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Strategic Software Decisions in the Internet of Things Ecosystem

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***Abstract*— The IoT continuous to restructure scientific, industrial, commercial, and engineering endeavours in impulsive ways. This paper discusses the practice of Agile Method in IoT projects. The agile method and its best practices can be applied involving observing, warning, and prevention. But a need for version control software at the device level, demands a different kind of software design for IoT. It changes the way IoT device development works. This paper highlights the key software design considerations and discusses the key software design decisions made for IoT.**

***Keywords*— IoT, software design decisions for IoT, Internet of Things, agile method, agile IoT, agile, CI/CD, continuous integration, continuous delivery, successful embedded software development.**

I. INTRODUCTION

The applications which are already developed are ready for reusing them in different environment by migrating these applications from windows to web to mobile to cloud. We need to more concentrate on fast and error free deployment too. This is the today's need of mobility with more scalability in applications.

INTERNET OF THINGS (IOT)

The Internet of Things is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment [6]. The IoT includes extending internet connectivity above standard devices to any range of usually dumb or non-internet-enabled physical.According to Gartner [19], Gartner expects there to be 20 billion internet-connected things by 2020 and 100 billion by 2030.

Technology will be embedded in everything in the digital business of the future. In the IoT paradigm, most of the objects that are around us will be connected to the network in one or another form. The basic concept is the pervasive presence of a variety of things or objects such as Radio Frequency IDentification (RFID) tags, sensors, actuators, mobile phones, among others which through unique addressing schemes, are able to interact with each other and cooperate with their neighbours to reach common goals [20]. With IoT, the services we can exploit, production, medical, agriculture, and other arenas in a way that could have been fantasy a century ago.

Agile

Agile is a time boxed, iterative approach to software development that builds software incrementally from the start of a project instead of trying to deliver it all at once near the end [7].

Most agile development methods have trend to breakdown product development work into small increments. This minimizes the amount of up-front planning and design. Iterations, or sprints, are short time frames that typically last from one to four weeks. At every iteration a working product should be delivered [7].

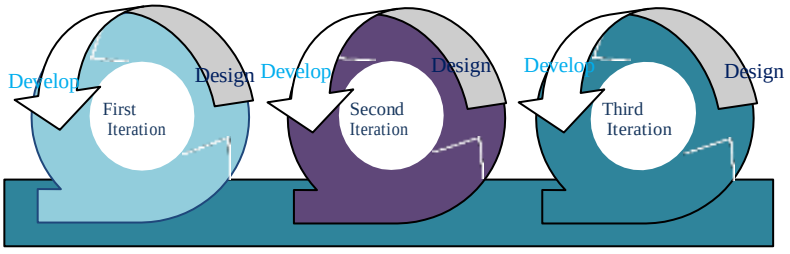

Fig. 1 Agile methodology

II. AGILE AND INTERNET OF THINGS

The practice of IoT in numerous diversities of processes such as manufacturing, medical, agriculture requires a streamlined framework. IoT significance to agile is in three prime areas as frequent updates, administration and responsiveness to the changing requirements. Consumers are demanding more customized products as a result of growing needs. Industries continue to renovate on ways to deliver these customized products quicker to customers. It must be more cost- efficient method that should maximize investors' benefits but deliver value all the same.

Managing the development of real-time embedded system for interdisciplinary project with Scrum and its best practices has provided quick, efficient, and continuous results [1]. High performance and high availability systems can be developed using Agile; even it can be used effectively in the systems which work with geographically dispersed teams [2].

With more and more devices being connected to the internet administration for both software and hardware is become more relevant. That supposed an incremental or iterative approach towards deliver would be more sensible [16]

III ONE STEP AHEAD OF AGILE

In contexts of Internet of Things (IoT), the core part of software is aiming at creating the infrastructure and middleware layers to enable execution of services, storage, transfer and transformation of information, and integration with other systems [22]. End-user applications can aim on offering data and services to the users. Such core infrastructural software must offer surety in terms of Quality of Service and accuracy. Moreover, it has to deal with the resources it is exploiting as well as the other software and devices it is interacting with, may change for many reasons, like letdowns, changing interfaces and implementations, changing requirements, etc. [22]

