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Scalability and Performance Analysis of SIP based Multimedia Services over Mission Critical Communication Systems

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ABSTRACT

Various studies have suggested enhancing the performance of large-scale systems, such as mission critical communication systems (MCCSs). However, few have modelled and evaluated the performance of such systems in a way that targets overall system performance in real time. Moreover, it is not enough to define the Key Performance Indicators (KPIs) for a system without using them for system performance measurement and performance evaluation. The Session Initiation Protocol (SIP) and IP Multimedia Subsystem (IMS) both have a set of KPIs, such as the registration process delay, that can be used to measure and thus optimize overall system performance. This article articulates different options for system simulation and evaluation. The registration process affects performance and reflects the overall system performance. The article shows how the registration process is delayed and how the overall system scalability are negatively impacted by system overload.

KEYWORDS

IMS, IP Multimedia Subsystem, Long Term Evolution, LTE, Modelling, Performance Evaluation, Session Initiation Protocol, SIP

INTRODUCTION

IP Multimedia Subsystems (IMS) (3GPP, 2006) and Session Initiation Protocol (SIP) (Rosenberg, 2002) performance play a major role in multimedia communication networks by altering the Key Performance Indicators (KPIs) related to the Quality of Experience (QoE) metrics of the end-to-end service. Registration Request Delay (RRD) is one of the SIP KPIs that also influence both IMS KPIs and end user QoE. Therefore, it is crucial to evaluate the performance of both SIP and IMS based on the RRD metric in order to give an indication of the overall system capacity and scalability potential.

5G communications is the new technology that will integrate multiple access technology in to one integrated solution adopted by all vendors and manufacturers. End users and devices will be able to communicate seamlessly with fewer restrictions and more options compared to older technologies Scalability is among the challenges that limit the exploitation of the full capabilities of the current technologies. Many recent studies have tried to overcome the scalability challenge associated with the 5G standards set. A new integrated solution with external SIP application that is accessed over

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LTE with different voice codecs is introduced in other studies (Haibeh & Hakem, 2017). However, the solution proposed lacks the support of standardised adopted solutions thus introducing complexities in implementations. In a similar SIP performance evaluation an enhancement trial (Subramanian & Dutta, 2009), transaction states of the SIP server are characterised to model the performance of the server. In the trail M/M/c queuing model was used along with a benchmarking performance indicator that reflects system performance. The trial showed that the multi-threaded architecture utilising parallel processing of SIP messages provides a more scalable and efficient solution for larger number of clients. However, the study was based on simple SIP servers that do not reflect more complicated processing required by multimedia services that tend to use more than one SIP server.

Another study (Ono & Schulzrinne, 2008) used the Stream Control Transmission Protocol (SCTP) as a transport protocol for SIP messages instead of TCP and UDP. The implications of using different transport protocol over SIP scalability and performance is presented and it is shown that SCTP has a negative implication over SIP scalability due to the added overhead. Other research (Yavas, Hokelek, & Gunsel, 2016) has focused on the scheduling mechanisms to prevent SIP system overload and to increase its scalability, the proposed solution uses a priority-based mechanism to dynamically estimate the behaviour of the server and provide a more scalable solution compared to the conventional SIP servers. Again, this study evaluates one single SIP server.

This paper analyses how overall system capacity and scalability is affected by additional traffic generated when more users try to access the systems services. This could happen in a mission critical communication system during natural disaster or large-scale attack, resulting in a sudden increase in the number of users.

It was found that, within limits, the system's ability to process the registration requests per time unit increases exponentially when the number of users is increased. Once the limit is reached however, the number of processed requests starts to decrease and eventually degrade leading to system failure. The simulation results show that the system was able to handle a maximum of 7,400 registrations per second, a workload that could occur during a nationwide disaster with many users trying to access the Mission Critical System (MCS).

The need for a more detailed study of other SIP and IMS KPIs to provide a better understanding of the overall system performance is thus clear. The study will enable further progress towards system performance enhancement and optimization in order to avoid single point of failure of the system.

RESEARCH METHODOLOGY

A previously developed research methodology (Creswell, 2009) was followed for both the qualitative and quantitative approaches when setting the parameters for all measurements and simulations. The methodology for deciding the qualitative values that need to be investigated can be summarized as follows:

1. Determine the challenges that need to be investigated within the scope of the study. While the project embeds several challenges, the focus was placed on the signalling domain especially between the end user and the core network and the signalling interface between the core network and IMS.
2. Determine the benchmark for what is considered acceptable SIP performance and decide on the metrics that will be measured and used to judge and compare the performance of setup.
3. Decide the appropriate simulation tools to generate the results from multiple sources that meet the appropriate comparison criteria based on the selected tool.
4. Determine the key factors that affect the SIP signalling, in addition to multimedia services operation in LTE and IMS that affect the overall QoS for the Mission Critical system.

Diabetes-Related Cognitive Decline, a Global Health Issue, and New Treatment Approaches

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