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PERFORMANCE ANALYSIS OF SMART INFRASTRUCTURE MODEL FOR E-GOVERNACE INTEGRATION

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ABSTRACT

Contemporialy, e-government is at the implementation stage in various countries of the world. E-governace creates digital interactions via ICTs between Government to citizens, employees, bussiness and agencies. The E-Governance plateform need low cost and high speed infrastructure which must provide high quality transmission (data, video and voice traffic) and reliable connectivity with effecient service delivery. The server centric architecture design for E-Governmentis not cost effective and dependable. This paper presents a performance analysis of Smart Infrastructure Model (SIM) for E-Governance integration in the developing countries. The SIM strategy comprises of cloud zoneing with long term evolution (LTE) Worldwide Interoperability for Microwave Access (WiMAX) which supports flexible channel bandwidths (1.4 – 20 MHz) as well as frequency-division duplexing (FDD) and time-division duplexing (TDD) to allow flexible deployment around spectrum ownership. Adding to the computational improvements, the proposed model is self-starting, self-configurable with low latency, and with wider coverage, as such supporting SIM e-governmentapplication deployment in the urban, suburban and rural envirnments. Adapting high speed SIM will significantly influence the design and implementation of e-governance applications and deployments. This paper presents SIM simulation results in context of latency, throughput and utilization.

Keywords: E-governance, SIM, FDD, TDD, Models, Framework, Deployment, Architectures

INTRODUCTION

The developing nations needs an optimized integrated architecture framework for e-government that represents the alignment of newest IT infrastructure with business process management in public sector organisations and clearly understand the implementation constraints of the proposed architecture framework. This research contibutes to literature in the E-Government models, helping experts to learn how to use and manage the contemporary 4G LTE information technologies to revitalise business processes, improve decision-making, and gain a competitive advantage from the adoption of e-government.

The e-government SIM presented in this paper will eradicate complications surrounding e-government infrastructure deployment models (see figure 3). An understanding of the proposed e-government processes and flowchart model, as well as performance analysis of traffic behaviour in our proposed model willvalidate e-government SIM proposalin this work.

Contextualization- What Is E-Government?

The work observes that the term e-government in the context ofthe developing countiesis ofrecent origin and there exists no standard definition since the conceptual understanding is

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still evolving. However, the website in [1] defines E-Governmentas digital interactions between a government and citizens (G2C), government and businesses/Commerce (G2B), government and employees (G2E), and also between government and governments/agencies (G2G). In the world today, the use ofICTsby government agencies are necessisted bythefollowing reasons:

a. Need for exchange of information with employees,citizens, businesses and other government departments
b. Need for efficient delivery ofpublic services while reducing systematic rigiditiesand paperwork
c. Need to improve internal efficiency and avoid overcentralization
d. Need for cost savingsand increase revenue generation
e. Need to re-structuretheadministrative processes, hence reducing bureaucratic routine
f. Need for accountability and transparency
g. Need for absolute convenience via mobile based service deliveries, home delivery of processed papers, and no need for office visits and follow ups, no need to approach different offices for different work, clarity on requirements.

Following the definition in [1], the digital interaction consists of governance, information and communication technology (ICT), business process re-engineering (BPR), and e-citizen at all levels of government (city, state/province, national, and international).

According to [2], E-government refers to the delivery of government information and services online through the Internet or other digital means. Accordingly, government leaders and officials are increasingly aware ofthe potential of e-government to improve the performance of government organisations and provide potential benefits to their citizens and business partners [3].

The study in [4] shows that e-governmentis still at the rudimentarystage and has not obtained many of the expected outcomesin termsof cost savings. Horizontal and vertical interoperability can be regarded as the key to realizing the potential gains in e-government [5]. For all classes ofthe e-Government delivery models, the SIM certisfies the interoperability functionalities. Essentially, the e-Government delivery models can be briefly summed up as showned in [6]:

- G2C (Government to Citizens)
- G2B (Government to Businesses)
- G2E (Government to Employees)
- G2G (Government to Governments)
- C2G (Citizens to Governments)

This work focuses on the adaptation of SIMinfrastruture in the e-governace frameworkfor the developing countries. SIM will have a profound impact on the entire e-governace landscape. The authorsenvision SIM to offera highly focused solution to the challenges of multiple heterogeneous networks, therebyfundamentally advanceingthee-Government delivery models Figure 1 shows the proposed implementation framework for both system modules and dimensions.