Software is one of the driving forces behind the IoT paradigms. Their further evolution is deeply linked to the capability of software to be adaptable to real time changes. The needs brought by IoT for innovative methods of software Scalability, Adaptability and Maintainability, which are not visualized at design time. In Agile methodology, focus is on faster development to cope up the fast requirement changes. In a IoT applications, Faster development as per faster requirement change is a need. This is more effective if operations could also be agile. So, future technology such as Devops implementing CI/CD can be the solutions for this fast and agile development as well as faster operations need. –The agile movement is in some ways a bit like a teenager: very self-conscious, checking constantly its appearance in a mirror, accepting few criticisms, only interested in being with its peers, rejecting en bloc all wisdom from the past, just because it is from the past, adopting fads and new jargon, at times cocky and arrogant. But I have no doubts that it will mature further, become more open to the outside world, more reflective, and therefore, more effective.‖ — *Philippe Kruchten* [21]

CI/CD: CI is a one of software engineering technique. Its' objective is integrating software continuously by automating integration process [55]. Developing an IoT system needs a holistic approach that mixes traditional data collection from cloud backend, along with data collected straight from embedded mobile or devices. Supporting this heterogeneous environment can prove challenging and lead to complex systems that are difficult to develop and deploy in a timely fashion [24]. The set of CI/CD (Continuous Integration and Continuous Development) tools and services have given solution to the IoT challenges which can be part of DevOps. The term DevOps, coined in 2009, is a concatenation of Development and Operations [25]. Development and Operations (DevOps) is an emerging Software industry movement to bridge the gap between software development and operations teams. DevOps supports frequently and reliably releasing new features and products– thus subsuming Continuous Deployment (CD) practice.

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CD practice is aimed at deploying frequently software or new changes into production environments by providing as much automation support as possible [23]. Continuous Integration and Continuous Development is suitable for IoT as it can satisfy the need of changing software for many reasons, like failures, changing interfaces and changing requirements. Culture isthe DevOps principle that has the greatest impact on specification. This principle embraces the standards, values, and ways of working that are manifested in collaboration, shared responsibility, and autonomous teams [25].

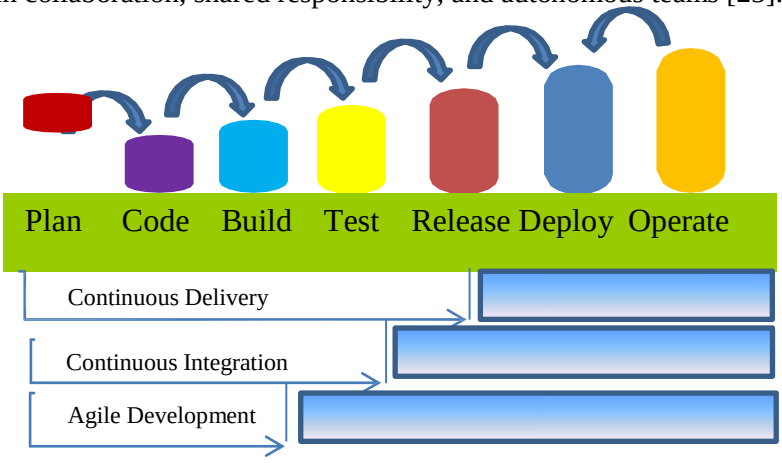

Fig. 2 CI/CD [Continuous Integration and Continuous Development]

IV. RELATED WORK

Lai and Leu [56] introduce web applications continuous integration procedure (WACIP). WACIP handles fundamental software engineering issues likes' test-driven development (TDD). They emphasize on web application should overcome environmental change quickly, and CI can alleviate development risks.

Seth and Khare [57] discuss about Jenkins Master-Slave architecture and CI in multiple platforms, such as mixed environment consisted with Windows 8, Ubuntu, Fedora, etc. They also explain their proposed CI to supporting developing software for android mobile environment.

Mitesh Soni [58] introduces DevOps culture and CI. Soni emphasizes that insurance industry need to respond dynamic market requirements rapidly. To accomplish it, Soni introduces DevOps culture, CI and Cloud Computing. Practices of continuous delivery are mostly proven to have positive impact on the quality of the system, stability of the deployments, feedback frequency and readiness to act if requirement for changes arise [59]. Continuous delivery and continuous deployment will begin to dominate over sporadic non-automated delivery of software [30].Automation is possible and exploited in all the activities and processes related to building, deploying, and operating software systems [35].

IV. CONCLUSIONS

IoT is a challenge for known business models. But alignment of a framework that applies appropriate value stream to processes such as agile increases competitive advantage. Sustainability of continuous improvement is fundamental input required to scale through competition. But need for version control software at the device level— at the firmware, demands different kind of software design for IoT. It changes the way IoT device development works. There was a need for products with new features. The set of CI/CD [Continuous Integration and Continuous Development] tools and services have given solution to the IoT challenges.

V. FUTURE WORKS

Future work can be to check with software design decision impact for different IoT projects in different domains where operating scenario is very diverse.

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