Measurements and Comparative of Resource Management in Satellite Systems

Pedram Hajipour, Leila Mohammadi

Abstract—In this paper we describe design and simulation of a queuing delay model base M/M/1 and M/D/1 in Next Generation Network of communication over Internet Protocol which satellite in different orbits are a test bed used to test call setup quality and some of the key performance benchmarks such as mean response time to process the Media Gateway Control protocol calls and mean number of jobs was reviewed. The two different call flows simulation process based on registration information situation that can be used as a test bed is described (Single phase or two phases models). The test bed simulation will use for deploying Next Generation Network services in order to verify protocols and features implementation. The call flows of the test bed also allow testing and evaluating over different delays in various signaling way. In our scenarios, satellite is a Media Gateway Controller node in call flows and ground stations are Media Gateway nodes.

Index Terms—MEGACO, COPS, single phase, two phases

I. INTRODUCTION

Voice over Internet Protocol (VoIP) are especially sensitive to delay issues where delay is already high due to the satellite link, propagation delay plays an important role in the link quality. The satellite communication systems have great advantages to MEGACO protocol as a technology that allows universal access to IP services.

In this paper, we use MEGACO(Media Gateway Controller).The MEGACO was introduced by working group of the Internet Engineering Task Force (IETF) and International Telecommunication Union (ITU) Study Group 16 which was later replaced by RFC 3525 [3,4,5]. Key contribution in this paper is obtaining a better understanding of the performance of the MEGACO structure when there is a call flow between two Media Gateways by a satellite. The M/M/1 and M/D/1 queuing models with propagation delay proposed in [6] was simulated on proposed network and presented analytical result. In this work, we use previous efforts in these area.Wu et al. [7] analyze the queuing delay and queuing delay variation using embedded Markov chains in a M/G/1 queuing model under varying service rates and network delays of an end-to-end network. Ross [8] treated an M/G/1 queue with the PER rule and server breakdowns having exponential inter-breakdowns and general repair times. Towsley [9] studied an M/G/1 priority queue with server failures having exponential inter failures and general repair times.

Lipson [10] presents an approach for using model checking of Markov Reward Models to analyze properties of a simple network. The focus is on transient properties related to the number of jobs processed prior to system failure or system repair. Rewards are expressed as simple rates of incoming requests for call setups. Hajipour [11] evaluated security in MEGACO structure which it has COPS protocol for managing packets in call flows.

II. PROCEDURE FOR PAPER SUBMISSION

A. MEGACO Protocol

As shown in “Fig.1,” MEGACO (officially H.248) is an implementation of the Media Gateway Control Protocol architecture [3,5] for controlling Media Gateways on Internet Protocol (IP) networks and the Public Switched Telephone Network (PSTN). The general base architecture and programming interface was originally described in RFC 2805 and the current specific MEGACO definition is recommendation H.248.1. MEGACO defines the protocol for Media Gateway Controllers to control Media Gateways for the support of multimedia streams across computer networks. It is typically used to provide Voice over Internet Protocol (VoIP) services (voice and fax) between IP networks and the PSTN, or entirely within IP networks. The protocol was the result of collaboration of the MEGACO working group of the Internet Engineering Task Force (IETF) and (International Telecommunication Union) ITU Study Group 16. The IETF originally published the standard as RFC 3015, which was later replaced by RFC 3525.

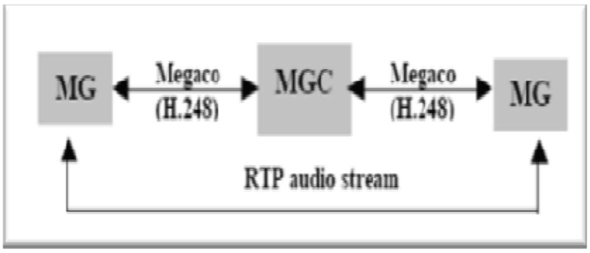

Figure 1. MEGACO Architecture

III. CALL FLOW SCENARIOS BASE MEGACO

A. Single phase call flow

In single phase model, the resource reservation and providing resources is done by the same time. In two phases model, firstly resource reservation is done and as the second MG is not Off-hook.

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There isn't an available resource. Now the assumption that routing distance of each other is so long that it can be embedded a heavy delay in queuing models for request/response commands for each scenario. Therefore there is a heavy traffic between the Media Gateway Controller and Bandwidth Manager. If the call signaling in network sent with best effort service quality, we can be accepted the correct conclusion that the delay between routers with network traffic is direct ratio.