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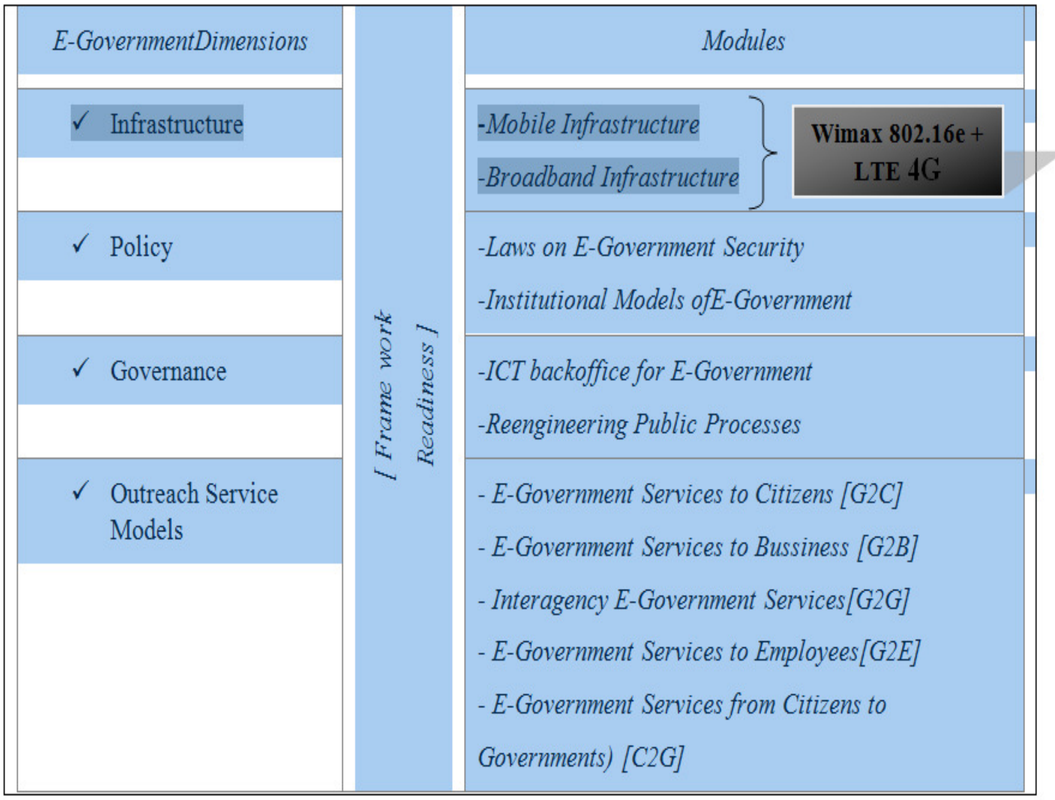

Figure 1. E-Government dimensions

From Figure1, the authors perceive the infrastructure dimension as the most critical as it forms the main basis for other dimensions. The SIM strategy interface LTE Wimax with e-government cloud following the convergence toward OFDMA and P technologies. Access network technologies (switches, Routers, gateways, etc) allow users connectivity toany location of the e-portalin real time. Fixed-mobile convergence (FMC) in SIM design addresses network convergencein our context. Also, service convergence and device convergence facilitates and provides convenience and simplicity forend user sin the model. All these characterizations provide efficient connectivity to services ofe-government.

RELATEDWORKS

The authors in [5] aurgues that as e-Government practice matures, one can observe a shift in focus towards quality management, evaluation and ultimately a quest for realized benefits. There have been four major interrelated trends in global markets over the last decade, which have brought the concept of e-government to the forefront of politics and top government officials [7] viz: Innovation, Information Society, Globalisation, and Democracy. This is applicable to the developing countries as well. E-government requires careful study of the cultural, social, and economics environment [7]. Somes issues presented for consideration in e-Government includes [7]: Process reengineering, Physical boundaries, improved responsiveness, Literacy, Infrastructure, Skilled professionals, Information sharing, Trust, Security and privacy controls, Legislation and regularity compliance. The work in [8] presents a novel DSS Framework for E-government. The paper utilized the DSS components to help decision-makers within the e-government domain. The authors in [9] presents the stages of e-government viz: Stage 1 - Emerging presence, Stage 2 - Enhanced presence, Stage 3 - Interactive presence, Stage 4 - Transactional presence, Stage 5 - Networked (or fully integrated) presence.

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Following the literature survey in [5], [6], [7], [8] and [9], the infrastructure dimension represents the most sophisticated level in the online e-government initiatives. It is characterized by an integration of G2G, G2C and C2G with broadband connections. By distributing high-speed Internet access from cable, Digital Subscriber Line (DSL), and other fixed broadband connections within wireless hotspots, WiFi connectectivity has dramatically increased productivity and convenience [10]. This work presents SIM model with performance analysis on traffic parameters that supports efficient delivery.

LAYER-1 SMART INFRASTRUCTURE MODEL (SIM)

The SIM is modeled as a pre-integrated, end-to-end e-governmentinfrastructure for last mile connectivity to greatly reduce delay in service access and enhance efficient service delivery as shown in figure 3. The SIM model delivers high-speed Wireless and fixed broadband connectivity to e-governmentclients (government offices, homes, and public locationsp-hotels, cafés, and airports).The proposed model fits heterogeneous environments, roaming users using multi-interface mobile terminals. As such e-governement services can be accessed anytime and anywhere. The band width and range of SIMmakes it suitable for providing portable mobile broadband connectivity amongthin clients through a variety of devices as well as providing a wireless last mile broadband access for data services in the e-governmentdomain. Figure 3 shows the e-government SIM proposed in this work. It presents high-speed datamodel optimized for mobile devices and data terminals. It is based on the new 3G/4G WIMAX technology with LTE integrations and WLAN, as such yielding increasedcapacity, good spectral efficiency and speed. Its main features are compactable with 3GPP LTE component in [14]:

1. Peak downloads rates up to 300 Mbit/s and upload rates up to 78.5 Mbit/s basedon the user equipment category 8 using 20 MHz of spectrum maximum). All DTE (terminals) have the capacity process 20 MHz bandwidth averagely.
2. Uses orthogonal frequency-division multiplexing (OFDM), multiple-input multiple-output (MIMO) antenna technology depending on the terminal category
3. Low data transfer latencies for small IP packets in optimal conditions, andlower latencies for handover and connection setup time
4. Improved support for mobility for nodesmoving at up to 350 km/h or 500 km/h last mile cases.
5. Supports OFDMA for the downlink, Single-carrier FDMA (SC-FDMA) for the uplink for power conserveation.
6. Support for both FDD and TDD communication systems as well as half-duplex FDD with the same radio access technology
7. Extended spectrum flexibility between1.4 MHz-20 MHz wide.
8. It Supportsover 200 active datausers per 5 MHz cell zone
9. Thearchitecture have support for inter-operation and co-existence with legacyWireless standards.
10. SIM supports Multicast-Broadcast Single Frequency Network (MBSFN), thuscan deliver services such as Mobile TV using the LTE infrastructure of SIM.

The anticipated benefits of e-government include efficiency, improved services, better accessibility of public services, and more transparency and accountability [11]. Other e-government non-Internet forms include telephone, fax, PDA, SMS text messaging, MMS, wireless networks and services, Bluetooth, CCTV, tracking systems, RFID, biometric identification, road traffic management and regulatory enforcement, identity cards, smart

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cards and other Near Field Communication applications; polling station technology (where non-online e-voting is being considered), TV and radio-based delivery of government services (e.g., CSMW), email, online community facilities, newsgroups and electronic mailing lists, online chat, and instant messaging technologies [1]. These forms part of the access layer inframe work of e-government architectecture. The e-government architecture defines the standards, infrastructure components, applications, technologies, business model and guidelines for electronic commerce among and between organisations that facilitates the interaction of the government and promotes group productivity [3].The work classifies the architecture into access layer, e-government layer, e-business layer, and infrastructure layers as depicted in figure 2. This paper leverages oninfra structure layer to develop the SIM expedient for e-government end to end service delivery. Our simulation models are presented with the OPNET modeller tool [12]. Figure 4 shows the flowchart algorithm for implementation.

