Multi Agent Management System for Next Generation Mobile Networks. [MAMS for NGMN]

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Abstract:

Future generation mobile networks provide a plethora of multimedia services to the customers at all times and at all places. Satisfying the dynamic needs of the customers requires, complex network architectures and high performance delivery systems. Further the management of such networks really needs fast response and immediate solutions for all the network related issues. Developing new services managing customer expectations and providing such services with efficiency, effectiveness and with quality at optimal cost, are the challenges to be handled by the next generation network management systems. Hence there is an urgent need to enhance the functional aspects of the current day network management systems, so that the offered services are up to the expectations and are able to with stand the competition.

In this paper, we propose a Multi agent based management system for the next generation mobile networks, with the focus on the Long Term Evolution (LTE) network. This proposal will provide an effective management mechanism, capable of executing different management functionalities, through interactive, mobile, autonomous and cooperative agents, moving across the network and also interacting with different network nodes/ components, for effective Fault diagnosis and Configuration management. Our model utilizes the basic simple network management environment, accesses the objects in the Management Information Bases of the corresponding devices and facilitates quick identification of faults and suggests necessary reconfigurations for better performance. As a verification check, our mechanism demonstrates considerable improvement in performance, in comparison to that of standard SNMP, in terms of Fault identification, bandwidth utilization, processing time and also reconfiguration of the Networks and their resources.

Key words: Multimedia services, LTE network, Multi Agent based Management System, SNMP, Management Information Base, Fault Diagnosis and Configuration Management.

I .Introduction

Next Generation Mobile Networks consist of heterogeneous wireless networks of different technologies, coexisting and interoperating to provide required services for the mobile user. It will be a mix of many generations like 2G, 3G, beyond 3G, and also WiMax, developed over the last two decades, in addition to LTE network. The architectural complexity and Ubiquity nature of these modern networks add higher degree of difficulty to the service providers and network managers, whose tasks are getting compounded with increased expectations of the customers. Under these circumstances, providing good quality of Service (QoS), to the demanding users and keeping them happy at all times, will be a nightmare to the service provisioning people and their processes. Thus there is an urgent need to have an automated, highly responsive and agent based management systems, to address multi dimensional issues of the next generation mobile networks, which have inherent problems associated with the critical mobility factor.
Generic, NGMN set up is shown in Figure 1.

Monitoring the network components, quick identification of the faults, analyzing the effects and scaling the network resources with the relevant configuration changes to meet the customer needs on real time basis, with efficiency and effectiveness are the fundamental process components of today's Network management systems. The most common, Simple Network Management Protocol, being the

application layer protocol, operates on the basis of Client /server model. It is unable to handle the dynamic network changes taking place in the mobile network and is grossly inadequate for the effective network management [1] and [10]. In today's network management systems, various tasks are generally static and consume more network resources, especially the bandwidth and add to latency [2].

Though the Distributed network management systems have been in existence for some time, the computational load of the network analysis has not been successfully distributed due to its implementation limitations [3].

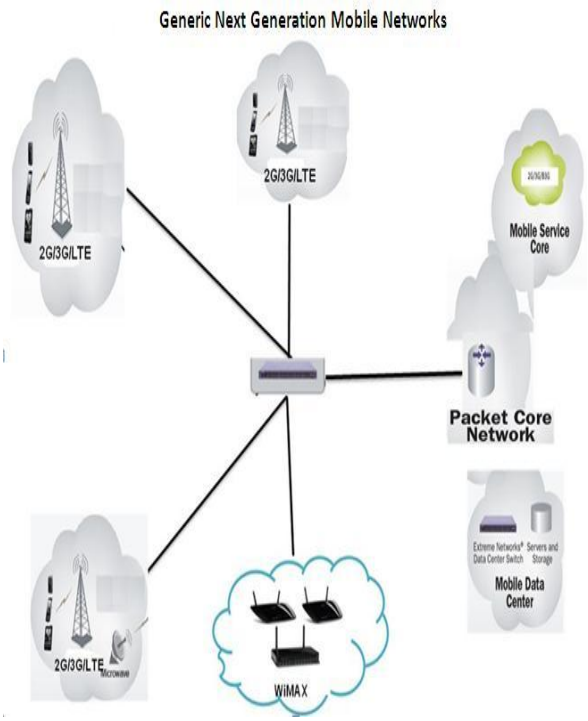

Figure 1.Generic Next Generation MobileNetworks

Thus the mobility factor of the mobile networks demands a quick response. Software agents based logical frame work can support dynamic devices and bandwidth hungry applications to achieve end to end results in a diligent way to ensure customer delight and to minimize customer churn.