"Fig.2," Illustrates stages of the proposed scenario for call setup between two Media Gateways by MEGACO in satellite system. The scenario is composed of the following stages.

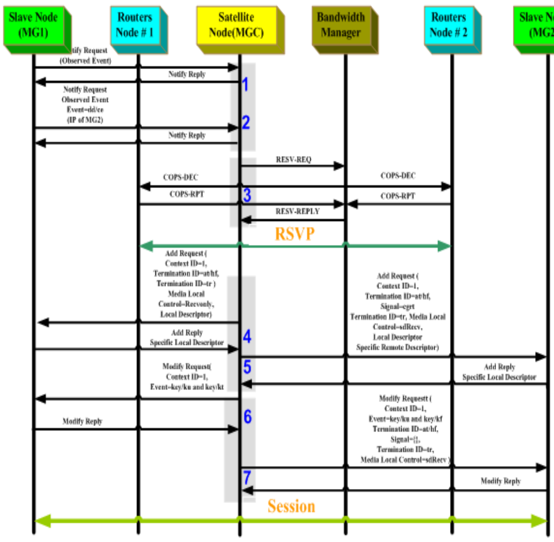

Figure 2. Single phase MEGACO call flow base resource reservation in satellite system

A. Two-phases call flow

"Fig.3," Illustrates stages of the two phases scenario for call setup between two different domains by MEGACO in satellite system. The scenario is composed of the following stages.

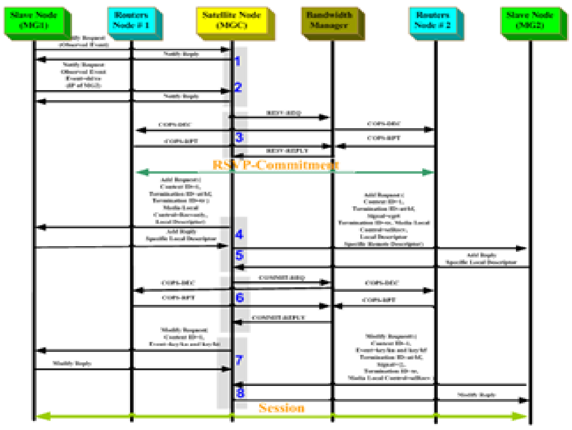

Figure 3. Two phases MEGACO call flow base resource reservation in satellite system

1. The aggregate arrival processes are approximately by a Poisson process. This is due to the well-known property that any process which results from the superposition of a large number of independent point processes approaches a Markov process, if each individual point process" thins out" within the result process.

2. The input and output processes traffic in one direction and according to Markov model, their previous values are not dependent. Call setup scenario was analyzed by M/M/1 queuing model.

3. Performance of MEGACO was analyzed by the mean response time and the mean number of jobs in the system. "Equation (1) is", Mean response time (the difference between the times it takes for a Notify) sent from MG1 to reach MGC until the final response is sent by MGC to MG1. Refer to "(2)", Mean number of calls is defined as the mean number of sessions that are currently in the system [6].

Mean number of jobs N (random variable) in the system at study state is given by the system at study state is given by currently in the system [16-21].

$$N=\sum_{k=1}^{J}\rho_k/(1-\rho_K) \qquad Where \qquad \rho_k=\lambda_k/\mu_k \tag{1}$$

$$\lambda_j=\sum_{k=1}^{j-1}(\lambda_k Q[k,j]) \qquad for \qquad 1<j\le J \tag{2}$$

J is equal to the number of stations in the queuing model. Q is the one step probability matrix corresponding to the queuing model; that is, Q [i,j]the probability that a job departing station i goes to station j. We obtained the mean response time for calls by Little's law which it is equivalent to:

R=N/λ.

4. In Queuing models, (single phase and two phases) only 80 percent of the Add Request messages will be successful in getting the Add Reply response and 90 percent of that Modify Request response will get the Modify Reply response.

5. Queuing models (single phase and two phases) are assumed as 0.5/μ for sending the Add Request followed by Add Reply, Modify Request and Modify Reply with 0.3 /μ.

6. The larger of two ways delay component in a satellite access system due to the location of the Geo Stationary orbit and the speed of light is the propagation delay between the satellites and the ground equipment, i.e.

"Equations (3,4) is", The mean response time and the mean number of calls for the M/D/1 queuing based MEGACO model can be obtained from any standard work [23,24,25] and are as follows: ($\rho=\lambda/\mu$)

$$w=\frac{1}{2\mu}+[1+\frac{\mu+\lambda cs^2}{\mu-\lambda}]..................(3)$$

$$L=\frac{\lambda}{\mu}+[2+\frac{\lambda+\lambda cs^2}{2\mu-2\lambda}]..................(4)$$

Where c_s is the coefficient of variation c_s is zero for the deterministic distribution M/D/c queue.