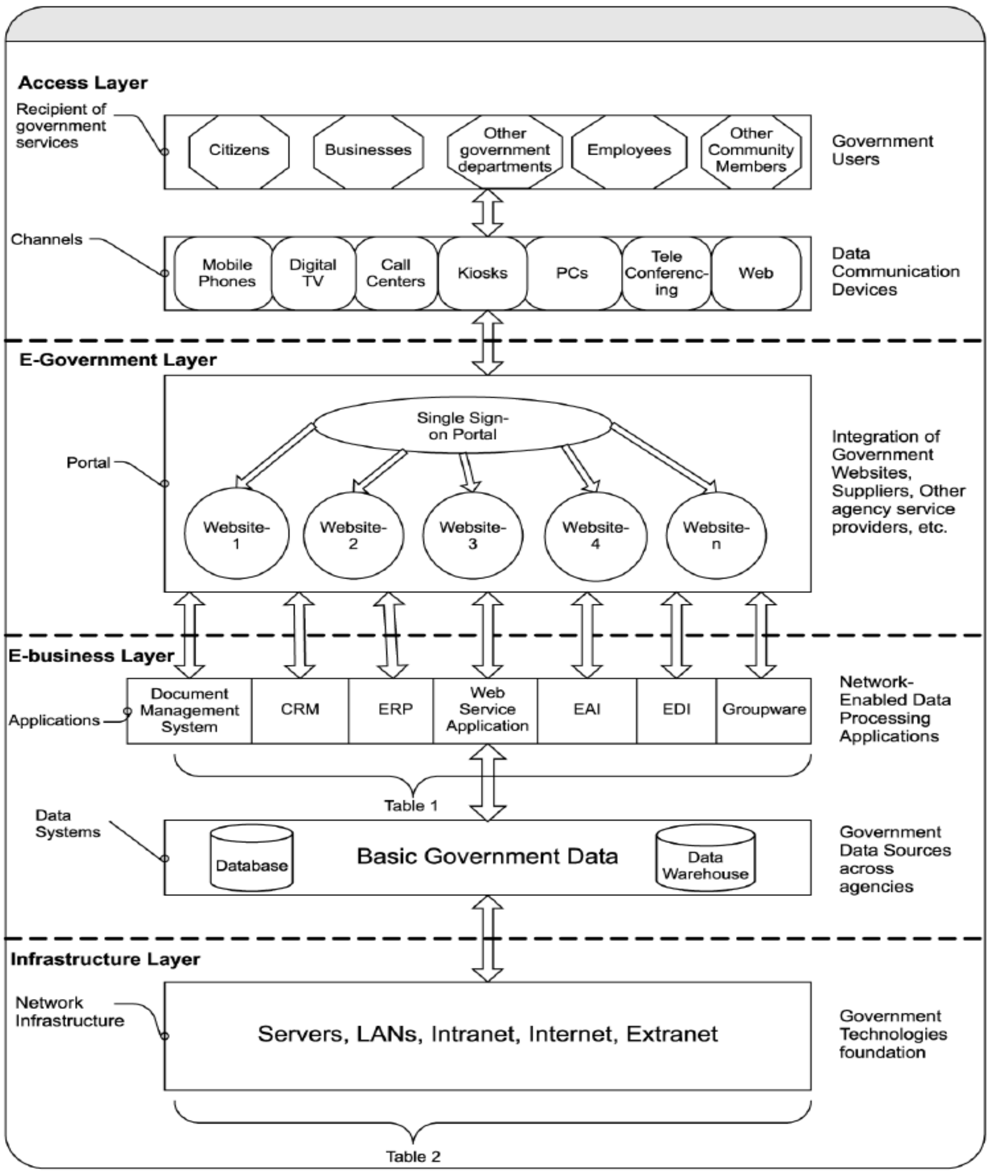

Figure 2. Framework of E-Government Architectecture [3]

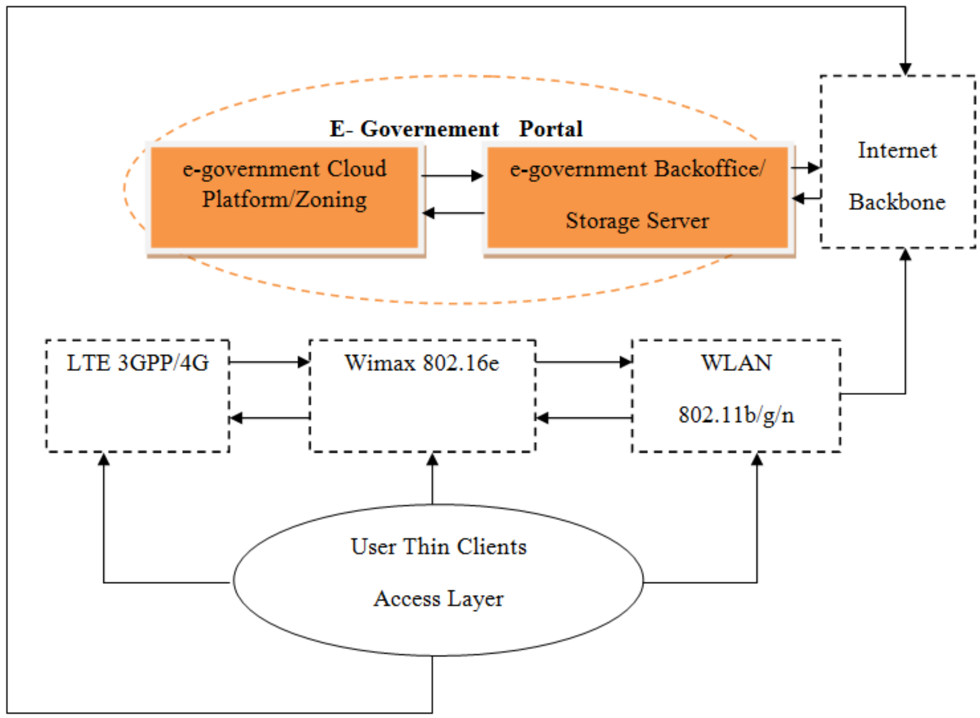

Figure 3. E-Governement Smart Infrastructure Model (SIM)