Active research is progressing fast towards building the agent based network management systems, in order to find out optimal solutions for managing the next generation mobile networks. With the inbuilt intelligence, mobility and coordination with their peers, mobile agents can manage the rapid changes of these complex networks and carry on at site computations and thus increase the speed of the associated functionalities [4].The rest of the paper is organized as under:

Section 2, highlights the relevant work, with the identification of the limitations of the current day network management systems in practice. In section 3, we discuss the suitability of agent based technology tools utilized for our proposal to achieve the goal of obtaining better performance of the proposed network management system functionalities. LTE net work simulation model and the simulation results are discussed in detail. Finally we conclude the paper with the results and future challenges in the last section.

II. Relevant work-

Deployment of LTE/ SAE as the next generation mobile network and its related services is the major goal of NGMN Alliance's Ecosystem Working group[5].Inter working of networks, composed of different technologies operating in distinct frequency bands cause number of challenges to the Operators/ service providers as they deploy these networks. The co-existence of existing technologies with the new NGMN deployment and the impacts from the lack of network, consistency in network performance, between these heterogeneous networks are the major issues that should be managed at the network management level and hence the application of agent technology is more appropriate at this juncture. Some of the key parameters to be addressed are radio access network selection, handovers and active- idle transition, which need to be handled in robust and reliable way, using mobile agents with their agility.

To make the best use of the mobile agents for NGMN management, we propose a flexible architecture in which Agent manger invokes multiple agents, keeping in view of the services being offered in the network and forms a layer on top of the SNMP infrastructure. This approach enables us to exploit the advantages of SNMP and the management system can easily handle the legacy systems for better coordination of the heterogeneous NMS. In their paper [6], Andrzej, Bernard and Tony elaborated their views on the application of mobile agents for network management; however the thrust was on theoretical issues only.

D. Gavalas et al [7] gave good presentation of the application of mobile agents in transferring bulk monitoring data and acquiring atomic table views of the simple network management protocol. But the compatibility issues were left to the imagination of the readers/ network managers. The work done at Carleton university is very interesting , since the actual mobile code was utilized for managing the network and hence provides a strong base for the implementation projects in this area.[8]

Robert Pinheiro, et al [9] describe a conceptual model that collects data relevant to the management functions, across the network components and enables the availability of aggregated statistics with the help of mobile agents. The focus is more on monitoring data and various agent adaptation mechanisms.

III. Proposed Model

In this proposal, we present the many advantages of multi agent based management system, with regards to the important functionalities like Fault Diagnosis and Configuration management, in order to achieve quick results, with an optimal utilization of the currently available network resources of the NGMN.

Performance related parameters measurement in mobile networks, with centralized SNMP based management is really a Herculean task, because of the network delays and information bottlenecks at the manager node. Having the flexibility of analyzing the nodes locally, by virtue of their movement across the network, mobile agents can provide superior solution to performance management in comparison to the conventional management systems.[11]and [12].

In this case the Agent manager invokes and dispatches the agents to various destinations of the network components and the agents will carry on the assigned tasks on the move and follow the instructions as per the defined norms or wait for next steps. The clear advantages in this regard are as under:

- Specific and correct info is collected on the spot without any delay.
- Instant manipulation of the data at the node itself quickens the process.
- Filtering operations minimizes the quantity of data transfer and extracted inputs reach the Agent manager for further necessary action.
- Agent manager focuses more on monitoring the customer needs and contributes towards achieving customer satisfaction, by providing timely support to the NMS.

Figure.2 depicts the proposed agent interaction model for the NGMN management system. The network communication channels are used as the means for the mobility of the agents and agent manger controls the task allocation and the corresponding results as provided by the agent.

