Managing Associated Risks in Cloud Computer Applications

Boukari Souley & Ajus M. Umara
Mathematical Sciences Programme
Abubakar Tafawa Balewa University(ATBU), Bauchi, Nigeria
bsouley2001@yahoo.com +2348069667696 **+2348036343308**

Abstract

Cloud Computing, the long-held dream of computing as a utility, has the potential to transform a large part of the IT industry, making software even more attractive as a service and shaping the way IT hardware is designed and purchased. Developers with innovative ideas for new Internet services no longer require the large capital outlays in hardware to deploy their service or the human expense to operate it. This paper focuses on an overview of cloud computing as a technology and has chosen the party agent reports of an electoral process as a case study. The case study was used to develop an application which was tested and deployed on a local computer and subsequently deployed on the cloud infrastructure. Java programming language and Google App engine were the tools used to develop and deploy the application. The work demonstrates the benefits of deploying applications using the cloud service over on-premise deployment especially where real time data is needed like reporting incidents during elections.

Keywords: Google App Engine, Java Programming Language, cloud infrastructure

Introduction

Business applications are moving to the cloud. It is not just a trend - the shift from traditional software models to the Internet has steadily gained momentum over the last ten years. Looking ahead, the next decade of cloud computing promises new ways to collaborate everywhere even through mobile devices [14]. It is not just because it provides cheaper means of running applications in terms of purchasing software licenses, upgrades are automatic, and the fact that scaling up or down is easy that cloud computing is being adopted, but also because the architecture of the cloud technology itself allows redundancy of data by constant backing up of all its clients data. Managing data therefore becomes an easier task for risk managers using cloud computing because it reduces the cost of doing such locally, allows IT personnel to focus on more productive engagements and assures reliability.

Cloud computing is a category of computing solutions in which a technology and or service lets users access computing resources on demand, as needed, whether the resources are physical or virtual, dedicated, or shared, and no matter how they are accessed (via a direct connection, LAN, WAN, or the Internet). The cloud is often characterized by self-service interfaces that let customers acquire resources when needed as long as needed [9].

Businesses have failed in the past and not because they are bankrupt or do not have customers but because their data have been tampered with. It is not news that data moves practically all businesses especially in the IT world. It is considered a valuable asset that cannot be replaced by an insurance company.

Cloud computing is here and from all indications it has come to stay, the only thing we need to do is to make more effort in making people go into it with the "want' attitude and embrace it altogether than with the "follow the people" attitude.

Goals:

- To identify the risks that cloud computing poses to consumers via cloud use.
- Identify some risks management strategies on how consumers can help mitigate the risks from their own end.
- Develop and deploy an application in the cloud to demonstrate some of the risks mitigation strategies mentioned above.
- Compare the difference in benefit of using the cloud service as opposed to traditional on-premise deployment.

Related Works

Cloud Technology

Cloud computing is a notion that is having its day, for good reason; technology is ripe, the economics are compelling, and there is tremendous legitimate need. Using the cloud metaphor, data has to get from its owner or originator to the cloud where it is processed and back to the owner, hopefully without compromise or damage. Going back to the basics for a moment, data exists in three states, processing, storage, and transmission. It is vulnerable to a number of threats in each state. Various measures are applied to deter the threats or isolate the data from the threat, basic risk management, if the measures are not applied continuously, the threat remains. Protecting data against damage during transmission is based on encryption for confidentiality and various measures for integrity. Getting the data from the owner to the cloud and back is, therefore, a straightforward problem solved by encryption, the question arises when the data is in the cloud. Storing encrypted data is not a problem. Assuming the data is stored encrypted. It is when the data is decrypted for processing that issues may arise.

What happens to the data during processing is often dictated by the application manipulating the data, intermediate storage is not unusual and a variety of approaches to segmented and distributed processing exist. Prudent questions should be asked regarding what happens to the data whenever it is not protected by encryption. The more sensitive and valuable the data is, the sharper the questions should be. A risk assessment should address all the availability and integrity issues. Redundant communications and processing are standard approaches to many of the issues, although simple cut cable outages due to human error occur often enough to give pause.

So far, the potential damage that a trusted cloud insider could inflict has not been addressed, there is often an assumption that cloud vendor security is bulletproof, which may be naive. Customers should not assume vendors have robust and durable security throughout their computing architecture. Asking questions is never inappropriate. Becoming familiar and comfortable with the vendor's protection is just good sense.

Cloud computing is a great leap forward for many, however, assuming there are no risks is extremely naive. Learning about the risks to assets when they are outside the owners' direct control and how those risks can be minimized is more than just a good idea **[2].**

Cloud Computing System

In a cloud computing system, there's a significant workload shift. Local computers no longer have to do all the heavy lifting when it comes to running applications. The network of computers that make up the cloud handles them instead. Hardware and software demands on the user's side decrease. The only thing the user's computer needs to be able to run is the cloud computing system's interface software, which can be as simple as a Web browser, and the cloud's network takes care of the rest. Cloud computing is defined as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction[12]

Cloud computing frees organizations from the need to buy and maintain their own hardware and software infrastructure. There are two key business drivers to consider in relation to cloud computing: (a) economics, and (b) simplification of software delivery [4]. Cloud computing offers additional technical benefits including high availability and easy scalability, providing faster, more direct access to IT resources.

With respect to privacy, there is the possibility that cloud computing may lead to commingling of information assets with other cloud customers, including competitor [7].

With respect to security it was observed that data and code residing in cloud computing environments will become more tempting targets to hackers. With respect to reliability, few non-cloud IT infrastructures are as robust as cloud computing service offerings, but

organizations are still concerned about availability [1].

Cloud Computing Models

Applications of cloud computing broadly span three areas known as cloud service delivery models called (a) *Infrastructure as a Service* (IaaS), (b) *Platform as a Service (PaaS)* and (c) *Software as a Service (SaaS)* [3]

Based on a survey carried out, there are key differences in the services provided in the private and public clouds. Public clouds are dominated by Software as a Service (SaaS) followed by infrastructure as a service (IaaS). Private clouds are dominated by IaaS followed by platform as a service (PaaS) [8].

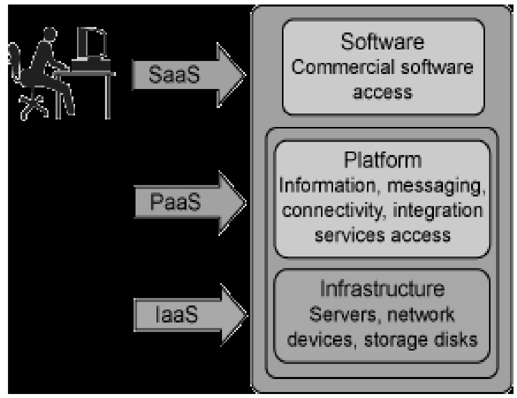

Fig. 1 Cloud computing layers embedded in the "as a Service" components [5]

While the services are directly related, they don't require interdependence (e.g., a Cloud Application does not necessarily have to be built upon a Cloud Platform or Cloud Infrastructure).

In [11], it was proposed that cloud trends to become more entwined over time. But Cloud solutions – at any of the three levels described above -– are attractive for just about any company with an application that runs in a data center or with a hosted provider, that doesn't want to reinvent the wheel or pay a premium [13].

Cloud Computing Architecture

The Cloud Computing Architecture of a cloud solution is the structure of the system, which comprises on-premise and cloud resources, services, middleware, and software components, geo-location, the externally visible properties of those, and the relationships between them [6].

When talking about a cloud computing system, it's helpful to divide it into two components namely: the front end and the back end. They connect to each other through a network, usually the internet. The front end is the side the computer user, or client, sees. The back end is the "cloud" component of the system. The front end includes the client's computer (or computer network) and the application required to access the cloud computing system. Not all cloud computing systems have the same user interface. Services like Web-based e-mail programs leverage existing Web browsers like Internet Explorer or Firefox. Other systems have unique applications that provide network access to clients.

On the back end of the system are the various computers, servers and data storage systems that create the "cloud" of computing services. In theory, a cloud computing system could include practically any computer program you can imagine, from data processing [5] to video games. Usually, each application will have its own dedicated server. A central server administers the system, monitoring traffic and client demands to ensure everything runs smoothly. It follows a set of rules called protocols and uses a special kind of software called middleware that allows networked computers to communicate with each other[10].