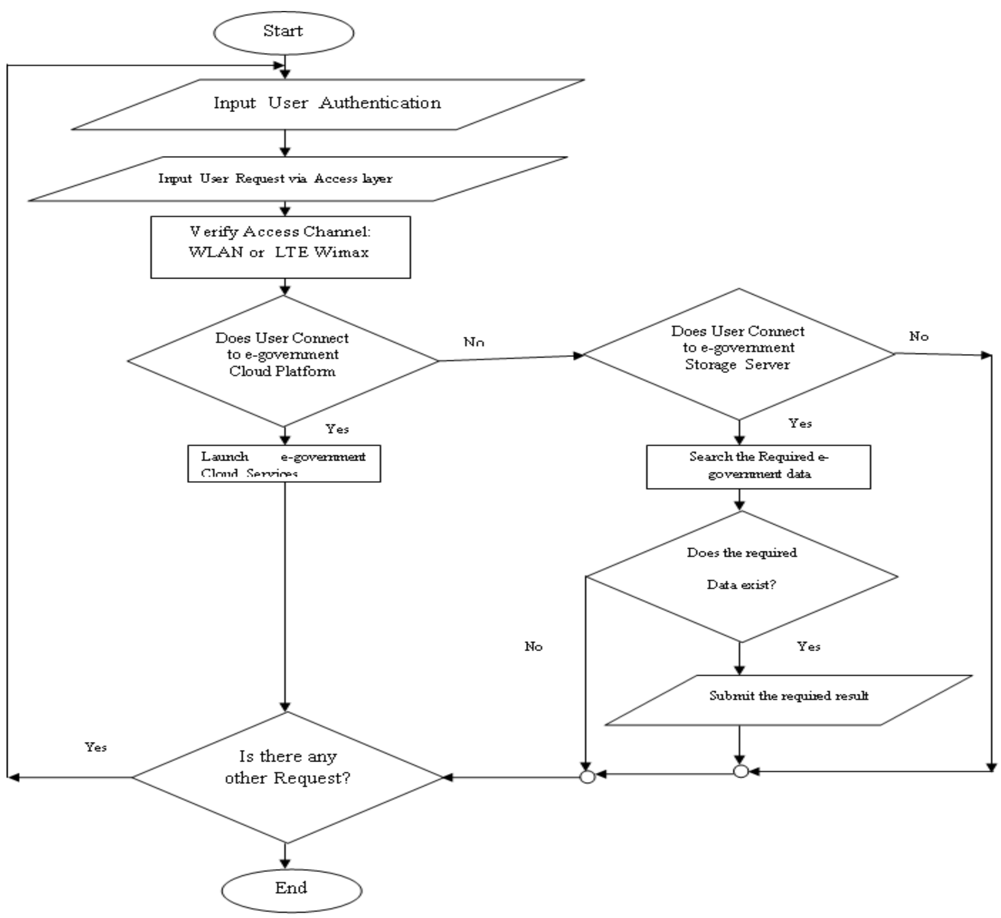

Figure 4. E-Government Smart Infrastructure Model Flowchart algorithm

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METHODOLOGY

System Simulation

This section describes the simulation approachad opted in this paperfor high speed data access and low latency vis-a-vis e-government connectivity infrastructure. A modified version of OPNET modeller [12]simulation library called OPNET 12.0 WiMax has been used. The simulation environment definesa network model, anode mobility model, process and services model. The system model specifies the type of network, thecloud platform and characteristics of the SIMLTEs. Also, system model considers the coexistence ofe-government cloud server, mobile and fixed wireless devices. By extension, OPNETD evelopment Kit (ODK)was used to add nodes to our network model and afterwards traffic (discrete application-FTP and E-mail, custom applications, and application demands) was injected into the model.The characteristics of the SIMparameters are summarized in Table 4,4.1,and 4.2.The configurationstepsincludesnetwork topology creation, traffic injection into the network model, configuring LTE WiMAX Parameters, confirmation of consistency test and simulation runs. Traffic system simulation analysiswas carried out after successful execution of the simulation runs to ascertain the system throughput, load, utilization and latency responses.

Parameter Configuration

Byleveraging on existing concepts ofparameter characterization, distinct steps were employed toachieveoursimulation model. There were eight steps required to implement WiMAX functionality in a network model viz:

i. Define Service Classes
ii. Configure Efficiency Mode
iii. Configure Physical Layer (PHY) Profiles
iv. Associate Subscriber Stations with Base Stations
v. Define Service Flows
vi. Assign Traffic to Service Classes
vii. Configuring Physical Layer Parameters
viii. Configure routing protocols (for a case of modeling a router backbone to LTE WiMAX)

Table 4. LTE Node Attribute

Attribute	*Values*
Service Class Name	Platium
Initial Modulation	QPSK
Initial coding Rate	½
Average BDU Size (byte)	1500
Activity Idle timer (sec)	60
Buffer Size (byte)	64kb
Window size ARQ block	512
Block size (bytes)	256
Retransmission time interval	0.5sec
Block lifetime interval	3

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Table 4.1. LTE Mac Service class definition

Service class name	*Gold*
Scheduling Type	Best Effort
Max. Sustainance	300Mbps
Traffic Priority	Promoted
Type of SAP	IP

Table 4.2. LTE Admissin Control Report

Statistic	*Value*
Total Capacity(Msps)	19.808000
Admitted Capacity(Msps)	19.542000
No of Admitted Connections	76
No of rejected connections	16

THE RESULTS STUDY

This section presents optimization results obtained after the simulation run in this work. The number of maximum simulation thres holdwere generated based on our selected performance metrics. We believe that reliablity of our model depends highly on the results generated in our model. Global statistics as well as node statistics reports were gathered after test runs. To analyze system performance, we can collect several statistics and analyze reports depicting the system behavior and performance metrics viz: SIM throughput, latency and utilization. The available statistics were collected on a global, per-node, or a per-connection basis as shown in figures 5.7, 5.8, 5.9, and 5.10. We now present a detailed discussion on the results obtained so far.

DISCUSSION AND RESULTS

Figures 5.1 shows SIM simulation outcomes based on the attribute values of Table 4.4.1,4.2 and 4.3.

In the figure 5.1, after successful runs, t is clear that we get result of figures 5.3, 5.4, 5.5 and 5.6.

