Testing Techniques for Internet of Things Applications

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ABSTRACT

The Internet of things goals towards conversion of numerous features of public's day-to-day survives by spreading the possibility of figuring to the physical world, after this shifting the surroundings of figuring additional to a dispersed and reorganized form. The Internet of things is a scheme which is unified with work out objective procedures. It is one of the numerical mechanisms which attach to a piece other and allows interchange and evaluate the statistics above a connection. The constituents of Internet of things scheme is measuring device that is sensor etc. In an internet of things, huge contact and business will be attractive habitation, and it also supply reckless and better assists connected to other structures. The extent of strategies and their collective behaviour reasons novel tests to increase the outmoded software challenging. After constructing the arrangement, the main task is to test the system. The objective of analysis is to afford healthier vision and mechanism interrelated to numerous strategies.

Keywords: Testing methods, IoT Challenges, Usability, Reliability, IoT applications.

1. OVERVIEW

IOT is a thriving statistics expertise productiveness. IOT strategies and arrangements will rise every month in order to support all feature of us who survives from their home-grown, fitness, shipping, and also in spending. Unlike businesses are also taking on the equipment in order to make the goods and facilities healthier and their distribution, earlier. Once the product that is IOT equipment is built, it is much required that it has to

be checked and structures are to be verified before it is given to the consumers.

Not only for IOT devices, for all the applications once it is built, directly it should be not deliverto the customer. Certain tests have to be done before deploying it. So, which type of testing techniques should be used plays an important role. Because the system should be tested in sucha way that it should satisfy the customer needs and beyond that also. So testing plays very important role in order to reduce the error of the device which is built.

First and foremost, the built IOT equipment functionality should be tested and verified. Secondmost is, it should be verified to follow the many ethics. Third one is, the built IOT device enactment must be verified as soon as possible. And last is, it should be verified and validatedfor safety and confidentiality.

All this should be done before giving built IOT product to the consumer in order to make surethat the IOT equipment built is of good quality. All this is happening in the recent testing activities. But they fail in the testing methods they are using. Proper testing methods should beused so that error should be known from that testing methods and it should be resolved in all aspects.

But as the day's pass, the product built will not be small or easy to test. There is chance that the IOT equipment built may be bulky and it can be very difficult to be tested. So this will be interesting in order to provide quality guarantee.

Outmoded analysis approaches either work or do not work or it does not have capacity to test the built IOT device. So the new testing methods should be given and also some of the existingtesting methods should be used because most of the methods are not used to test the IOT systems which is important. So the product should be tested properly and assure the quality toconsumers.

2.   SCOPE

Testing the IOT devices has lots of scope because the IOT device which is built will not directlypassed to the consumer. The IOT device has to be tested and validated properly so that it shouldbe assured with quality and then deployed to the consumer. But it is not easy as it sounds, thereis lots of challenges in testing IOT devices which has to be overcome. So lots of research going in this area about the methods used to test the IOT device

significantly and assure the quality to the consumer.

3.   OBJECTIVES

The main objective is to discuss the testing methods used to test the IOT applications and devices and why different testing has to be carried out before deploying the IOT applications to the consumers. And the challenges that occur while testing the IOTdevices are also discussed. Because to test any device the first thing is to maintain suitable surroundings and then testing should be carried out. And discuss some of the new testing methods which support the existing testing methods.

4. RELATED WORK

In this paper, author mainly discussed about the requirements necessary for security purposes and how to secure the IOT applications [1] which is built, also discussed challenges that may occur during testing, how to overcome that challenges and tools, techniques used to test the IOT applications.

In this paper, author discuss on testing techniques used to test the IOT applications. Here author introduced testing IOT as Service-Iot-TaaS [2]. It is one of the service based method. It is mainly used for automated testing framework. It is used to solve the constraints regarding testing IOT applications. And mainly author discussed about some of the testing techniques that can be used to test the IoT applications.

In this paper, author mainly discussed about the structures of devices used for testing and also Iot applications. In order to do this one of the Iot architecture [3] is considered. Requirements are given which includes the information about the planning and organising steps. And also discussed the challenges that may occur during testing process.