Methodology

System Analysis

The risks of the cloud to some, outweigh the benefits, others on the hand, see the prospects in it, and have adopted it as a means of doing business. Though these companies have their reservations, cloud computing happens as a result of trust between customers and service providers. The cloud needs the trust of users. With any cloud computing service, it is important that the provider has a trusted relationship with those people using the service. Current cloud computing architectures have security measures in place to ensure data integrity and confidentiality both while data is at rest and in transit as pointed out, that companies supplying cloud computing services know that the main concerns of moving to the cloud are security and privacy and understand that without reliable security, their businesses will collapse; So security and privacy are high priorities for all cloud computing entities [5]. While cloud providers shun away from responsibility for data stored on the cloud, organizations can also at their own end make efforts to minimize the risks by adopting both technical and non technical approaches.

Use case

During election periods in Nigeria, different political parties have agents that represent them at each polling station in order to ensure that each candidate/political party is treated equally and to report any act of misconduct to the appropriate authorities. The agent(s) must be present from the start of election process till every step is completed by all participants and results are obtained. A report, either verbal or written is then prepared by the agent on how things went on at his polling unit and submitted to the party office at the end of each Election Day. Any action to be taken based on the report will have to be against the next Election Day or never if it is the last. A report may be used afterwards if the political party has any case against either the electoral body or another political party. This process requires agents equivalent to the number of polling units that a political party is featuring in. Due to a lack of sufficient agents, some polling units are left unattended or have agents running around observing different polling units. The process is demonstrated in the use case model below:

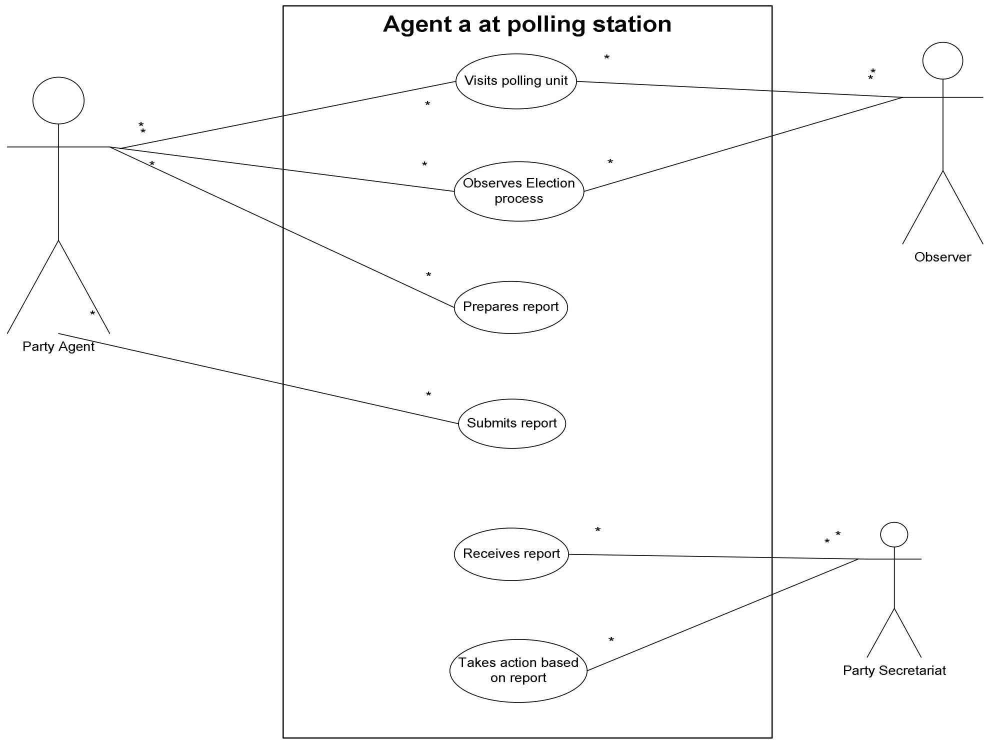

Fig. 2 Use case model for the Current Process

Problems of the Current Process

From the process described above, it can be deducted that there are flaws in the reporting system. These include:

- Lack of sufficient agents to report happenings.
- Happenings are not reported as they occur but after.
- All actions taken involve damage control not prevention.
- Agents handling more than one polling station can miss events while on transit.

The Proposed System

Based on the problems pointed out from the current system, a new system is being proposed to create a reporting system that will be available and provide real time reports of happenings at polling units and enable other individuals not necessarily agents to make their contributions on happenings at the units. The proposed system will have a more standard form of report in graphical form depending on the activity going on. The system has the following requirements:

Functional Requirements

- The system should be able to allow a reporter to enter the name of the polling unit which he is observing.
- The system should allow a reporter to enter the street where the polling station is located.
- The system should allow a reporter to enter the city he is reporting from.
- The system should allow a reporter to select the state where the city is located.
- The system should allow a reporter to select the type of the event happening in his polling unit.
- The system should allow a reporter to provide extra information about the event.
- The system should be able to accept the inputs provided and display a graphical report
based on the address provided.

- The system should enable a category of event to be selected for viewing.
- The system should be able to display all the locations where the selected event has occurred on the map.

Non-Functional Requirements

- The system should be user friendly.
- The system should be available at all times.
- The system should be accessible from different locations using different means.
- The system should enable a prompt viewing of reports
- The system should be accessible to multiple users in different locations and should be able to control excessive use of the system.

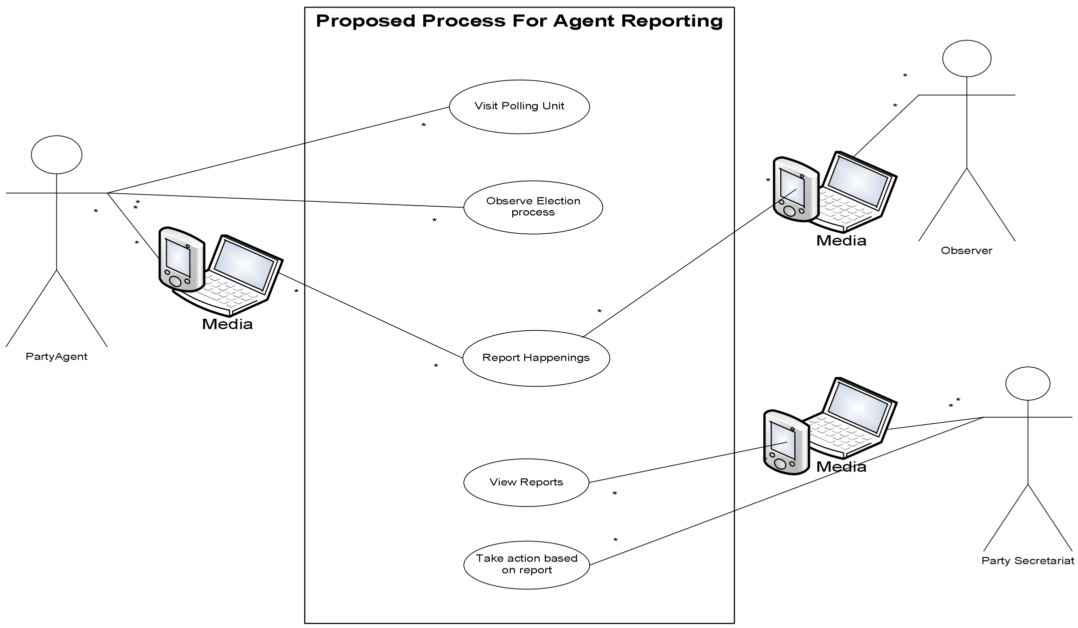

Fig. 3 Use case model for the proposed process

System Design

The system to be designed will involve building a computer application that will be used to report incidents and will be available to voters as well as other voluntary observers. Considering the requirements, it will not be sufficient to design a desktop application because then the agents will have to report any event on the system and then generate a report to convey physically to the party secretariat. This means that the application will have to be deployed on dedicated computer that will be available to the agent provided by the party the agent is representing. Moreover, the report uses a map to determine the location of the reporter in real time. If it were a desktop application, it would have to retrieve this information from a satellite map which will require internet connectivity. Still, the report will have to be delivered manually not to mention the report may be influenced. If a web application is to be considered, the application has to be built and then a hosting service acquired which promises availability all the time, of course web implies internet will be required to use the application. The application will still need to use the satellite map for the reports which will be an extension of the system though it will allow more than the agent to send in reports. At the same time some users may get excited and keep using the system unnecessarily creating traffic that can make the system inaccessible and the host cannot do anything about it. So rather than building a web application and then relying on the services of another application for the reports, why not going ahead and using a platform that will allow you to build, host and use the services available on the infrastructure all at the same time.

Interface Design

The input interface can be given as in Figure 4.