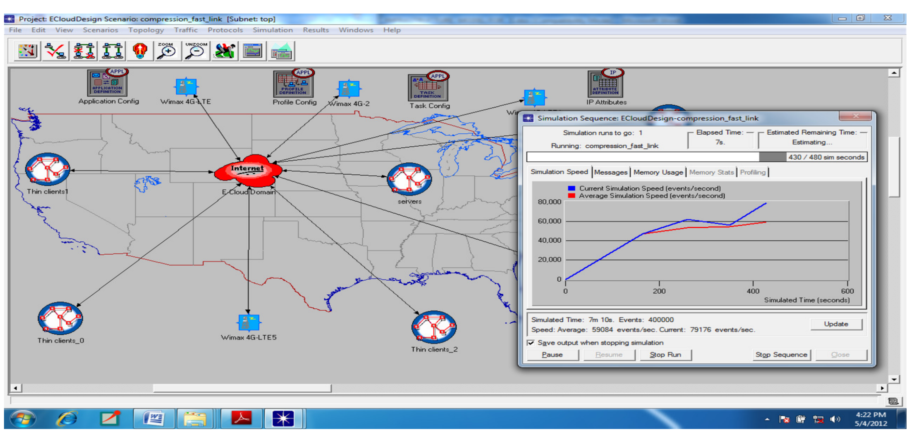

Figure 5.1. SIMsimulation outcomes

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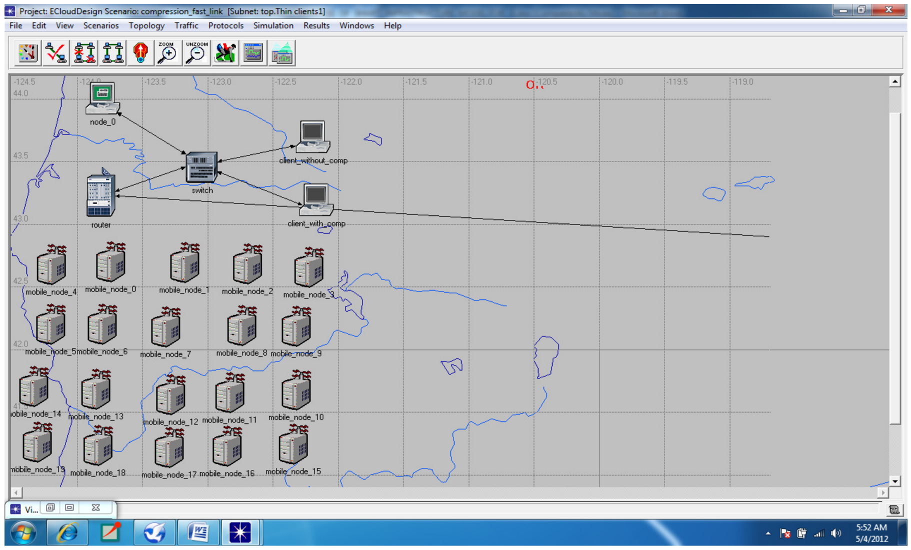

Figure 5.2. LTEthinmobile clients

Figure 5.2 shows the LTE thin moblie clients for an LTEbase station. These clients depend heavily on the e-government portal server to complete its computational roles. The exact roles assumed by the e-government server varies from providing data persistence to actual information processing, storage and analytics for various web services. The critical factors considered in our case are the latency response, throughput, load effects and utilization.

From figure 5.3, we observed that the results show significant downward trend after the peak overshoot of over 150Mbps and gradually retured to a range of about 25%above the initial rise level. This suggests that as long the network is lightly loaded; the active connections achieve dynamic bandwidth at each instance. In case, the average offered load is less than the link capacity and all user requests are queued and served accordingly. The behavior of the thin client subnet is characterized by the Erlang-C delay model. As such recommends heavy traffic sessions on the SIM links to ensure full utilization by the nodes and cloud portal.