In this paper, author mainly discussed about some of the testing tools used to test the Iot applications. Mainly author discussed on compatibility testing tool. Because as we know if any software is built devices used in that should be compatible with other devices used to build the applications. The tool discussed here is ICAT [4], it is one of the compatible testing tool.

In this paper, author mainly discussed about the causes that may occur after building Iot applications and use them. Like how that application is vulnerable to certain things after it is being used. So here before delivering Iot application to the customer, testing has to be done properly. As all the devices are connected through internet, there may be attacks from the third party. In order to avoid this some measures have been discussed so that applications can be secured. The testing concept used to check the vulnerabilities is penetration testing [5].

In this paper, author mainly discussed about the Iot applications, how the concept of Iot araised etc. And also said that Iot systems araised due to large amount of data that has been coming from different sources. Mainly sources can be network devices [6] connected to internet. Due to this some security challenges may occur. In order to overcome this author told that cutting edge technologies and some tools plays very important role.

In this paper, author mainly discussed about challenges that may occur while testing applications of Iot and how to solve that problems. And also discussed some of the techniquesused to test the applications of Iot, tools and frameworks which supports that process is also discussed. Mainly in this author focused on challenges that may occur and tools, frameworks like Record and play tools [7] etc. are discussed.

In this paper, author discussed about performance testing [8]. Performance testing is the type of testing which plays important role in testing the Iot applications. Because it mainly tests the applications performance in a way that applications should able to perform well in all the situations. If lots of loads occur at the same time, then application built should be able to handlethe multiple loads. There should be no crash in the applications due to multiple loads at the same time.

In this paper, author mainly discussed about how Iot platform is growing higher and higher nowadays [9]. There is lot of scope towards Iot applications. Discussed some of the research reports of Iot industry of different countries. And also discussed about the areas where Iot applications plays very important role like in health care industry, agriculture etc. And also discussed about the key components required to build Iot system.

In this paper, author mainly discussed about the challenges in testing and highlighted the challenges that occur frequently during the testing process. Also discussed the vision of testingthe applications because at the end testing is done in order to know whether the built application is working properly according to the user requirements and beyond to that also. This is called as measuring quality of the applications. Also discussed about interoperability effect in Iot [10].

In this paper, author mainly discussed about how evolution of computer took place. Due to this fundamental shifts [11] was caused and interactions with computers was started. At the same time rise of internet took place. So due to revolution of both computer and internet give rise to mobile apps and Internet of things came into existence. Also discussed about the internet of things and impact of that on testing.

In this paper, author discussed about Iot applications like how applications is built using the devices which is necessary. And also discussed about the framework which is used for testingIot devices or systems through heterogeneous edge [12] and also some of the test beds. Mainlyauthor presents hector which provides automatic testing technique which is used to test the Iot applications.

In this paper, author discussed about the tool which plays very important role in testing. The tool that was proposed was TITAN [13] which is used to test the iot applications efficiently. And also discussed the architecture of the tool used for testing. Some details also provided like how to complete and prove the applications of Iot.

In this paper, author discussed about the test patterns [14] used while testing Iot applications. And author formalizes the idea of the patterns used. Here pattern means in which way or in which order testing process should take place so that iot applications meet all the requirements. Mainly discussed about the strategies used to test applications and to examine the behavior of applications in different situations.

In this paper, author mainly discussed about how to carry out the software testing in Iot applications. Testing is the final process which is done. In this paper author discussed about acceptance of software testing in Iot applications [15]. This includes some of the steps like software and requires engineering concept, creation of the software, then software is verified and then validated whether output obtained is same as required output, then examination of faults is prepared and lastly testing takes place.

In this paper, author mainly spoke about testing the Iot applications. For what purpose application has to be tested is discussed [16]. What is the use of testing iot applications is also discussed. Testing process is carried out to know how the built application works, whether the output is according to the user expectation etc. Mainly testing is done in order to predict the performance of all types of applications.

In this paper, author mainly discussed about the requirements that are needed for testing and what are the recommendations required for the iot models which will be built or for the built model so that the model can assure that security threat can be overcome. So that threat modelling, analysis of security and one important testing is done that is penetration testing [17].

