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IoT methodologies: comparative study

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Abstract

The Internet of Things or the Internet of Everything is a new and a potentially disruptive technology paradigm. It describes several technologies such as RFID, short range wireless communications, and research disciplines that can connect physical objects from the real world to the internet. To implement IoT solutions, they exist software development approaches like Scrum and Kanban, also, others are adapted viz; Large-Scale Scrum, Scaled Agile Framework and so on., and many methods have proposed such as Ignite | IoT Methodology and IoT Methodology. Most of them have taken agile thinking as a strategy. However, they are monolithic, which are not easy to adopt. Then, a new method is needed to handle the real nature of IoT, particularity, to handle distributed, mobile and human out-of-the-loop concerns, and that can grow as new product evolve and new problems emerge. This research studies and analyses some of the existing IOT methodologies. Particularly, it focuses on these methodologies Scrum, Kanban, Scaled Agile Framework, Ignite | IoT Methodology and IoT Methodology. Our study evaluates their capabilities and compares their main characteristics and behaviors in terms of various methodologies of IoT. The comparison presented in this paper would benefit in selecting an appropriate methodology for the IoT projects. In addition, it identifies their advantages and limits in order to suggest a new approved IoT methodology.

Keywords: Internet of Things; agile method; IoT methodology

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1. Introduction

The Internet of Things (IoT) or the Internet of Everything considered a new disruptive computing paradigm [1], which describes several technologies (see Fig. 1) such as RFID, short range wireless communications, and research disciplines that can connect physical objects from the real world to the internet [2] [3]. To implement IoT solutions, they exist software development approaches like Scrum and Kanban. They experienced many issues because of IoT projects nature that leads to the appearance of adapted methodologies like Scaled Agile Framework (SAFe). Despite that, the IoT project teams propose their own methodologies according to their surveys and experiences such as Ignite | IoT Methodology and IoT Methodology [4] [5].

Fig. 1. Internet of Things Schematic.

Nevertheless, the last-mentioned methods have taken agile thinking as a strategy or based on best practices, they are also monolithic, which are not easy to adopt. At that point, an adapting methodology is needed to handle the real IoT project nature. Particularity, to handle distributed, mobile and human out-of-the-loop concerns, and that can grow as new product evolve and new problems emerge [4]. To mitigate these drawbacks, OMG proposed a new solution that offers a language to create a new method answering the issue cited [4]. This solution provides a practice architecture where, as shown in Fig. 2, both generic and domain-specific practices described and assembled on top of the Essence kernel.

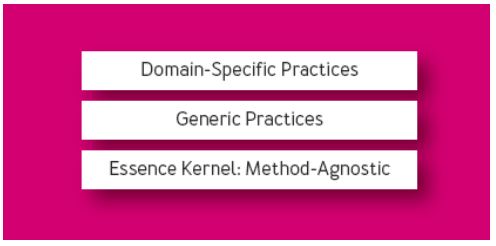

Fig. 2. The essence Practice Architecture [4].

This paper seeks to provide comparative study of five methodologies used in IoT development. To achieve this objective, a set of criteria will be used to shed light on which aspects should be improved to propose a future successful methodology.

The remainder of the paper is organized as follows. Section 2 defines IoT methodologies. Related work of several comparative studies is presented in Section 3. Section 4 defines a set of criteria using in comparative study, and presents this comparison in a table. Finally, Section 5 discuss and concludes our research work.

2. IoT methodologies

Every new project, the project team always needs to follow a methodology that helps them to satisfy the customer and work with peace of mind. So, several methods exist for this mission. This section presents a definition of selected methodologies for IoT domain.

The selection of these methods is based on many previous surveys also on the 13th annual state of Agile report [6] which shows that the Scrum (54%) and Kanban (5%) are the most common agile methods used by organizations, in addition, the SAFe (30%) dominates scaling methodologies. In the other hand, we choose Ignite | IoT Methodology and IoT Methodology because they are the first methods created in IoT organizations specifically for IoT projects.