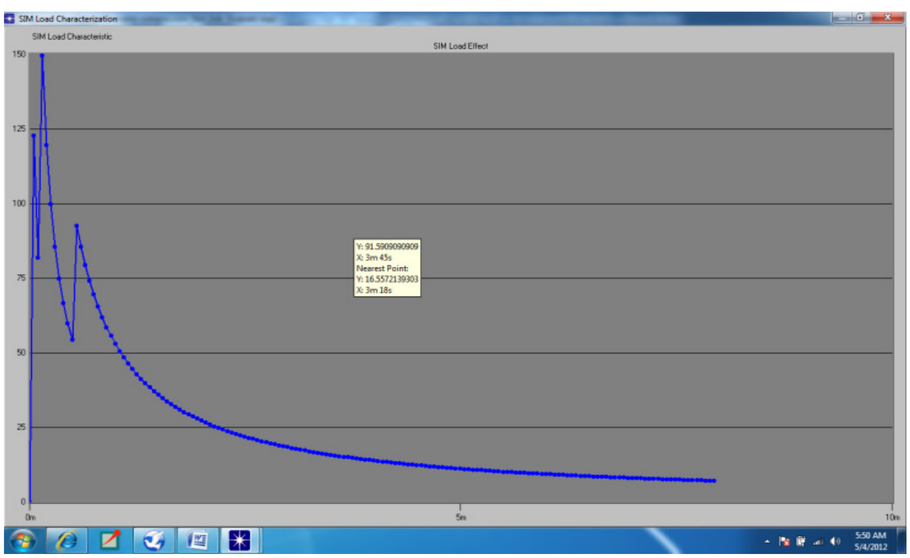

Figure 5.3. Thin Client Load Effect

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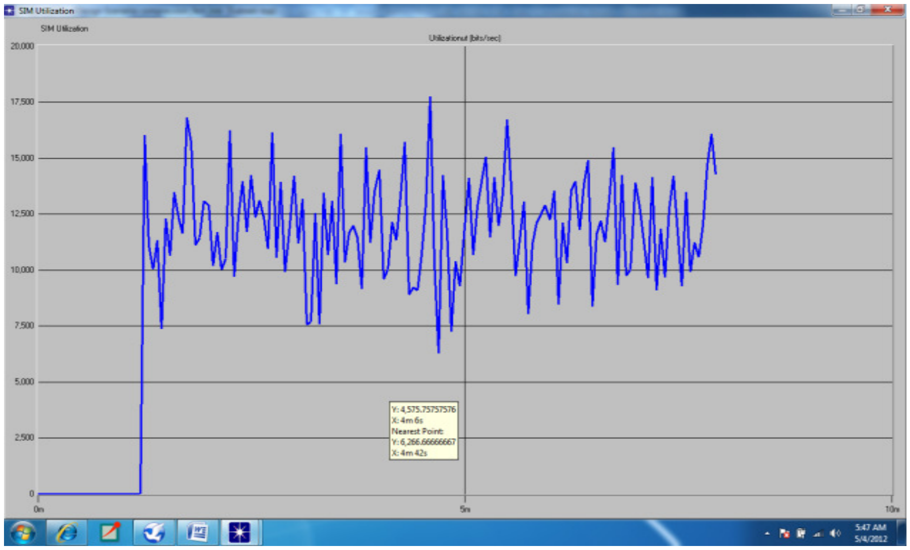

Figure 5.4. SIM Utilization Confidence

Figure 5.4 shows resource utilization confidence by the clients. The plot shows anon-increasing order of resource utilization whiles equentially allocating sufficient band width for service computations. In the simulation, 100 nodes are used and the arrival requests follow the confidence caliberation of 80%in the result settings, showing an efficent system test performance. In this case, best effort traffic like web services and email communications will have limited packet losses and very little jitter justifying traffic confidence in our context.

Figure 5.5: SIM Delay Response-latency which is less than 0.1 second while Figure 5.6 shows the SIM throughput response. The challenge for designers of future LTE networks for technologies like cloud computing and smart grids are to develop their systems to achieve required throughput and latency. To compute near-optimal tradeoffs between the increased complexity and latency associated with relaying information across multiple thin clients remains ambigous in our context owing to the unpredictability of LTE Wimax parameters. However, within creased radio coverage vis-a-visbase stations, fairness in connectivity will be evident. The impacts of SIM in relaying traffic is described in the plot of figure 5.6.Consequently, the packet lost in our model is very insignificant for signal transmitted and received by terminal devices, hence justifying the effectiveness of our model.