In this paper, author mainly discussed about the block chain, how it plays a very important role in iot applications. Here firstly author spoke about testing the iot applications and later discussed about how block chain [18] technology used in the iot applications. The iot applications built faces issue in terms of security and scalability. So while testing all these aspects has to be considered. So here block chain technology plays important role.

In this paper, author discussed about planned challenging outline which is useful in nonstop mixing methods, this outline may help in collaboration of scheme [19]. In count of this, author

also deliberated experiments of challenging of exposed software systems of the Iot applications.

In this paper, author mainly discussed about method used for one of the testing called acceptance testing [20]. Interactions between the user and system can be done using smart phones. This test is mainly based on the black box testing where mobile health functionality ischecked.

5.　　CASE STUDY

As we know case study is nothing but research which is done on certain things. In this paper, mainly we talk about testing iot applications. So deep research is done on testing techniques used for testing iot applications, challenges that may occur, how to overcome that challenges etc.

So that proper testing should be done which should identify the fault or error if any and solve that problems. So here I will consider one of the case study to explain how testing techniques used to test the built iot application.

Let us consider a company A which delivers their explanations to any of the healthiness facility either with "on sites" method or cloud-founded method as some of the model like pay-per-patient model so that they allow all wage-earners to deliver their facilities fully numerical, smooth, and paperless with less amount of investing money.

In order to test such application or architecture certain testing has to be done. So firstly we should think about the testing methods that we have to use in order test the iot applications built.

• 　　Initially Usability testing has to be carried out. Here usability testing ensures that howthe built application is used and it can have used in different ways. The applications which is built should not restrict to only one functions. It should be used in different ways also.

• 　　As per considered application, this should not only give notifications about the servicesthey provide but also it should provide error message, warnings also. If any events occur, all this events should be placed in one log or should create database in order to store in that. So that it can be used in the future.

• 　　Here Usability means which says how application display the things, how processes thedata and events that may occur should be tested properly. Here storing patient

information plays important role. So proper identification of patient has to be done and store appropriate information about the patients.

• 　　　Next we will do security testing. According to the example that we took, authentication plays very important role. Type of authentication that is important in this case is Role based. Access should be given only to the patients in order to view the details of patient. If details have to be shown to others also, authentication should be done by the patient only. All this will be tested using security testing technique.

• 　　　After security testing, connectivity testing is done. This plays important role because Iot is nothing but devices connected through internet. So checking connectivity between the devices is done. Transfer and receive of data should be smooth. There should be no complexity. Sometimes there may be loss of network. So application should be tested in offline conditions also.

• 　　　There should be alert signal when the system is offline so that manually the work could be done. And also data should be stored in offline also. When system comes online there should be no data loss. Data has to be propagated. There may be two types of failure. One is failure of system. It should be handled with extra servers and other requirements. And if there is slow internet connection also, the data should be handled.

• 　　　Next regulatory testing is done. Solution obtained should be in terms of standards of health care only. Applied for both, data from patient to devices and from devices to system which is known as central.

• 　　　Then finally, other tests can be conducted like saving date and time for every records, there should be graph maintained, system should be able to monitor some of the variations in patient's health etc.

• 　　　All these testing has to be carried out before delivering application to the particular customer so that application built should fulfil customer needs beyond the expectation. Now the architecture of considered case study is shown below in Figure1. This figure shows the architecture of considered company A. The architecture gives solution to certain questions that may rise. This architecture mainly consists of cloud from which data is retrieved and data is stored.

• 　　　Fig:1 consists of cloud through which data is retrieved and stored by most of the devices or we can say systems. The architecture which is built provides solution to the hospitals, clinics, health care industry, takes information of people in rural area and try to give solutions in remote places.