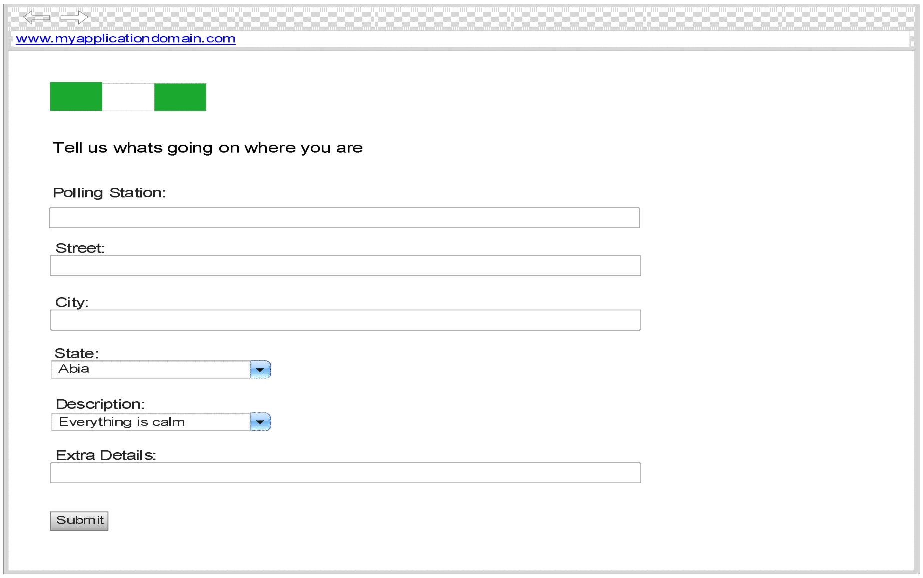

Fig. 4 Input interface design

OUTPUT DESIGN: The output interface can be given as in figure 5

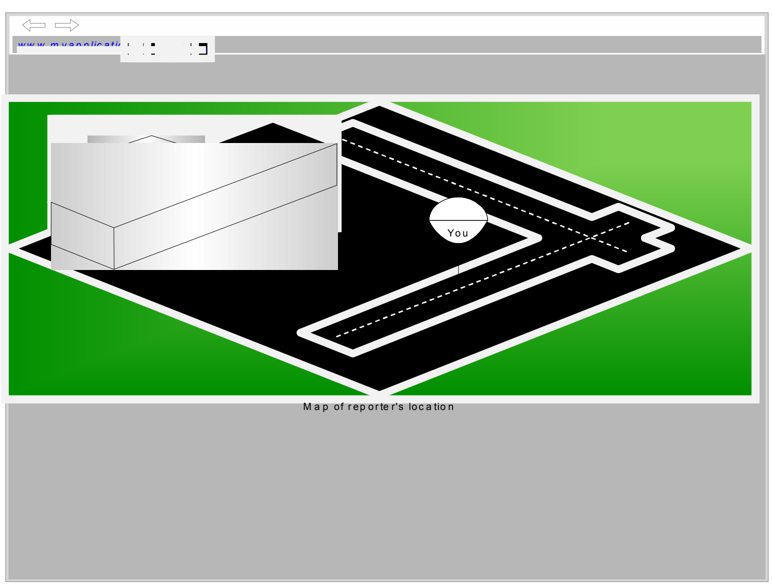

Fig. 5 Output interface design

Program Design

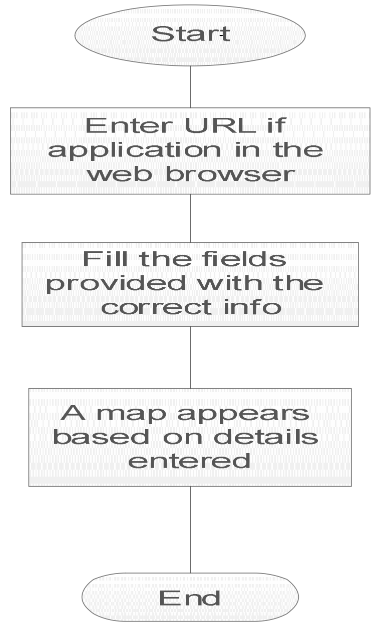

Figure6: Program Design for Reporing

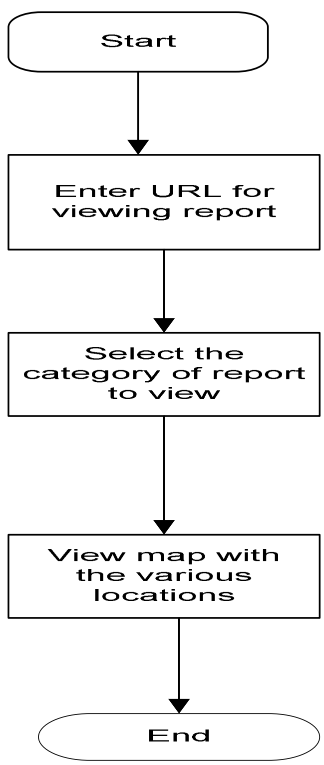

Fig. 7 Program design for viewing reports

A high level for the proposed system is given in figure 8.

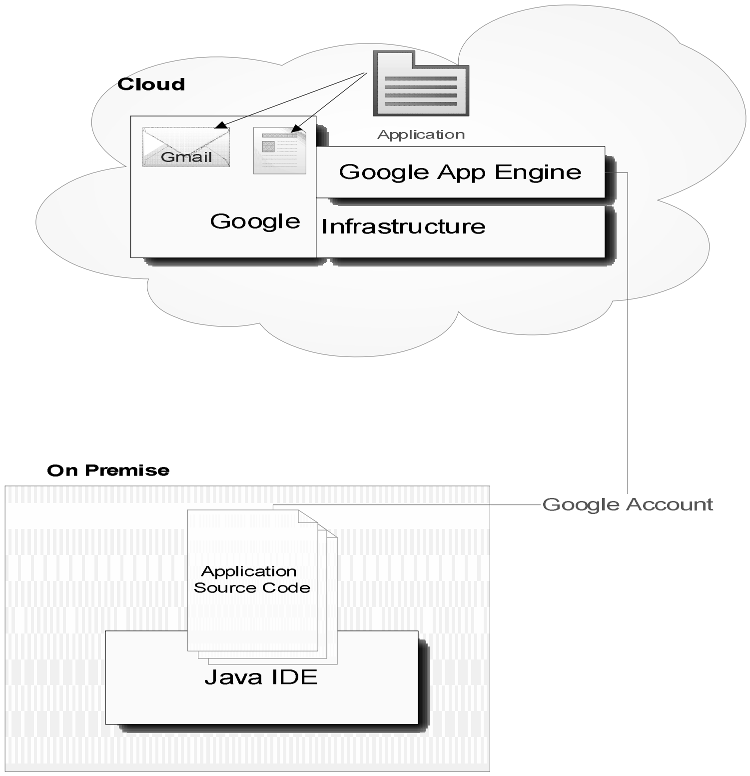

Fig. 8   High level view of the system

A low level view for the proposed system is given in figure

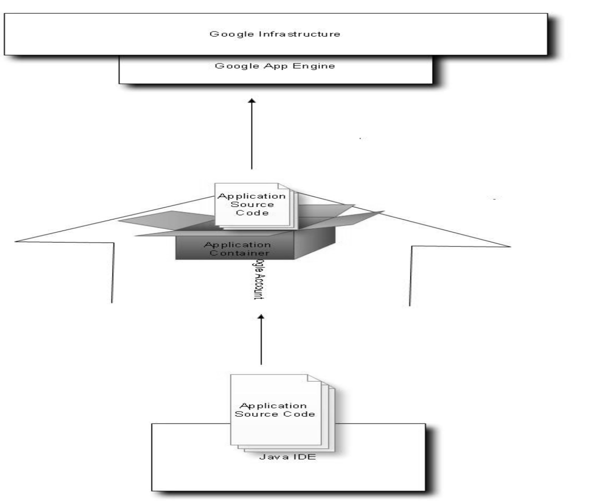

Fig. 9   Low level view of the system

System Architecture

A class diagram for the proposed system is given in figure 10 below:

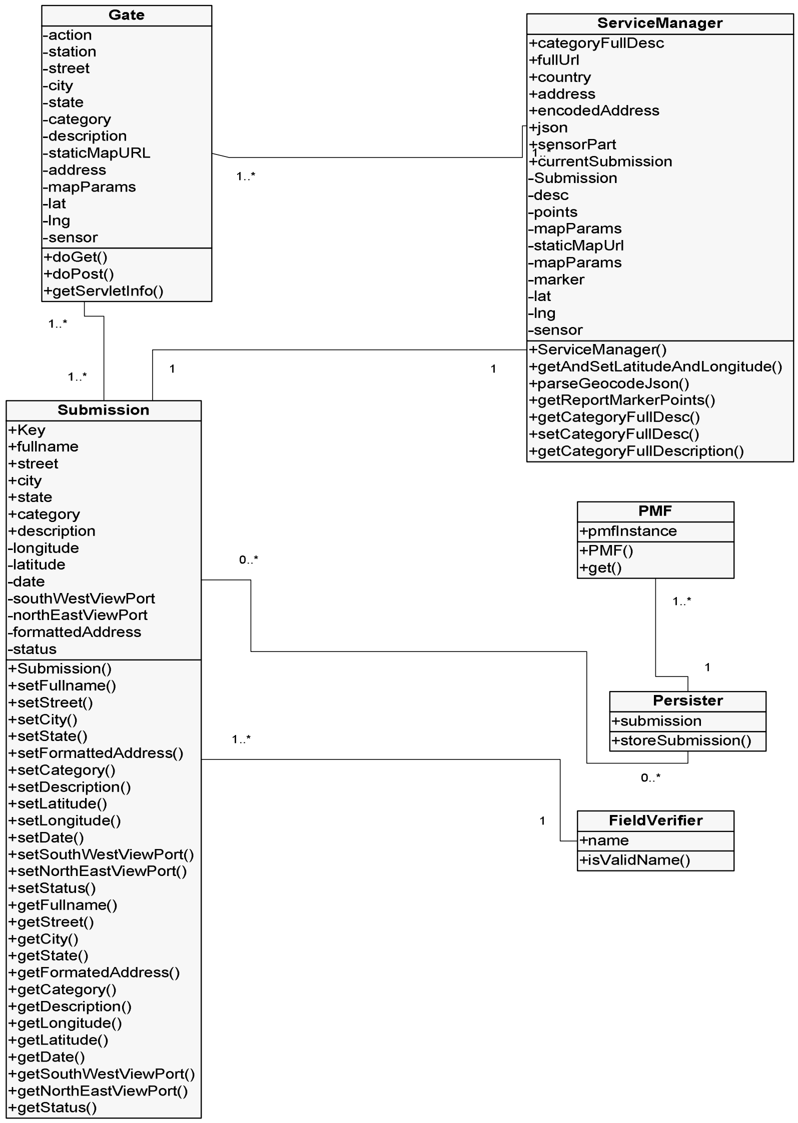

Figure 10: Class diagram of the proposed system

Testing and Results

Testing:

The application was implemented in the java programming language using Eclipse as the IDE .The data store used was the master/slave option because the application is not constantly in use. The map was implemented using Google geocoding API for the location of the individual reporter.

The system was tested for functionality, availability, security and resource consumption. For functionality, different values for the various fields at random were used. All entries returned respective locations for the values entered. Below are the values used and the test results:

Test Case1 Data entry

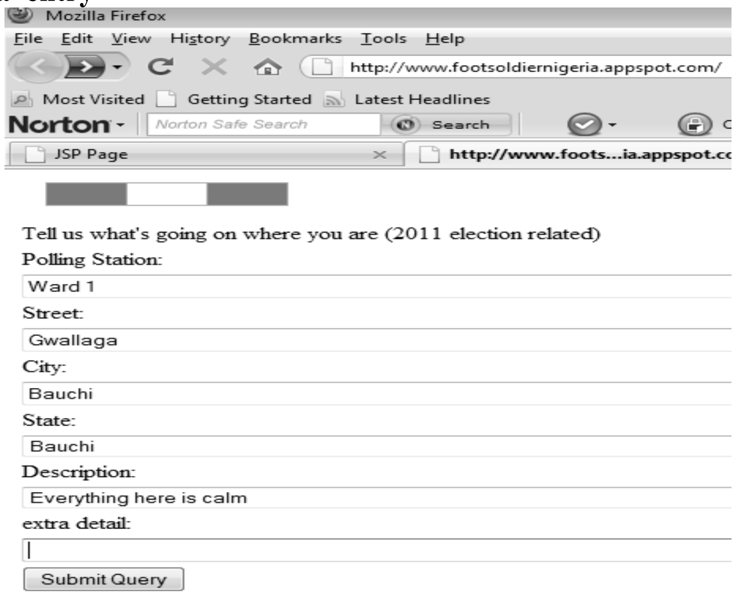

Figure 11 Test Case Data Entry

Test Case 2 Test Case 2 Data Entry

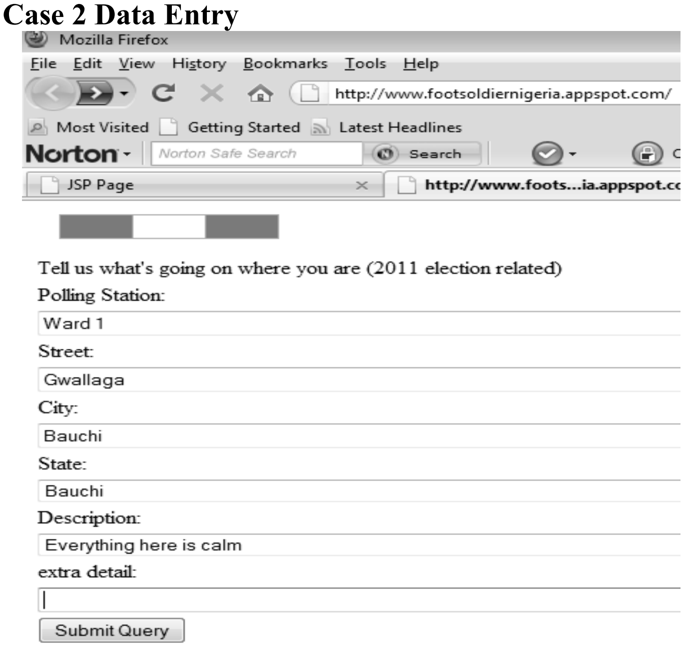

Fig. 12 #Test Case 2 Data Entry

Test case 3: Report viewing

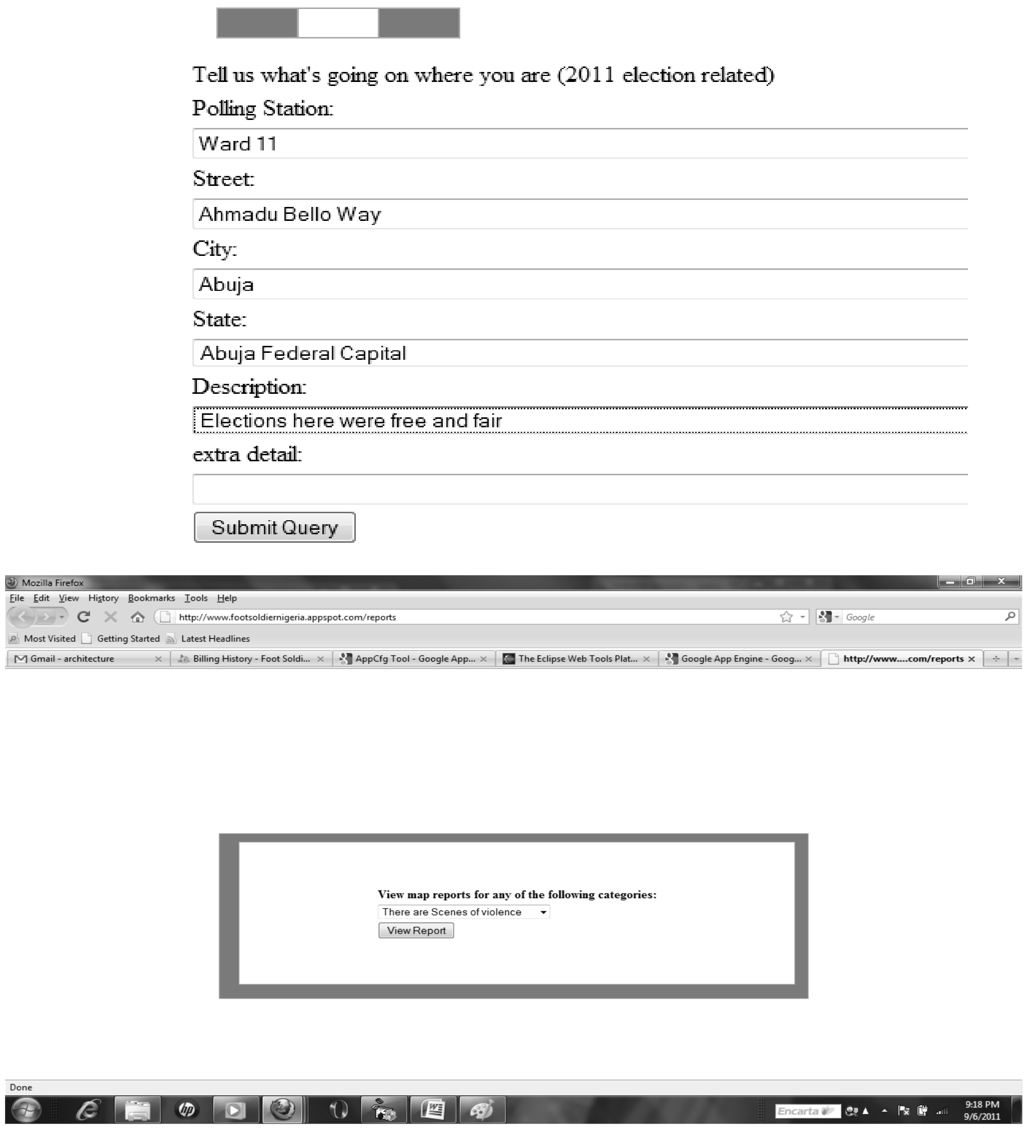

Fig. 13 #Test case 3: Report viewing

Figure #Test case 4: Availability: The system was tested for accessibility at random.

