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# Systematic Review of Literature Focusing Internet of Things (IoT) Utilization for Upcoming Industry 4.0

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**Abstract:** *It is necessary to study existing research challenges and approaches before initiating proposed research pilot development. In this paper we analyzed papers from various high indexed journals. Our aim is to depict filtered results as an outcome of rigorous reviews of framework, algorithms and methods. As software cost estimation is hot issue to maintain overall estimate employed for existing systems. This paper will definitely prove latest research thread which can be used as a reference solution for future development. Researchers working on similar domain of research can use shortlisted research papers as a pilot domain reference for future development.*

**Keywords:** *Concentric Computing Model (CCM) MQTT, CoAP, Sensor-as-a-Service (SaaS), XMPP*

## I. INTRODUCTION

Industry 4.0 is really a name provided to the present pattern associated with automation as well as information trade within production systems. It offers cyber-physical systems, the actual internet of things, cloud processing as well as cognitive processing. Industry 4.0 is often known as the actual 4th industrial trend. Industry 4.0 fosters exactly what may be known as the "smart factory". Inside modular organized wise industrial facilities, cyber-physical systems keep track of bodily procedures, produce a digital duplicate from the bodily globe as well as help to make decentralized choices. Within the internet of things, cyber-physical systems connect as well as work with one another with people within real-time each in house as well as throughout organizational services provided as well as utilized by individuals from the worth string. IoT devices tend to be attached to solitary server three-tier structures, including the broker between your server and also the devices. The main problem is based on creating a broker effective at controlling as well as being able to access a number of devices. Broker ought to service several bodily connections as well as protocol stacks therefore hybrid system required. Just about all brokers within the system tend to be attached to a typical network so the IoT system size could be bigger through decentralizing these types of broker-centric subsystems, known as IoT units, that combination info through numerous sensors. Hence, it is very important to identify existing research papers which can be used for future research.

## II. LITERATURE REVIEW

In this section, we presented few notable research approaches. IoT platform and related prototypes developed within the ebbits project, with focus on the industrial domain. These developments are based on an IoT middleware developed and deployed by the project, to enable the seamless integration of heterogeneous technologies and processes into mainstream enterprise systems [1]. Particular investigation determined the challenges facing the M2M communication of industrial systems and presented a data-oriented M2M messaging mechanism based on ZeroMQ (ZMQ) for the ubiquitous data access in rich sensing pervasive industrial applications. This investigation aimed to provide a generic and flexible M2M messaging mechanism to deal with the complex structure and heterogeneity problems of IIoT applications. Research identified the characteristics of IIoT applications regarding machine communication and then presented a data-oriented messaging mechanism based on the selected M2M messaging protocol [2].

Author studied IIoT. In IIoT, end devices continuously generate and transmit data streams which result in increased network traffic between device-cloud communications. Moreover, it increases in-network data transmissions that require additional efforts for Big Data processing, management, and analytics. To cope with these engendered issues, this article first introduces a novel Concentric Computing Model (CCM) paradigm which comprises of sensing systems, outer and inner gateway processors, and central processors (outer and inner) for the deployment of Big Data analytics applications in IIoT [3].

Author discussed that information and Operational technologies merge into the so called Industrial Internet of Things (IIoT), which is one of the basic pillars of the Industry 4.0 paradigm. Roughly speaking, yet-to-come services will be offered in the automation

scenario by industrial devices having an Internet connection for sharing data. In this paper new, full software, platform-independent approach is proposed for experimentally evaluating the delay in transferring information across intercontinental routes by applications leveraging on messaging middleware [4].

Existing approaches which support both batch processing (suitable for analysis of large historical data sets) and event processing (suitable for real-time analysis) are complex. Author proposed the hut architecture, a simple but scalable architecture for ingesting and analyzing IoT data, which uses historical data analysis to provide context for real-time analysis. Author implemented architecture using open source components optimized for big data applications and extend them where needed [5].

Research discussed that it necessitate a software architecture that encompasses a management fabric and a data-driven middleware that can leverage SOA, Clouds and Big Data platforms in a meaningful manner to support the needs of IoT applications. One can envision convergence onto a core set of interoperable, open standards. Author proposed a service-oriented and data driven software architecture. Author characterized the requirements of an IoT fabric and middleware to support innovative Smart City applications. (2) Author developed service-oriented software architecture, based on open protocols, standards and software, to meet these requirements while leveraging Cloud and Big Data platforms [6].

Due to the growing interest in IoT, the number of platforms designed to support IoT has risen considerably. As a result of different approaches, standards, and use cases, there is a wide variety and heterogeneity of IoT platforms. This leads to difficulties in comprehending, selecting, and using appropriate platforms. Author tackled these issues by conducting a detailed analysis of several state-of-the-art IoT platforms in order to foster the understanding of the (i) underlying concepts, (ii) similarities, and (iii) differences between them. Author demonstrated that the various components of the different platforms can be mapped to an abstract reference architecture, and analyze the effectiveness of this mapping [7].