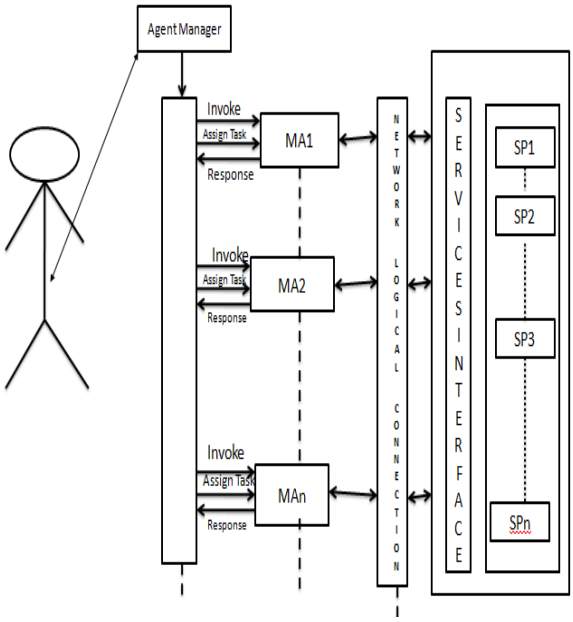

Figure 2. Agent Interaction Model.

We have used Java RMI for agent interaction amongst various components of the network, because of Java's portability across all platforms and ease of invocation of Methods. RMI provides for transfer of objects of complex data types via the object serialization mechanism. Both the Remote and Serializable classes have been utilized in this mode; for ensuring faster interaction of the launched agents, by the Agent Manager. Class diagram, elaborating the detailed interaction mechanism amongst the involved components is given in Figure 3.

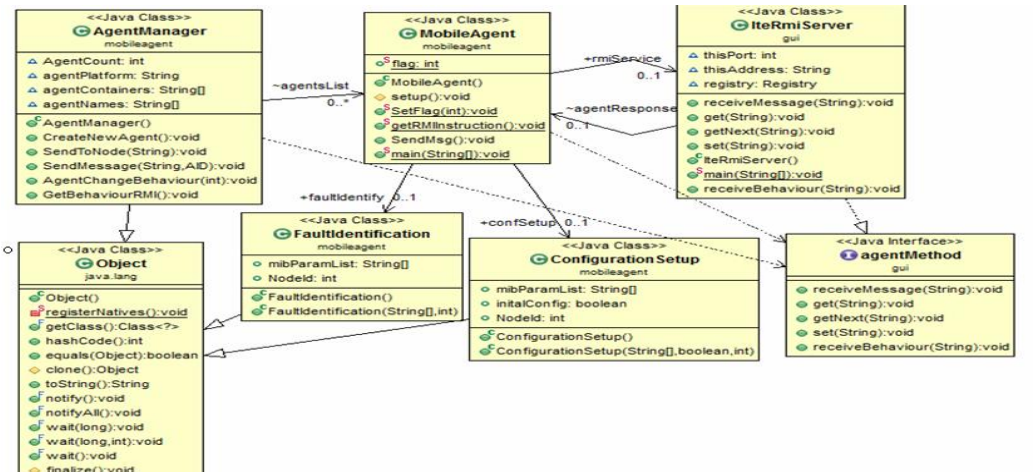

Figure 3 Agent Interaction Class diagram.

IV. LTE Network Simulation Model

we have simulated a ten node network to prove the concept , understand and analyze the results, in order to validate the proposed model being suggested for managing the Next Generation Mobile Networks, predominantly that of LTE[10]. Simulation parameters are listed in Table 1 for information and ease of understanding with clarity. Simulated network diagram is shown in Figure 4. Here we adhered to JADE (Java Development Environment) tool, because of its flexibility and support for dynamic mobility and interaction of the agents. Key classes and object parameters have been customized to cater for the limitations of the simulatuion environment using Java. Here the focus has been on the behavioral aspects of the network elements and the corresponding impact on the over all network performance and the services. Some of the features of NS3 have been effectively utilized for creating the real world environment.