#Test case 5: Security: The security of the source code and data was tested.

.

Test case 6: Resource consumption: the memory consumption and CPU Time and cost was evaluated

Results

The results of the test performed were summarized in the table3 below:

Table 3 Results of tests

Test Cases	Result	Reference
Test case 1	Passed	Appendix A (Figure 25)
Test case 2	Passed	Appendix A (Figure 26)
Test case 3	Passed	Appendix A (Figure 19)
Test case 4	Passed	Appendix A (Figure23 & 24)
Test case 5	Passed	Appendix A (Figure 14)
Test case 6	Passed	Appendix A (Figure 21 & 22)

Discussion of Results

Based on the results obtained, it was observed that when an application is deployed on the cloud, depending on the requests made, the CPU consumed only 0.01 percent of CPU time for multiple requests while on premise deployment for one request required the same amount of CPU time for one request. Also, deploying it on premise required acquisition of the additional support software for running the application. In terms of memory, the eclipse java software and the application source code alone consumed 237.5MB on disk while running an instance of the application on the cloud consumed only 55.1MB as shown in Fig 8 and 9 of appendix A. The security only applies to the admin console since the system does not require user authentication for reporting. The admin console uses a Google account to authenticate a developer to enable him make changes to application settings or versions which implies that the same security measures implemented on Google accounts are used for the applications.

Conclusion

An overview of cloud computing technology was conducted and the associated deployment risks were provided. The election reporting system was analyzed based on current processes and a set of requirements for the proposed cloud deployed application were identified. The requirements were then used to develop a reporting system for agents and observers using java language and Google App engine as the cloud service provider. The application simply used details of a location provided by a party agent/observer and displayed a map showing the location of a party agent which reports could be generated for use by appropriate personnel. This application prototype is strongly recommended. INEC and agents of political parties should adopt the application as a reporting service so that incidents are reported and treated in real time.

References

[1]. **Armbrust M., Fox A., Griffith R., Joseph A., Katz R., Konwinski A. (2009),** *Above the Clouds: A Berkeley view of cloud computing.* Retrieved from http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.pdf

[2]. **Chris A. (2011),** *Data at Risk: Cloud Computing and sensitive Data* http://EzineArticles.com/?expert=Chris_A_Inskeep

[3]. **Cloud Security Alliance (2009),** *Security guidance for critical areas of focus in cloud computing.* Retrieved from http://www.cloudsecurityalliance.org/guidance/csaguide.pdf

[4]. **Erdogmus H. (2009),** *Cloud Computing: Does nirvana hide behind the nebula? IEEE Software*, *26*(2), 4-6. Retrieved from IEEE Xplore Digital Library: http://ieeexplore.ieee.org.libproxy.uoregon.edu/stamp/stamp.jsp?arnumber=04786942

[5]. **Grace W. (2010),** *Cloud Computing fundamentals* *www.ibm.com/developerworks/cloud/library/cl-cloudintro*

[6]. **Gerald K. (2010),** *Cloud Computing Architecture,* *www.ct.siemens.com*

[7]. **ISACA (2009a),** *Cloud Computing: Business benefits with security, governance and assurance perspectives.* Retrieved from http://www.isaca.org/AMTemplate.cfm?Section=Deliverables&Template=/ContentManagement/ContentDisplay.cfm&ContentID=53044

[8]. **IBM Academy of Technology (2010),** *Cloud computing insights from 110 implementation projects (White Paper)*

[9]. **IBM Developer Works (2011),** *New to Cloud Computing*

[10]. **Jonathan S. (2011)**, *How Cloud Computing Works* http://howstuffworks.com

[11]. **Janet C. (2009),** *Cloud Service and Deployment Model* http://janetclarey.com/2009/11/05/cloud-service-and-deployment-models/feed/

[12]. **Mell P. and Grance T. (2009),** *The NIST definition of cloud computing*. Retrieved from http://www.csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc

[13]. **Michael C. (2009),** *Defogging Cloud Computing: A taxonomy Applications in Cloud Computing Architecture (April 2009)* [14]. **www.salesforce.com**, *What is Cloud Computing?*