2.1. Ignite | IoT Methodology (Ignite)

Ignite is an open source methodology based on real-world experience that covering all aspects of IoT developing [4] [5]. It involves two main parts. The first part called "strategy execution", which defined IoT Strategy and prepared organization for IoT adoption, then created and managed a portfolio of IoT Project to support IoT strategy. The second is "solution delivery", which applied plan, build and run IoT solution [5].

2.2. IoT Methodology

IoT Methodology is an iterative methodology inspired by Lean startup and design thinking. Its objective is making the companies and smart cities innovated which aiming to provide a loosely structured ecosystem, and uses several steps for iteration, viz; CoCreate, Ideate, Q&A, IoT OSI, Prototype and Deploy [4] [7] [8].

2.3. Scrum

Scrum approach was influenced by lean development principles applying in Japanese industry. It has been developed as a set of guidelines helping team members understand how to work in order to produce a system in a constantly changing environment flexibly. This approach is simple to implement and works in any domain [9] [10] [11].

2.4. Kanban

The notion of 'Kanban' comes from Japanese which means 'signboard'. It is a method highly flexible that required an explicit definition of process policies. It concentrates on the success of the software product by applying six principles which are Visualized the workflow, Limit Work in Progress, Manage the workflow, Make processes/policies explicit, Implement feedback loops, Improve collaboratively. Like scrum, Kanban is designed to help teams at work together effectively [9] [12] [13].

2.5. Scaled Agile Framework (SAFe)

SAFe comes to solve problems related to the development and delivery of software and systems in the shortest time. It is based on agile development, Systems thinking and Lean product development [14] [15]. It focuses on nine Lean-Agile principles such as Take an Economic View; Apply Systems Thinking; Assume Variability, Preserve Options; Build Incrementally, with Fast Integrated Learning Cycles and so on [14] [16].

3. Related work

As surveys of the previous comparative studies of IoT methods. The main goal of the work done in [17] is an overview of IoT system development methodologies such as Ignite | IoT methodology, IoT methodology, IoT Application Development, and so on., in order to evaluate them from a set of criteria (14 criteria) based on the characteristics of these methods. The work presented by Christof Ebert et al. [18], is a comparative study of five agile

scaling frameworks that appeared to solve all business industry road blocks like telecommunication companies. The selection of these frameworks is based on surveys and what they see in industry usage.

In this paper, we aim to compare five methods, so as to know their characteristics, similarities and difference between them, also, advantages and inconvenient.

4. Comparative Study

4.1. Criteria

Every new project in software company needs a study before starting the development that leads to identify its specific needs, size, complexity and so on. Then, due to these criteria, the team project makes the choice of a management method which provides a work guidance to team members. However, there are several methods sharing the same concepts and values, but each of them has singularities (e.g. process) and it is not useful in all situations.

The great choice of a specific method depends on the understanding of the method, i.e. the understanding of practices, process, roles, and so on. Therefore, for this study, we have determined some criteria that provide a general view of each selected method.

- criteria concerning the information of the creation of the method
  Methodologist: who create this method.
  Organization: where is creating this method.
  Date: creation date of the methodology.
- Approach: is a management strategy which means that the team manages and controls the processes that make up their organizations, also means that they manage these process interactions as a system
- Team size: is the number of members of a development team required for augment workplace productivity of this method.
- Roles and responsibilities: establishing and communicating on “who does what” is a prerequisite for process performance.
- Artifacts: means any kind of information created, produced, modified or used by a man in the development of a computer "system".
- Meeting: allows to pose the foundations and the vision of the project and determines how will unfold addressing all the key aspects and points, hence the importance of succeeding. Also, to see the progress of the project, do the tests and so on.
- Rhythm: allows to bring a regularity benchmark in time.
- Change philosophy: designates that if a method accepts a change in requirements during the project development cycle and when.
- Top priority: Priority is a key attribute of each requirement. The top priority is the requirement which must execute first.
- Hardware: indicates whether the method is used for hardware.
- Software: indicates whether the method is used for software.