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IV. PROPAGATION DELAY MODELS

As shown in “Figs.4, 5” The GEO orbit is by far the most popular orbit used for communication satellite. A GEO satellite is located in a circular orbit in tee equatorial plane, at a nominal of 36000 km at a stable point, which sees the satellite at a fixed location in the sky. The propagation delay for GEO is between 220~240 (ms) which can effect network synchronization or impact voice communication [22].

The second most common orbits is the low earth orbit(LEO),which is a circular orbit nominally 160 to 640 km above the earth. The delay is approximately 10 ms, however the satellite moves across the sky. The propagation delay over the radio link for LEO is between 8~12 (ms).

The MEO orbit is in a higher orbit, 1600 to 4200 km. However propagation delay is bigger than from previous orbits. The propagation delay over the radio link for MEO is between 64~68 (ms). Today, numerous overseas calls originated in the United States are actually transmitted as VoIP over satellite calls, particularly if provided by the smaller long distance carriers.

V. CALCULATED RESULTS IN SATELLITE NETWORK

Each of the two phases and single phase models has certain advantages. In single phase flow model exchange less signaling between network equipment and this will cause acceleration in establishing a call. While the two phases model is used to optimize network resource management and as the second MG is not Off-hook, hasn’t occupied bandwidth and resources providing. Depending the satellite system can be used any of the two models. In satellite system with high traffic, the two phases model is suitable because it allow better use of resources. In This paper was considered former assumption mentioned and was assumed μ = 0.5, in order to calculate system’s mean response time with publication delay varying between 10 - 240 ms where the distance between MG and MGC is approximately 36000 km (“Figs.6,7,8,9”).

Each 15 km is assumed to be equivalent with 1ms delay. As one can see the mean response time with variation of arrival rate is approximately linear. The mean response time increases with propagation delay.

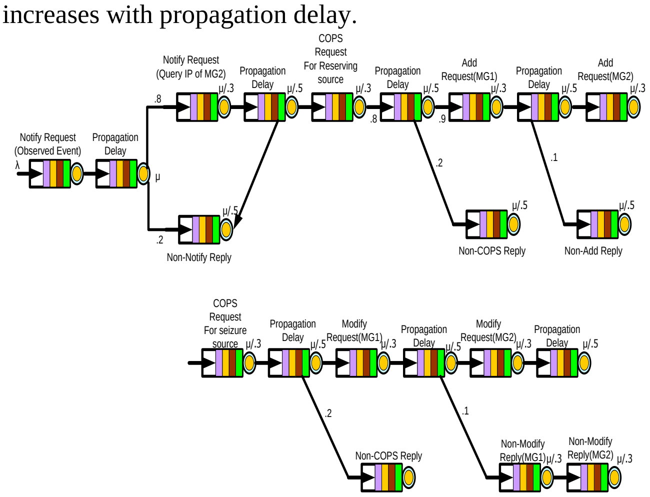

Figure 4. Single phase queuing model base MEGACO,(μ = 0.5)

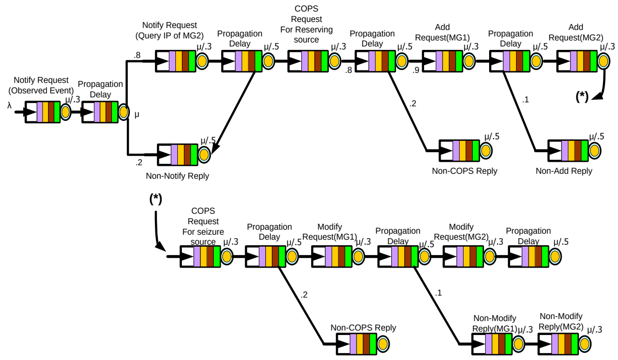

Figure 5. Two phases queuing model base MEGACO,(μ = 0.5)