APPENDIX A

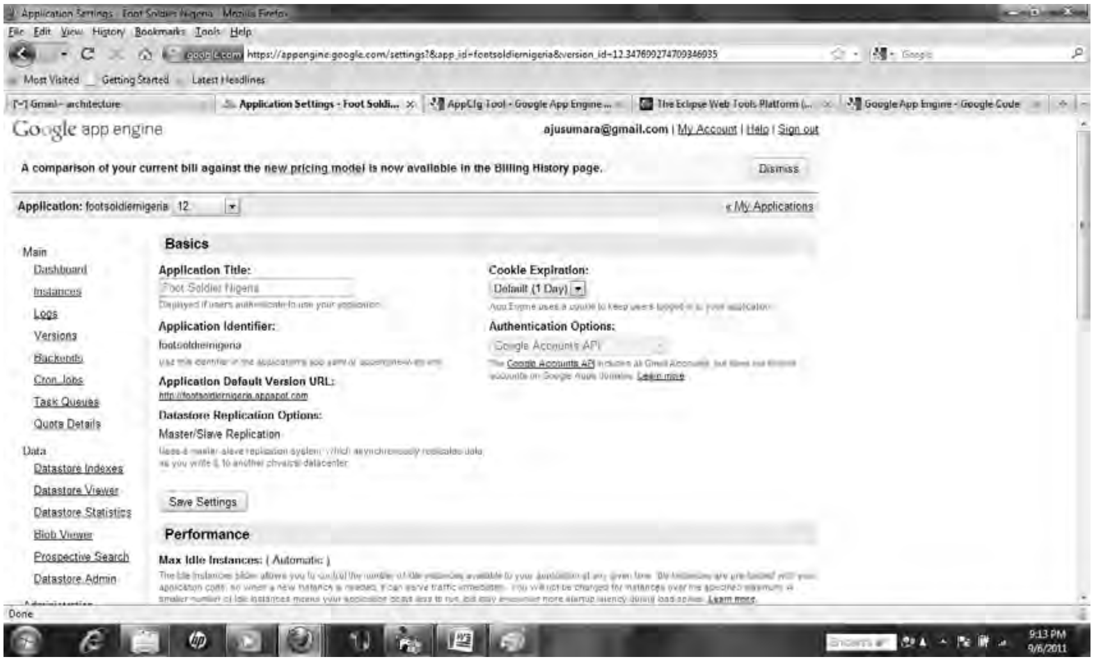

Fig 14. Application registration page

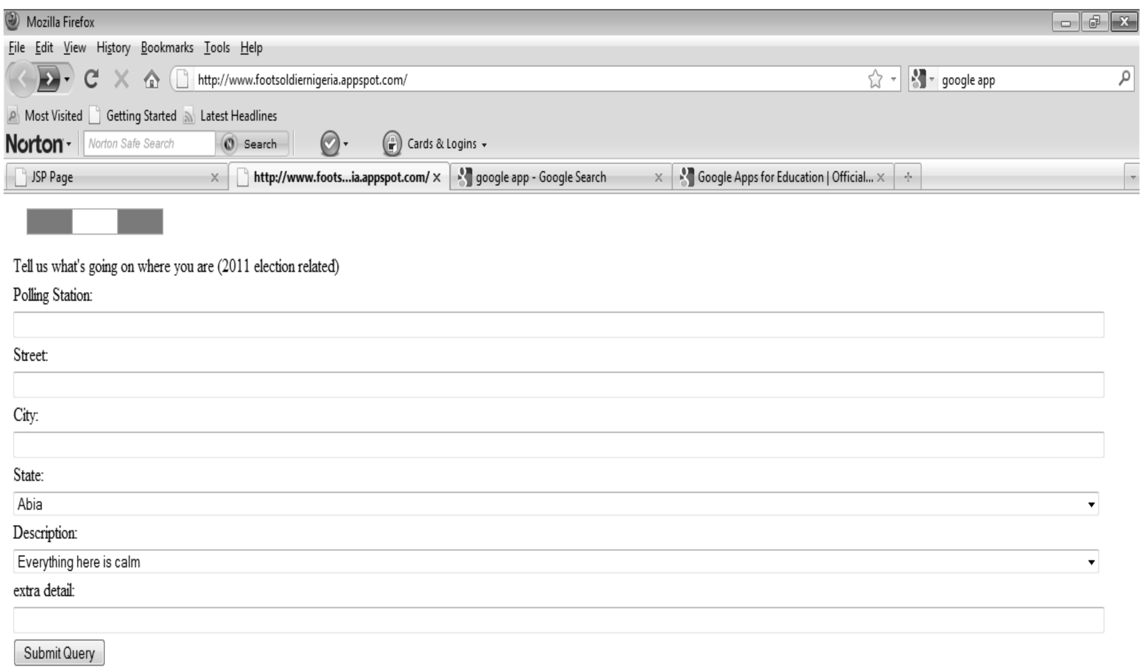

Fig 15. Main Page

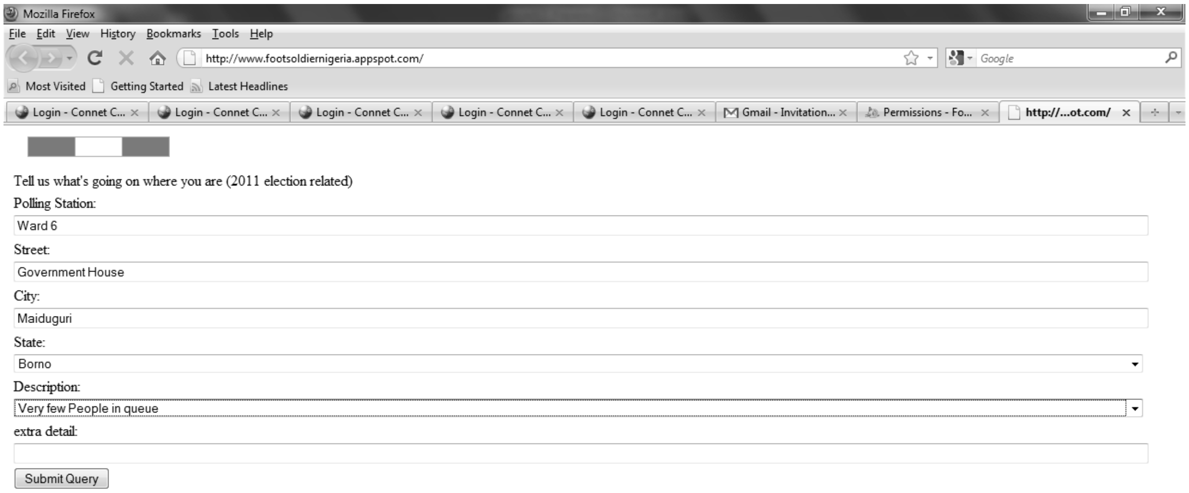

Fig16. Location of report entered

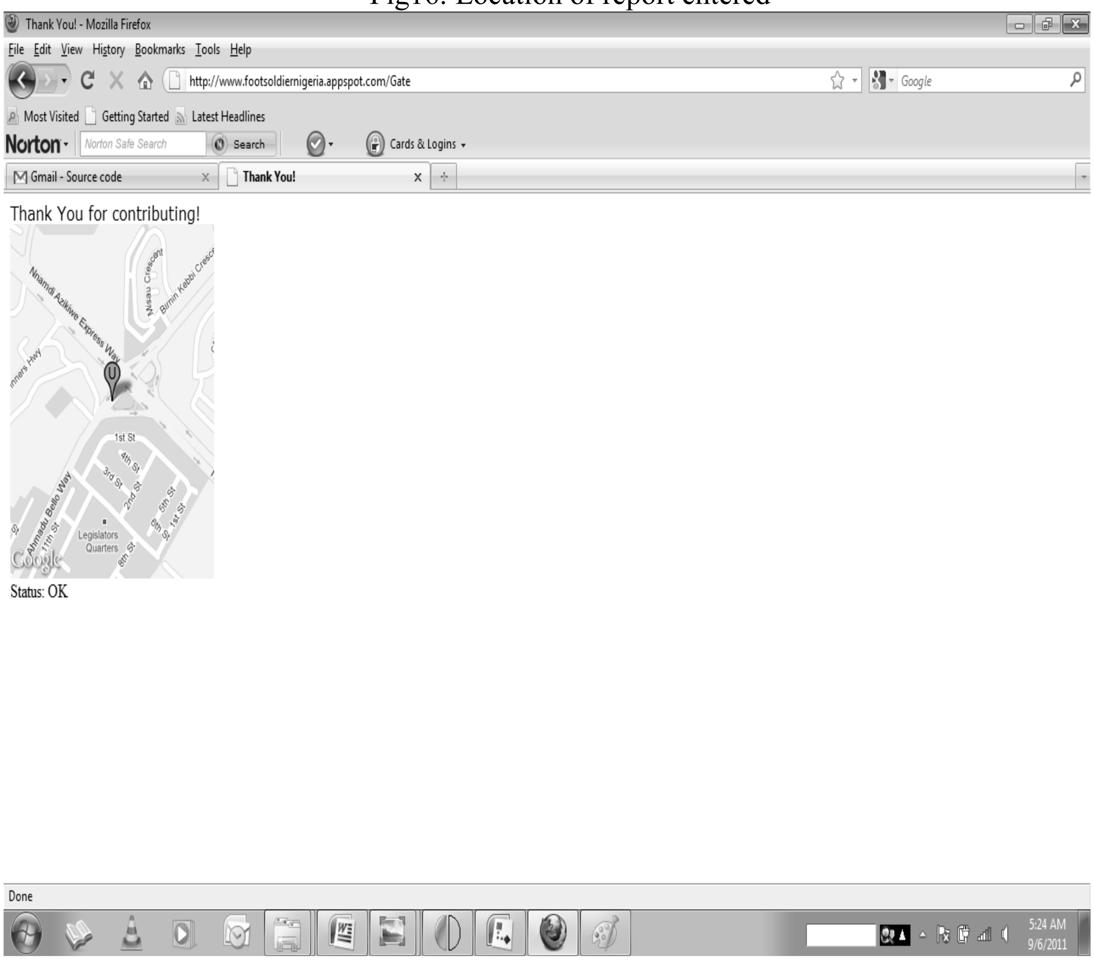

Fig17. Map with location entered in figure 15

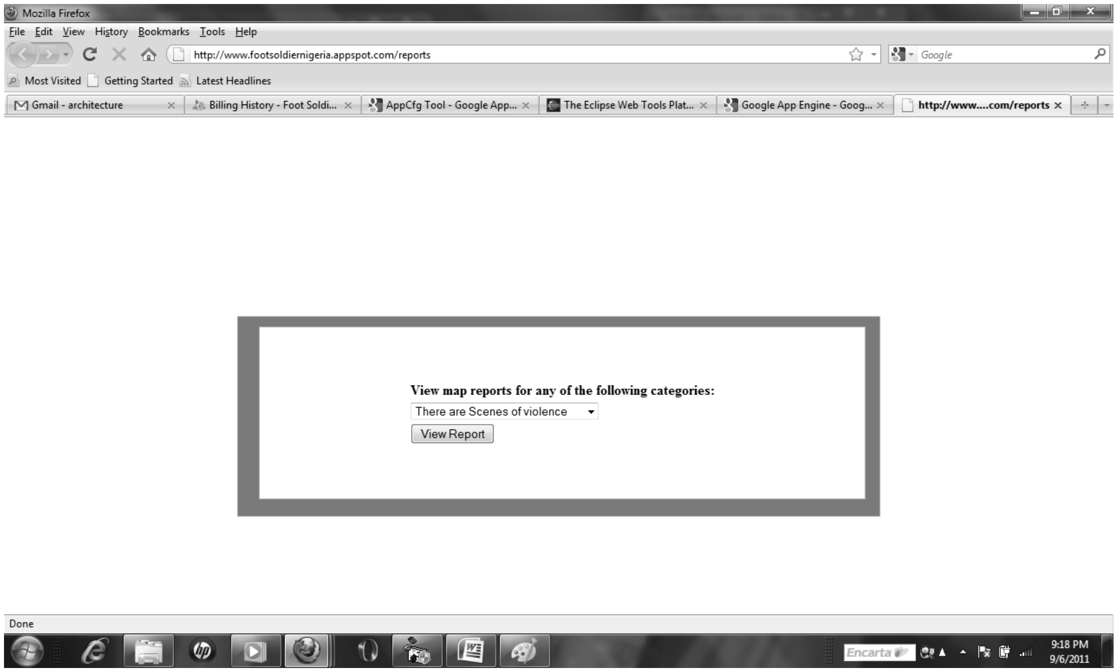