4.2. Comparative study

Table 1. Comparative study

	Ignite	IoT Methodology	Scrum	Kanban	SAFe
Methodologist	Bosch software innovations team	Consultancy for Internet of Things team	Kent Scwaber and Jeff Sutherland	David Anderson	Dean Leffingwell
Organization	Bosch software innovations	Consultancy for Internet of Things (C4IOT)	Easel Corporation	Corbis	Rational software/ IBM
Date	2014-2015	2015	1995	2006-2008	2007

	Ignite	IoT Methodology	Scrum	Kanban	SAFe
Approach	No iterative	Iterative	Iterative	Iterative	Iterative
Team size	Large	Large	Small	Project specific (No size limitations)	Large Enterprise includes more than 1 release trains (50 to 124 people in each release trains)
Roles and responsibilities	-	end user designer implementer project manager	Product owner Scrum master Cross-functional Team	No prescribed roles	Epic owner Entreprise
Artifacts	IoT Project Dimensions IoT Architecture Blueprints IoT Technology Profiles	IoT Canvas IoT—Architecture Reference Model	Product Backlog Sprint Backlog Sprint Board Product increment/release	Kanban Board	Lean budgets Portfolio Kanban Board Program Kanban Board Multiple Team Kanban Board Program increments/Releases Improvement Backlog
Meetings	budget planning business planning	kickoff sessions a blend of engineer meetings	Sprint planning Daily Scrum Sprint Review/Demo Sprint retrospective Backlog grooming	Kanban Board update	Program increment planning Program increment / iterations Scrum of scrums System demos Inspect and adopt session
Rhythm	-	-	2-4 weeks	1week	6-12 weeks
Change philosophy	No change	After an iteration	After a sprint	Any time	After an iteration
Top priority	Security in IoT Solution Design phase	Creating a prototype of the solution	Items scheduled for the currents sprint	Items on the Kanban Board	Items scheduled for the currents iteration
Hardware	√	√	-	-	-
Software	√	√	√	√	√

√: Defined. -: Not defined

5. Discussion and conclusion

Today the software world needs a good method that covers all aspects of a project to satisfy the customer. In this case, a global view will give a vital information about the selected methods to the team. In order to know their competitive advantages and choose the method that meets the specific needs of the project.

Several studies show that the scrum method remains the most used despite the evolution of development technologies. Scrum is a method which delivers products in short cycles, enables fast feedback and rapid adaptation to change. However, it is not a complete method, accept no more than one team and not designed to support large, highly distributed projects which span several organizational silos [4] [5]. In the other side, we find that Kanban

delivers the increment earlier than Scrum and accepts the changes any time not like Scrum which accept the changes after a sprint. Also, Kanban looks like Scrum in its process. For these challenges, agile's people develop new methodologies based on existing like Scaled Agile Framework (SAFe) which supports smaller-scale solutions employing 50– 125 practitioners, as well as complex systems that require thousands of people [15]. However, it is considered too heavy and complex [18]. In addition to that, IoT projects break down into two parts, software part and hardware part. However, Scrum and SAFe are for software not for hardware which makes their use in this type of project difficult.

Despite all the efforts to improve the methods for making them applicable to the IoT domain. The IoT project teams did not convince to these exchanges and they propose their own methodologies according to their surveys and experiences such as Ignite | IoT methodologies and IoT methodology. They are the first two methods designed to the IoT domain. Ignite Cover all aspects of IoT project and base on real-world experience. likewise, the strong point of IoT Methodology is the use of an IoT Canvas and an IoT OSI reference. Nevertheless, they are monolithic methods. Ignite is limited on strategy execution and solution delivery. It reuses various existing generic practices, combining these with innovative practices especially for the IoT, in a way that makes the new practices difficult to reuse and share. Moreover, they are not complete method that covers all the important phases necessary for developing IoT systems. To overcome these drawbacks, OMG proposed a new solution that offers a language to create a new method that provides a practice architecture where both generic and domain-specific practices are described and assembled on top of the Essence kernel. But Essence kernel has no explicit notion of architecture as in the simple development, this is left to the teams to define [4].