Table 1 Simulation Parameters

Parameter Name	Range	Description
Bandwidth	ULINK:1920–1980 MHz DLINK : 2110 MHz – 2170 MHz	ULINK: 50Mbps. DLINK:100Mbps
Resource Blocks	1.4 MHz – 6 RB 3 MHz – 15 RB 5 MHz – 25 RB 10 MHz – 50 RB	eNodeB spectrum channel bandwidth
Protocols	SNMP,UDP, RTSP	
Packets	Data, Multimedia	IPv4 packets
eNodeB Type	Macro,eNodeB base-station specification	10–15 eNodeB Macrobase-stationsconsidered
Communication	Socket, RMI	

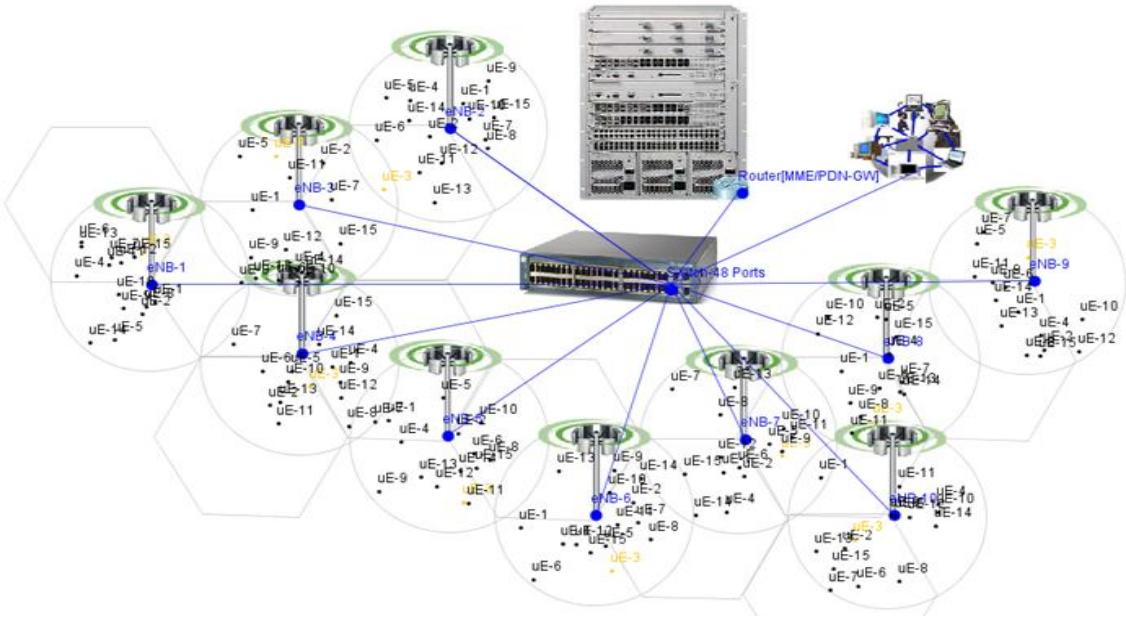

Figure 4 Simulated LTE Network

V. Simulation Results and Analysis.

It is evident from the result analysis that the overall performance of the Multi agent based network management system is much better than that of the standard SNMP. For comparison purpose, we have looked at the following parameters, carefully and projected the corresponding results in the graphs given below. Critical observations are in respect of the Fault identification and Configuration management parameters, which play very important part in an optimal network management system.

Figure 5 indicates the time advantage in fault identification by the proposed multi agent based management system. The important issue is its effectiveness with the increased MIBs and the corresponding objects, which contribute for fault diagnosis.

Second parameter as shown in figure 6 is the utilization of band width by both the network management systems, where agent based management system outplays the SNMP.

Third and most prominent parameter we have considered is that of the overall performance in terms of the processing time corresponding to that of

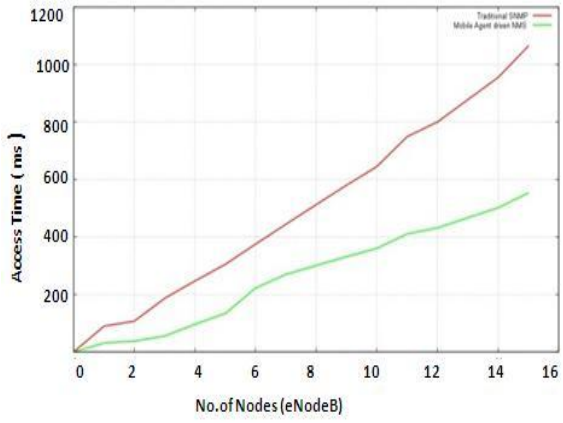

Figure 5 Fault Id Time Vs No of Nodes

Fault identification and Reconfiguration to overcome the anticipated faults and the inherent damages that can result in network break down etc. Figure 7 indicates the advantage of using agent based NMS in terms of overall reconfiguration of the network, for effective service provisioning.