Figure: 18 Selecting Map report for various categories

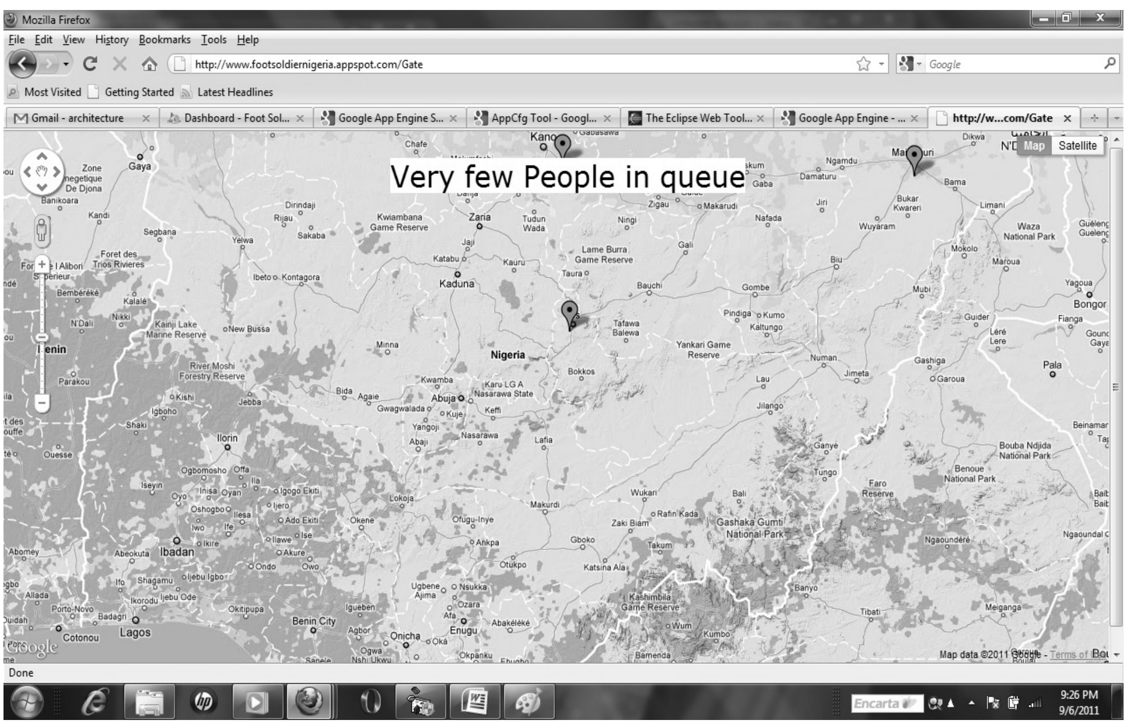

Figure19: Map report for category “Very few people in queue”

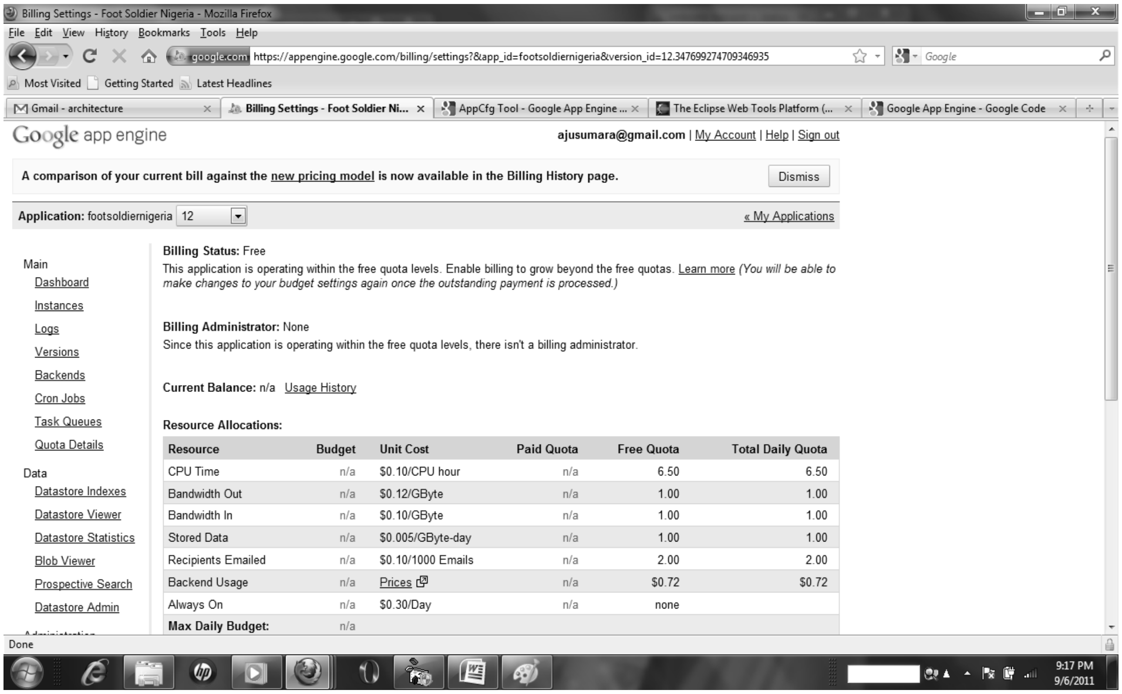

Figure 20: Application Resource Allocation

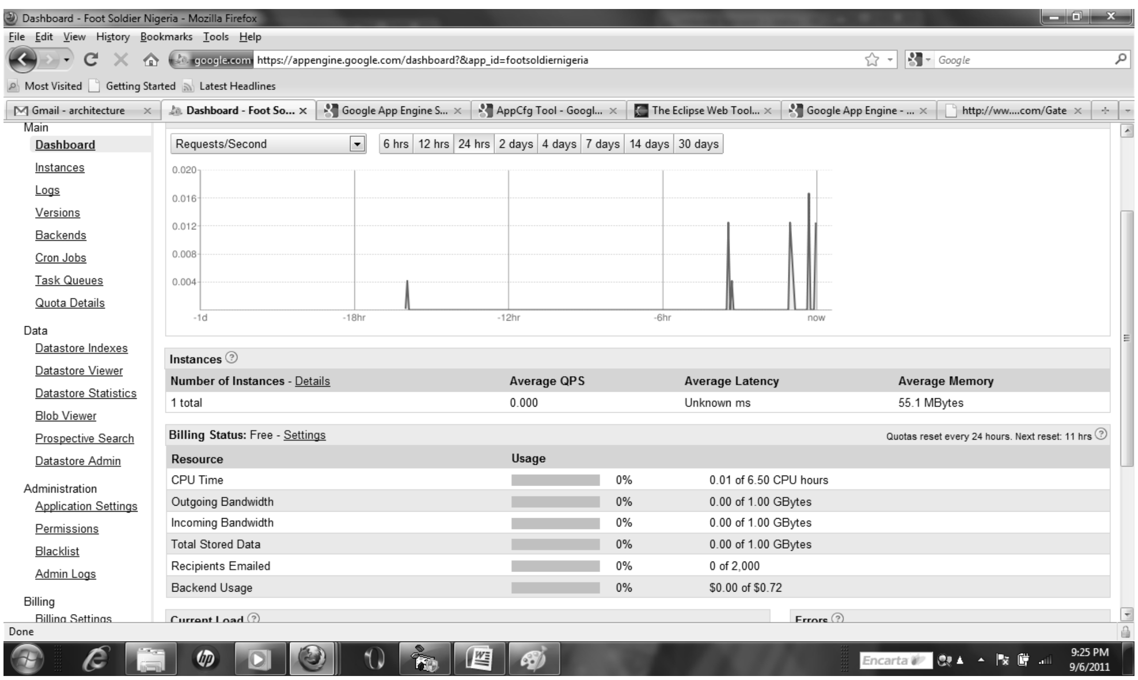

Figure 21:. Application Resource Usage (CPU Time)