The exponential growth in Internet-of-Things (IoT) devices, security and privacy issues have emerged as critical challenges that can potentially compromise their successful deployment in many data-sensitive applications. Hence, there is a pressing need to address these challenges, given that IoT systems suffer from different limitations, and IoT devices are constrained in terms of energy and computational power, which renders them extremely vulnerable to attacks. Traditional cryptographic algorithms use a static structure that requires several rounds of computations, which leads to significant overhead in terms of execution time and computational resources. Moreover, the problem is compounded when dealing with multimedia contents, since the associated algorithms have stringent QoS requirements. Author proposed a lightweight cipher algorithm based on a dynamic structure with a single round that consists of simple operations, and that targets multimedia IoT. In this algorithm, a dynamic key is generated and then used to build two robust substitution tables, a dynamic permutation table, and two pseudo-random matrices. This dynamic cipher structure minimizes the number of rounds to a single one, while maintaining a high level of randomness and security [8].

CoAP is a lightweight RESTful transport protocol designed for constrained devices. The RESTful model means that the client exchanges resources representations with a server. The server defines the representations of the resources in chosen namespace. A client initiates a request to the server and the server then returns a response with a representation of the current resource. CoAP provides a request/response interaction model between application endpoints, supports built-in discovery of services and resources, and includes key concepts of the Web such as URIs and Internet media types. CoAP is designed to easily interface with HTTP (Hypertext Transfer Protocol) for integration with the Web while meeting specialized requirements such as multicast support, very low overhead, and simplicity for constrained environments. Author provided a detail study on the NB-IoT performance for the case of MQTT and CoAP payload transmission. Different deployment scenarios of NB-IoT have been compared. Results shows, that MQTT protocol performs better for in-band deployment, while CoAP shows higher throughput for standalone NB-IoT. In uplink, both protocols show similar performance [9].

Reliability is one of the most important characteristics of an IoT system which should be satisfied with high consideration. The way how IoT devices communicate with each other in different layers of architecture, plays an important role in building a reliable IoT infrastructure. Maintaining the desired level of reliability in IoT applications through application layer protocols, imposes a noticeable amount of overhead to different characteristics of IoT systems. Authors investigated these overheads through practical evaluations on a conventional IoT infrastructure. To this end, Authors compared two well-known application layer protocols, i.e., MQTT with many reliable features and CoAP with fewer reliability mechanisms, from different aspects [10].

The resources taken by the data processing, the software based protocol design is also challenging and important for achieving resource efficient IoT. Among many protocol layers, RPL and CoAP are two key protocols to support a large scale IoT transmission and enable the newly emerging Sensor-as-a-Service (SaaS) paradigm. Author characterized the IoT system from both theoretical and practical aspects, and analyzed the sensor edge computing strategy and lightweight routing and application protocols for IoT [11].

Extensible messaging and presence protocol (XMPP) is a preferential protocol to solve the problem of interoperability between heterogeneous networks. Hence, it is attractive to extend XMPP to the Internet of Things (IoT). However, XMPP protocol is initially designed for the Internet where the equipment is rich in resources, considering the characteristics of the IoT, the XMPP protocol needs to be optimized to meet the requirements of IoT, e.g., downsized protocol, publish/subscribe service and sleeping mechanism. Author proposed a lightweight XMPP publish/subscribe scheme for resource-constrained IoT devices to perform data exchange either periodically or upon any value change. According to the subscriber's needs, the publisher can adjust the data information published to the server. The proposed scheme strongly supports publish/subscribe architecture of the sleeping clients that actually prolongs the lifetime of battery-powered devices. Based on the standardized XMPP protocol, author presented a downsized and trimmed XMPP to implement this scheme. Also Security is an important feature of the IoT protocols and XMPP protocol [12].

### III. RESEARCH METHODOLOGY

This study has been undertaken as a systematic literature survey of data analytics of internet of things architectures and algorithms for understanding of IoT middleware. In this case the goal of the survey is to assess systematic literature reviews, so this study is categorized as a bi-directional literature review. The steps in the systematic literature review method are documented below.

#### A. Research questions

To address the methodology of proposed research, few pilot research questions are formulated as below which can be evaluated at the stage of research methodology development:

- 1) RQ1. What are IoT and IIoT architectures and service oriented architectures available?
- 2) RQ2. What are merits of these architectures?
- 3) RQ3. Which algorithms available for IoT middleware, SOA studies?
- 4) RQ4. How can we focus over Industry 4.0 methodologies?

#### B. Database Search Process

We followed systematic method to generate literature database. Initially, we identified significant electronic databases as: IEEE, ACM and Elsevier for publications search with phrase "Internet of things for industry 4.0". Following search string is developed and applied:

((IoT protocols\*) OR (Internet of things) OR (IoT architecture) OR))) AND ((middleware IoT) OR (IoT broker\*))

The outcomes of the above query over the selected databases is given in Table 1,2 and 3. We excluded few tables due to paper space limitations.