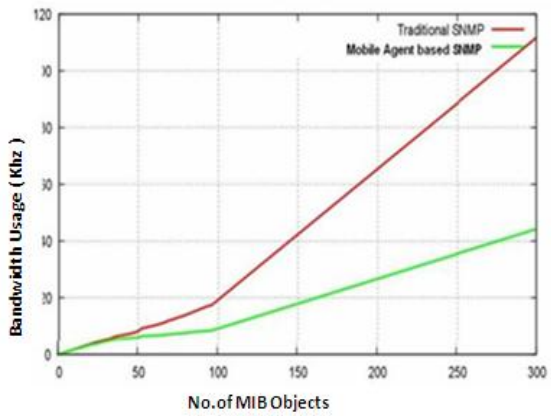

Figure 6.Band width utilization Vs No of MIB Objects

Fourth important parameter is that of the overall performance in terms of the Reconfiguration setup corresponding to that of the time and No.of eNodeB s Figure 8 indicates the advantage of using agent based NMS to manage more number of MIBs.

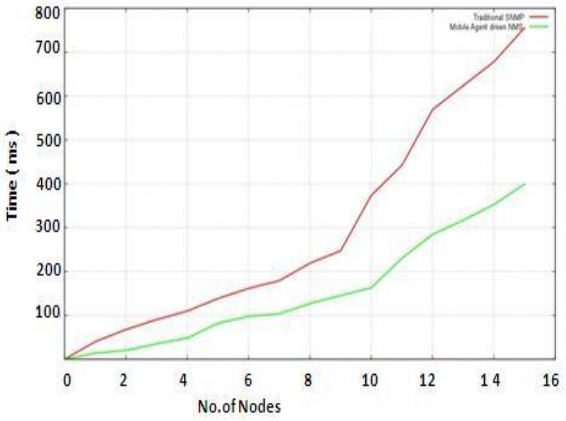

Figure 7: Response Time Vs No.of MIB Nodes

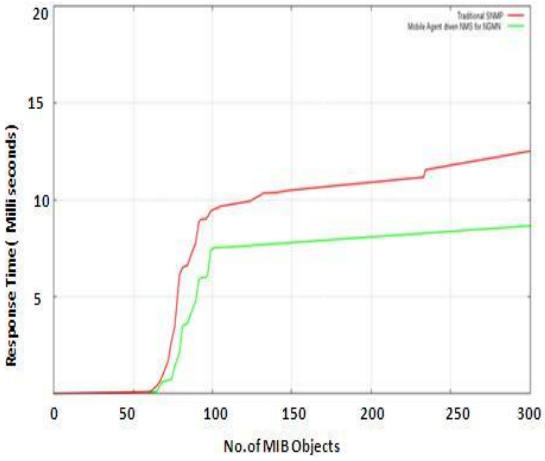

Figure 8 Re Configuration Time Vs No. of MIBObjects

VI. Conclusion and Future Work.

Network Management system is one of the critical components of the overall Services provisioning and management process and in turn contributes a lot for the business growth of any Service Provider. Next generation mobile networks are more complex, with the different system architectures, interoperability and integration issues of number of net work devices and their connectivity across the heterogeneous nature of the Networks. In order to address these complex issues of the present day Network Management aspects, Multi agent concept has been applied and this approach yielded very encouraging results, thereby we could identify the faults faster and complete the corresponding Configuration changes to provide quick and satisfactory services to the network users.

As the next step, we will be addressing the more challenging tasks of overall Network performance, the critical Security issue and the Accounting aspects, to have a complete set of NMS functionalities for Next Generation Mobile Networks.

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