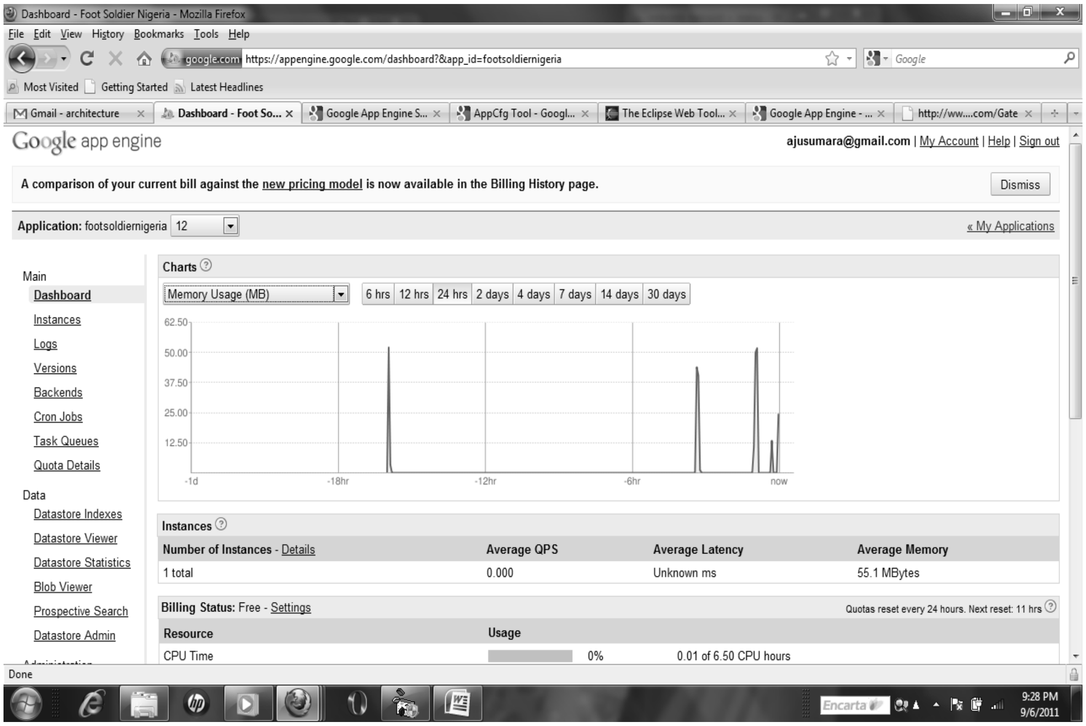

Figure: 22. Application Resource Usage (Memory)

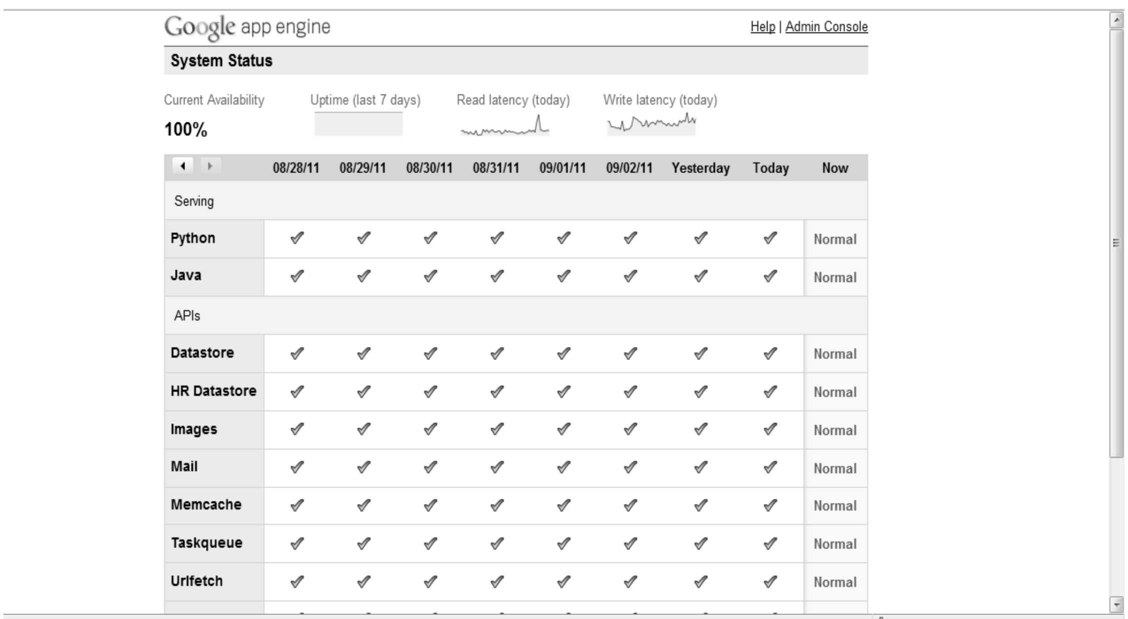

Figure 23: System Availability Status (1)

Figure 24: System Availability Status (2)

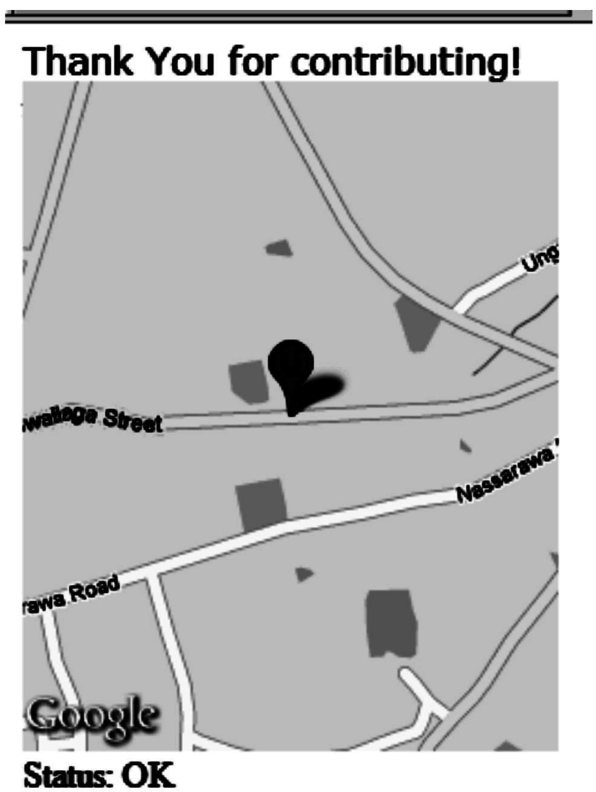

Figure: 25 Result of #Test Case 1

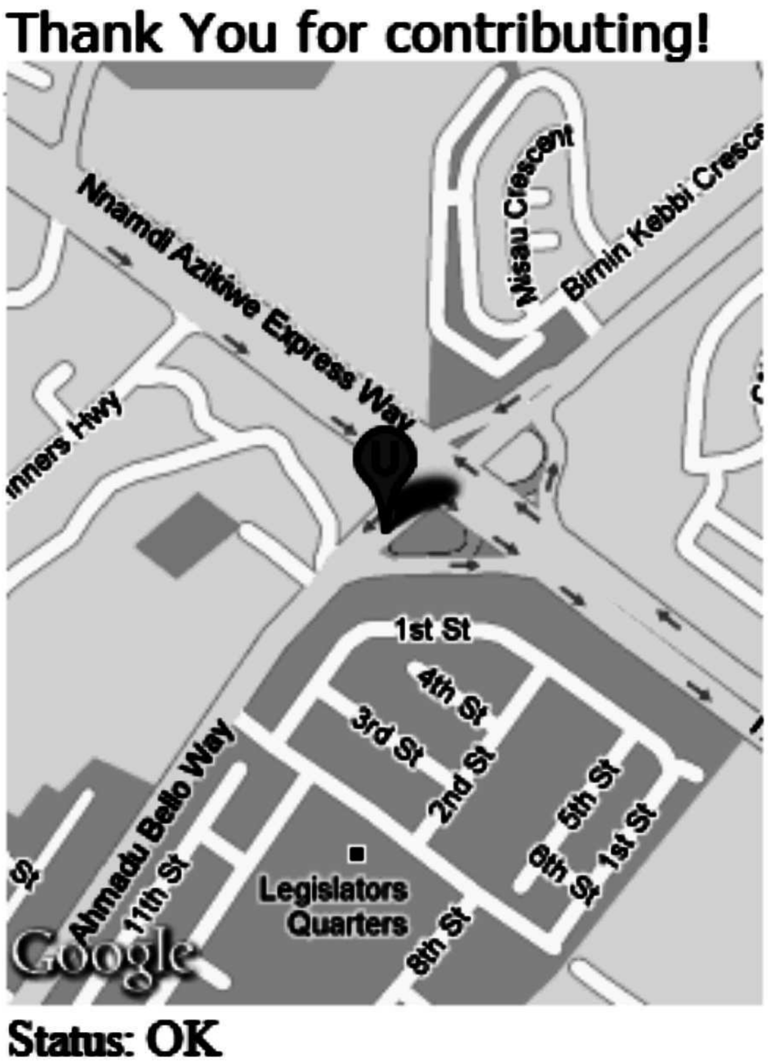

Fig. 26: Result of #Test case 2