Table 1  
Shortlisted IEEE literature

Input String	No. of papers (Primary Search)			
	Conference	Journals / Magazines	eBooks	Miscellaneous
IoT protocols	112	237	3	2
Internet of things	97	176	0	0
IoT architecture	101	89	0	0
middleware IoT	15	34	0	0
IoT broker	27	98	0	0

Table 2  
Shortlisted ACM literature

Input String	No. of papers (Primary Search)			
	Transaction	Journals	eBooks	Miscellaneous
IoT protocols	275	239	0	0
Internet of things	102	216	0	1
IoT architecture	78	97	1	0
middleware IoT	19	43	0	0
IoT broker	92	112	0	5

Table 3  
Shortlisted Elsevier literature

Input String	No. of papers (Primary Search)			
	Transaction	Journals	eBooks	Miscellaneous
IoT protocols	N/A	67	2	N/A
Internet of things	N/A	178	0	N/A
IoT architecture	N/A	88	0	N/A
middleware IoT	N/A	21	0	N/A
IoT broker	N/A	146	3	N/A

C. Data Extraction Criteria

In the second stage, we physically examined conference and journal paper titles (eBooks, publications prior to year 2017 and miscellaneous are omitted) of each one of the 347 (IEEE), 291 (ACM) and 351 (Elsevier). Publications analyzed from rest of libraries as an introductory search, rejected any which are not related to our domain of research and also multiple abstract similarity data rejected if published on more than one database. We filtered the unique data as per our domain of proposed research and finalized 116 documents with an immediate significance to our work. These were most significant and the information is about the IoT protocols, architectures, algorithms for middleware communication, reference architecture models etc. For immediate pilot study, we extracted 12 papers, as demonstrated in Fig. 1.

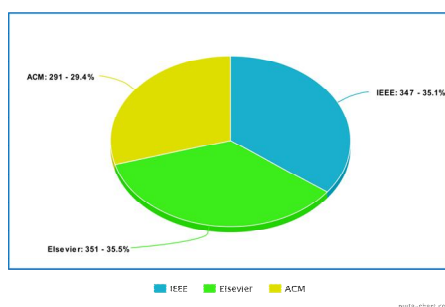


Fig. 1: Literature database search results chart

D. Quality assessment

We evaluated shortlisted papers for following aspects,

- Q1: Is author cited high impact factor publications?
- Q2: Is information provided by author is cited by other researchers?
- Q3: Is IoT broker analysis is used for real-time tasks and which method is popularly used?

The quality assessment answers are synchronized as follows:

- Ans.1: Yes. But authors also referred print journals before year 2000.
- Ans.2: Yes. Research citation record till 2018 is available with each e-article and many cross-references used in original cited article.
- Ans.3: Yes. Most commonly used information diffusion model.

**E. Data collection Strategy**

The present data is gathered from high indexed journals, conferences and transactions for study purpose, stored in Microsoft excel sheet. The information is separated as:

- 1) Title of research
- 2) Author name of research paper
- 3) Publication Date &Year, Volume, Issue, Page numbers, ISSN/DOI.

**F. Data analysis**

Data is organized in tabular format for further analysis (refer table 4). The tabulated data contains pilot search.

Table 4  
Final documents for review

Reference No.	Author	Year of publication
[1]	Khaleel et al.	2017
[2]	Meng et al.	2017
[3]	Rehman et al.	2018
[4]	Ferrari et al.	2018
[5]	Ta-Shma et al.	2018
[6]	Simmhan et al.	2018
[7]	Guth et al.	2018
[8]	Noura et al.	2018
[9]	Maksymyuk et al.	2017
[10]	Safaei et al.	2017
[11]	Sheng et al.	2018
[12]	Wang et al.	2017

With changing requirement trends, traditional service-oriented architecture (SOA) model has many architecture design issue. Traditional SOA–Reference Model does not support multiple protocol request communication. Hence, proposed research focuses on the design of the message scheduling broker for IoT environment with hybrid communication routing protocols considered like one request and it is filtered by broker based on their calculated priority. Additionally, proposed algorithms will use priority queue model which is considered as a reference messaging model. Multiple queues model is developed to increase the efficiency of the algorithm. Such middleware provides a solution for message delay issue with multiple protocol request handling.

**IV. CONCLUSIONS**

This paper focused on existing research challenges and approaches for year 2017 and 2018 with analysis of research papers from various high indexed journals. As an outcome of review, we discussed offline architecture for Industry 4.0 with LDA and SVM algorithm steps. Further, it is necessary to design more efficient hybrid algorithm for IIoT sensor and protocol (CoAP, MQTT, XMPP) communication. Thus, contribution of computer engineering is equally important to build next generation of Industry 4.0. The future development will definitely be a live industrial system with major digitalization and automation.



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