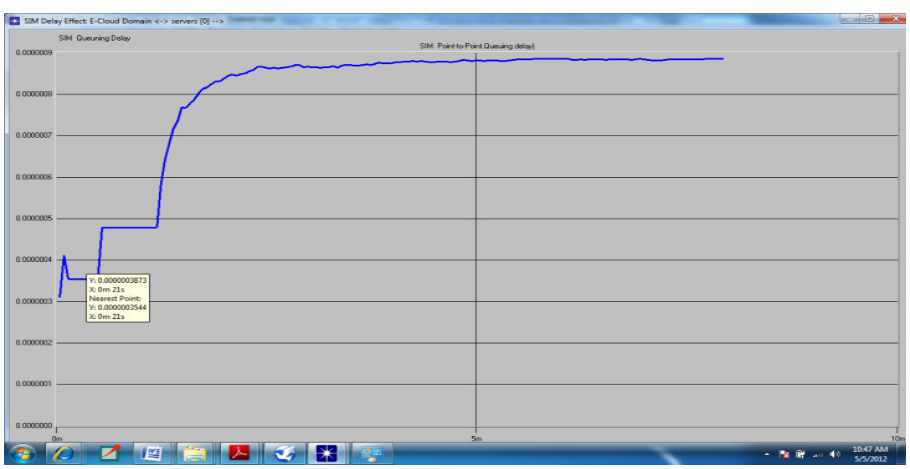

Figure 5.5. SIM Delay Response

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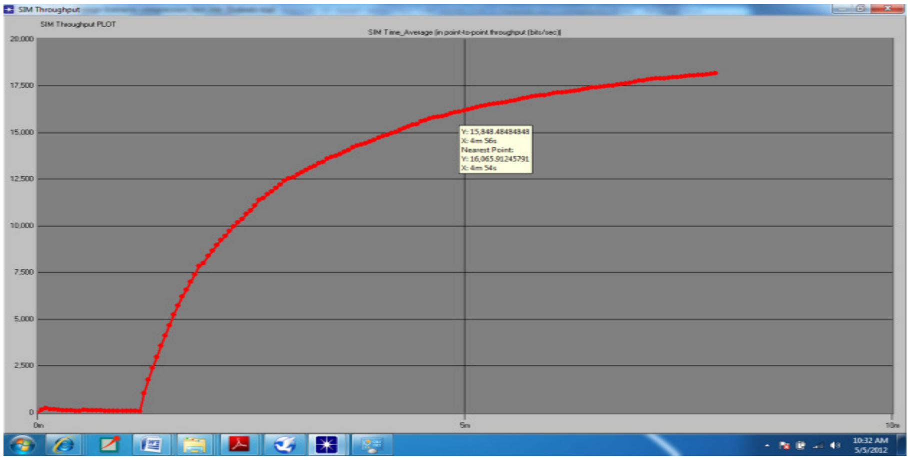
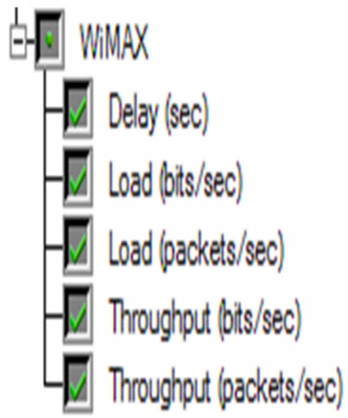


Figure 5.6. SIM Throughput response



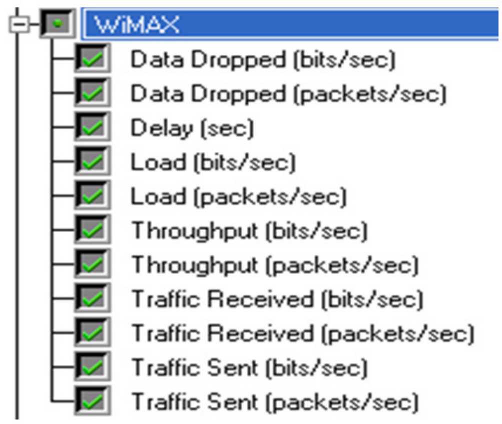
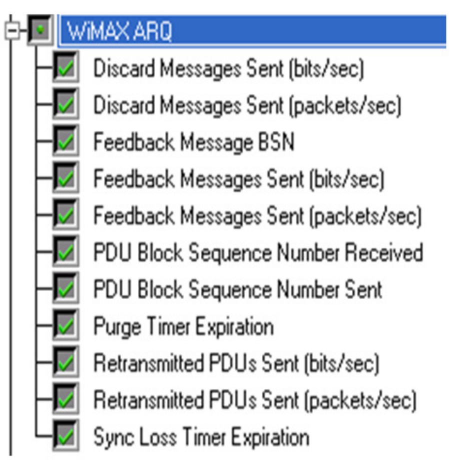


Figure 5.7. LTE WiMAX Global Statistics, Figure 5.8. WiMAX Node Statistics- report on general WiMAX traffic at the MAC layer

Figures 5.7, 5.8, 5.9 and 5.10 depict the result reports on global statistics and node statistics in this work.



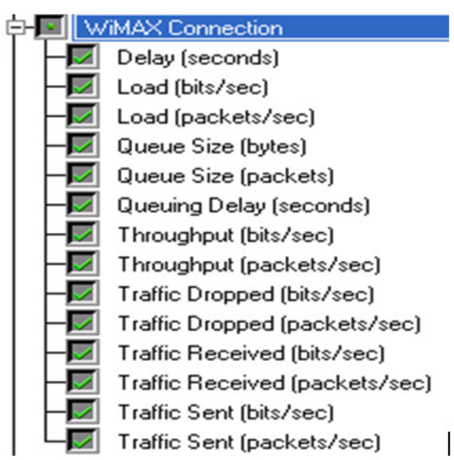


Figure 5.9. WiMAX Node Statistics-report on ARQ, Figure 5.10. WiMAX Node Statistics - report on node's uplinkanddownlink connections

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According to [15], connection efficiency (CE) was given as: Connection Efficiency = Admitted connections/Total connections. The SIM simulation model gave CE tobe 82.12%. Though under careful selection of our admission control values and other physical parameters, we anticipate a higher percentage.

CONCLUSION

This paper presents SIM for e-government integrations using simulation approach to validate the candidate scheme. It presents e-government benefits, dimensions, services, and technologies while focusing on the analysis of SIM simulation results. The e-portal with our back office offers a cost effective infrastructure unlike the traditional server centric models. Besides, it evident that packet drops dramatically as well as performance when outside coverage area in conventional WLAN networks. Following the con temporariy 4G LTE technologies, this paper shows a near perfect through put response within our mode land good connectivity efficiency (CE of82.12 %) enhacing file transfer at all instances. We trust that all e-government delivery models will adequately benefit from SIM proposal.

FUTURE SCOPE

Our future works will be extended into several directions to address the challenges of service avaliability (network convergence and dynamic QoS procedures). SIM algorithms for admission control and predictional gorithms (to determine when to carry out access service network gateway relocation) will be investigated. Furthermore, SIM security will be analysed as well.

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