Therefore, we are planning in our future work to make models of each method by deepening in our study to create a method to adapt to the concept of IoT. Not only to provide for all of today's needs, but also to be prepared for whatever the future may bring.

References

[1] V. Krotov, "The Internet of Things and new business opportunities," Bus. Horiz., vol. 60, no. 6, pp. 831–841, Nov. 2017, doi: 10.1016/j.bushor.2017.07.009.

[2] M. A. Feki, F. Kawsar, M. Boussard, and L. Trappeniers, "The Internet of Things: The Next Technological Revolution," Computer, vol. 46, no. 2, pp. 24–25, Feb. 2013, doi: 10.1109/MC.2013.63.

[3] S. Elhadi, A. Marzak, N. Sael, and S. Merzouk, "Comparative Study of IoT Protocols," SSRN Electron. J., 2018, doi: 10.2139/ssrn.3186315.

[4] I. Jacobson, I. Spence, and P.-W. Ng, "Is There a Single Method for the Internet of Things?," Queue, vol. 15, no. 3, pp. 25–51, 2017, doi: https://doi.org/10.1145/3106637.

[5] D. Slama, F. Puhlmann, J. Morrish, and R. M. Bhatnagar, Eds., Enterprise IoT: Enterprise IoT: strategies and best practices for connected products and services. Beijing Boston Farnham Sebastopol Tokyo: O'Reilly, 2016.

[6] VersionOne and CollabNet, "The 13th annual State of Agile report," 2018. [Online]. Available: stateofagile.com.

[7] T. Collins, "A Methodology for Building the Internet of Things," p. 25.

[8] "IoT Methodology – The Internet of Things project lifecycle guide for creative, technical and business people." http://www.iotmethodology.com/.

[9] S. Merzouk, S. Elhadi, A. Cherkaoui, A. Marzak, and N. Sael, "Agile Software Development: Comparative Study," SSRN Electron. J., 2018, doi: 10.2139/ssrn.3186323.

[10] M. L. DESPA, "Comparative study on software development methodologies," Database Syst. J. BOARD, vol. 5, p. 3, 2014.

[11] J. Sutherland and K. Schwaber, "Nut, Bolts, and Origins of an Agile Framework," p. 224.

[12] H. K. Flora and S. V. Chande, "A Systematic Study on Agile Software Development Methodologies and Practices," IJCSIT, vol. 5, no. 3, pp. 3626–3637, 2014.

[13] D. J. Anderson, Kanban: Successful Evolutionary Change for Your Technology Business, Illustrée. Blue Hole Press, 2010.

[14] R. Knaster, SAFe 4.0 distilled: applying the Scaled Agile Framework for Lean software and systems engineering. Boston, MA: Addison-Wesley, 2017.

[15] "What is SAFe | Scaled Agile." https://www.scaledagile.com/enterprise-solutions/what-is-safe/.

[16] Ivar JACOBSON, "SAFe Principles," Ivar Jacobson International, Jun. 29, 2017. https://www.ivarjacobson.com/publications/blog/safe-principles.

[17] G. Görkem, T. Bedir, and T. Eray, "IoT System Development Methods," in Internet of things challenges, advances, and applications, Chapman & Hall/CRC Press, 2018, pp. 141–159.

[18] C. Ebert and M. Paasivaara, "ScalingAgile," IEEE Softw., vol. 34, no. 06, pp. 98–103, 2017.