- Below is the figure which shows the architecture of Company A which gives solutionto all types of health care sector.
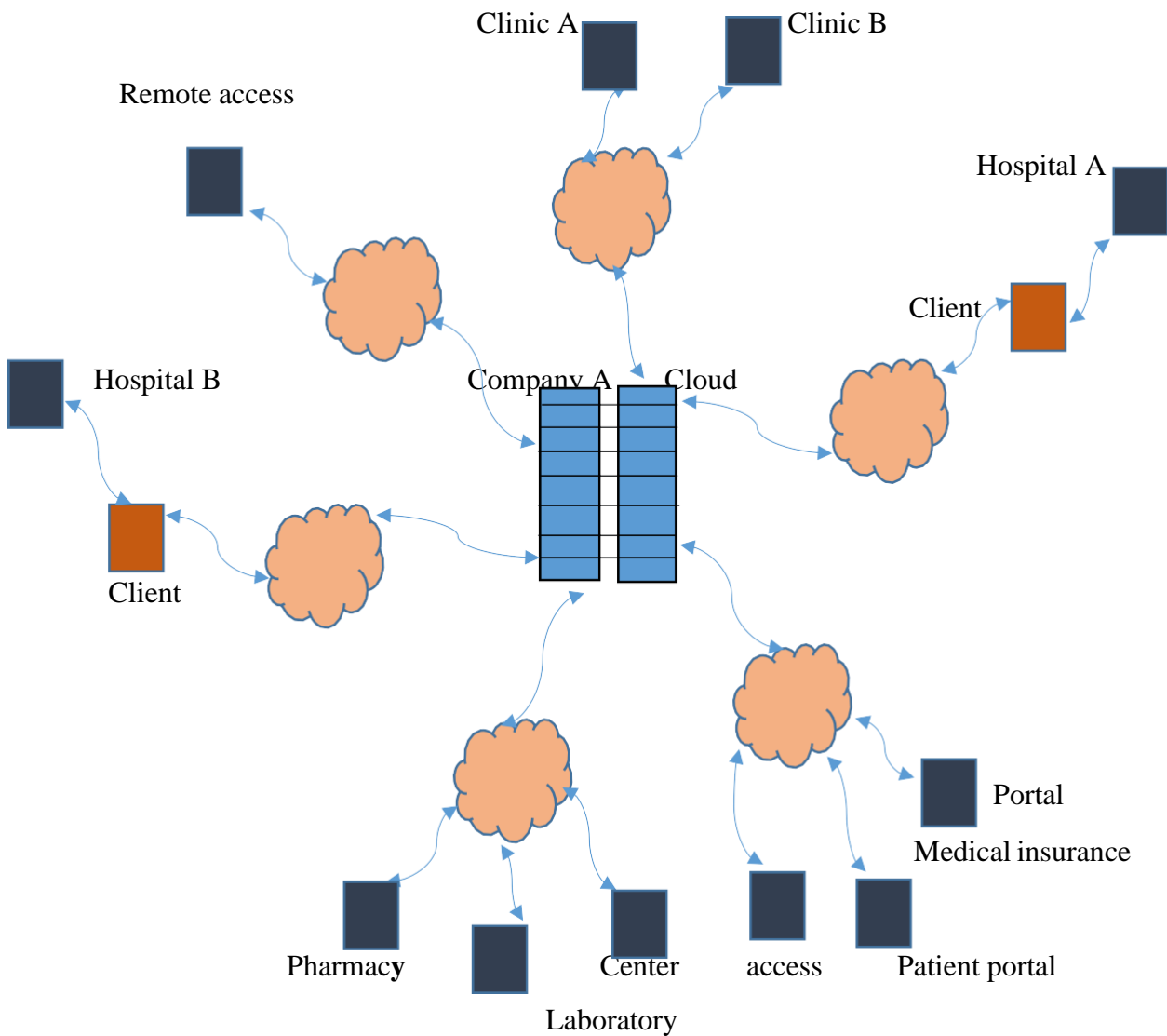
Fig: 1 Solution of Company A architecture