VI. COMPARATIVE BETWEEN SINGLE PHASE AND TWO PHASES MODELS

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VII. ACRONYMS CALCULATED RESULTS IN SATELLITE NETWORK

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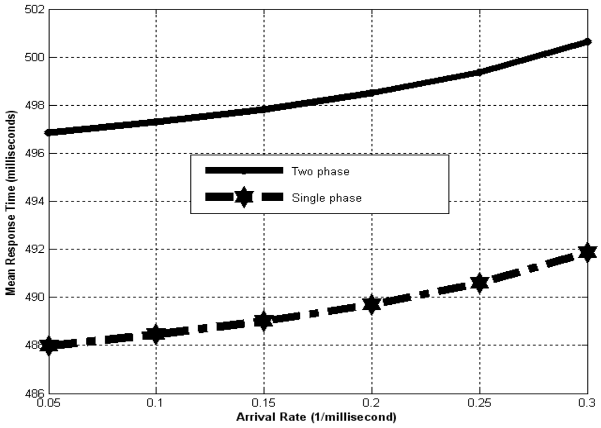

Figure 6. Mean response time base on arrival rate changes in M/M/1 model

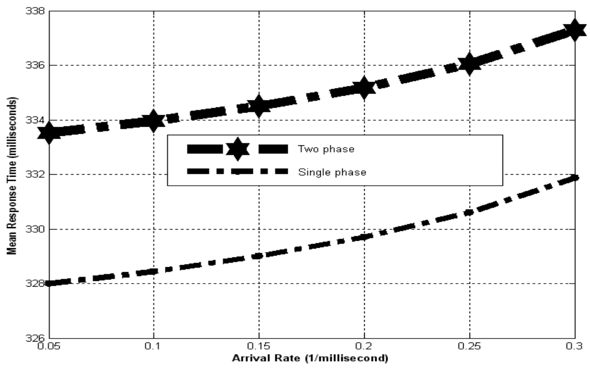

Figure 7. Mean response time base on arrival rate changes in M/D/1 model

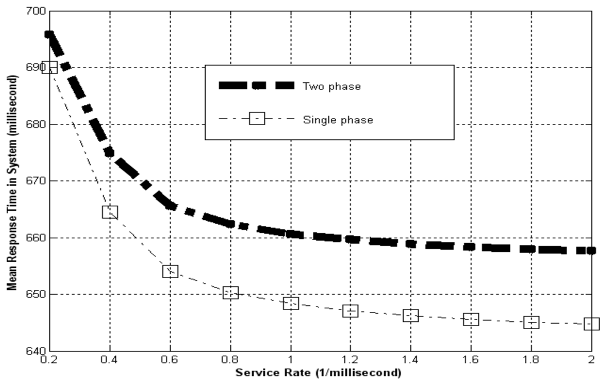

Figure 8. Mean response time base on service rate changes in M/M/1 model

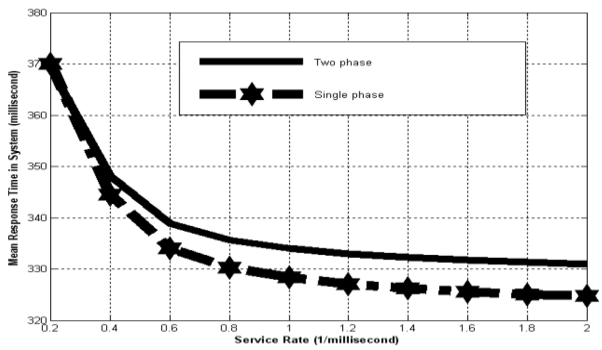

Figure 9. Mean response time base on service rate changes in M/D/1 model

VIII. CONCLUSION

We have presented performance models for MEGACO networks in satellite link and analyzed the behavior of the network under varying arrival rates, service rates, and network delays.

Based on the measurements and analysis, MEGACO network architecture was modeled by single phase or two phase ssmodels with propagation delay. We computed delay budget for call setup between MG and MGC and used from an M/M/1 and M/D/1models to calculate the delay budget and key metrics that were analyzed include (end-to-end) mean response times, (end-to-end) mean number of jobs in the system. In particular, our results show that for single server hosts and service rates of 0.5 ms-1, mean response times are Incident from satellite height.

We found two phases model is much better than one phase model when arrival rate changed because the mean number of jobs is low but the mean response time in two models is approximately equal together when service rate changed.

The average response time, success call and server utilization factor of the M/M/1and M/D/1 models were a predictable model with significant performance improvements and also met the ITU-T standards [23, 24]. In future, we continue to work on redesigning this queuing model based on the multi-threaded program model that is instead of M/M/1 or M/D/1 queuing model we intend to focus on M/M/C or M/D/C or the combination of both. Also intend to expand the study by redesigning the performance model with multiple MGCs located in remote locations and factor the network delays.

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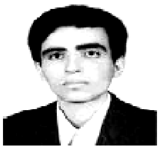

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