [24] <http://www.hakom.hr/default.aspx?id=116&subID=3366>
- [25] ECC Report 153 on Numbering and Addressing in Machine-to-Machine (M2M) Communications – Nov.2010
(<http://www.cept.org/files/5424/documents/ECC%20REP%20153%20Numbering%20and%20Addressing%20in%20Machineto-Machine%20M2M%29%20Communications.pdf>)
- [26] Rafiullah Khan, Sarmad Ullah Khan, Rifaqat Zaheer and Shahid Khan, “Future Internet: The Internet of Things Architecture, Possible Applications and Key Challenges”, 10th International Conference on Frontiers of Information Technology, 2012.
Books:
- [27] Boban, M., Information security and the right to privacy in digital economy– the case Of Republic of Croatia // Zbornik radova 37. Međunarodnog skupa za informacijsku i komunikacijsku tehnologiju, elektroniku i mikroelektroniku - MIPRO 2014. Zagreb: MIPRO, 2014. 1687-1692
- [28] Boban, M., Upravljanje sigurnosnim rizicima I krizno upravljanje u mrežnoj komunikaciji // .Zagreb, 2014. 549-572
- [29] Boban, Marija, Pravo Na privatnost i pravo napristup informacijama u suvremenom informacijskom društvu. // Zbornik radova Pravnog fakulteta u Splitu. 49(2012), 3 (105); 575-598