This is the case study which is considered to explain how the iot applications are tested and what does it accepts. So that deep explanation about how testing is carried out and what are the testing methods used for testing such architecture is done.
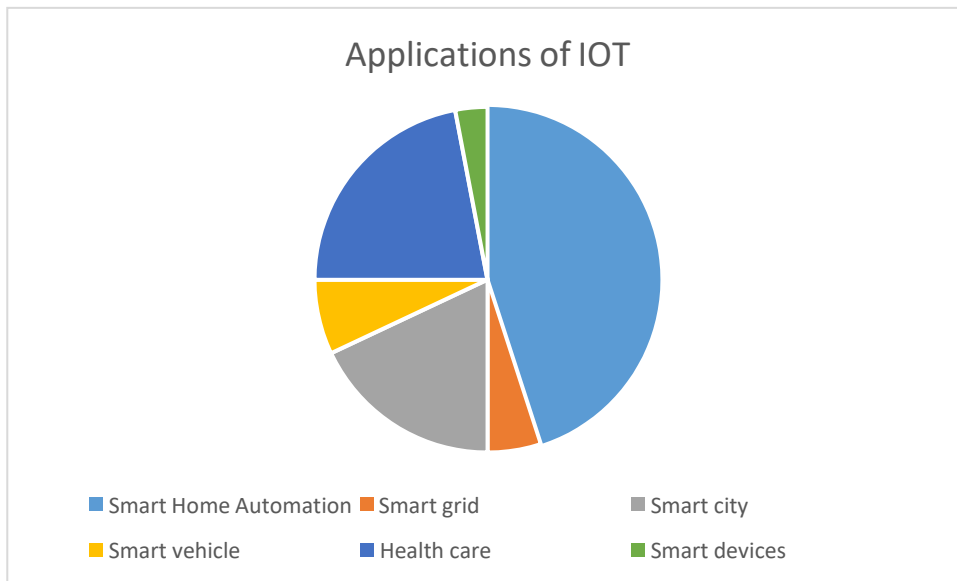
Fig: 2 Pie chart showing amount of Iot applications built

Numerical graph or we can say pie chart which shows some of the concepts which has been available for iot presentations shown in Fig: 2. From the graph we came to know that smart home automation is higher compared to other concepts.

There are some of the equations which is used to calculate the faults/ error while testing all the types of applications. Mainly we can calculate density of faults/error present as shown in equation one. Here deficiency is nothing but defect.

Density of the deficiency= count of deficiency/ LOC -- (1)

This can be illustrated by giving some values to count of deficiency and lines of code, so that we can calculate density of deficiency by using equation (1).

Density of the deficiency= 40/ 3000

$$= 13.33 \text{deficiency/Kloc}$$

6.   ADVANTAGES AND DISADVANTAGES

Testing plays a very important role in developing any software. Before deploying built IOT system to the consumer the system has to be tested properly with suitable test methods. In this paper, some testing methods used to test the IOT applications so that if any faults occur while testing it can be changed. But the main challenge is finding the bug in the build system. So

proper testing methods should be used in order to find out the error. By testing the system that is used in this paper, some problems can be solved and can assure quality for that applications. The main advantage by testing is that the user will be satisfied with the application that is built when it is tested in all types and it is user friendly. So the error is reduced and gives the output according to the user concerned.

Some of the testing methods are used to test the IOT applications but by only these methods, cannot assure hundred percent of quality assurance. Still some of the methods should be used and discussed in order to provide full quality assurance. Should work on some of the challenges regarding testing IOT devices and come up with new methods to test the system.

7.   APPLICATIONS

There are lots of applications of IOT. It's been using in our day to day life. Now the name says internet world. Some of the examples used in our daily life are IOT concept used in wearable devices like fit bit band, apple watches etc. which can be connected to mobile. From this we can get to know about health, sleeping activities, heart beat rate, steps that we walked etc. Lots of applications used in health care industry in order to monitor the health. IOT devices used in order to monitor street lights. As lots of IOT applications used in day to day life, before deploying any devices to the consumers it has to be tested properly by using some of the testing methods. So testing plays a very important role in IOT devices and security has to be maintained as internet is used and also data flow takes place between the devices so that confidential data should be secured from third party and also quality assurance should be given.

8.   INFERENCE AND UPCOMING WORK

In this paper, mainly discussed different techniques used to test the iot applications. Some of the testing methods considered to test applications are- Usability testing, Regulatory testing, Security testing etc. Discussed about the challenges that may arise while testing the iot applications, also discussed about the tools used for testing. Then in order to understand better about how testing process takes place, what are the testing methods used for testing and how it is done using one of the case study of iot applications.

In the upcoming work, should research on different techniques of testing that can be used to test the iot applications which can test the applications effectively. And there should be some solutions to overcome the challenges that may occur while testing the iot applications. So, solutions have to be find in the upcoming work. New testing methods has to be involved during

testing in the future testing process, so that there should be no fault in the output. Applications should pass all the testing techniques and should be user specific and also beyond their expectation and should be error free applications.

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