

A Study of Performance Evaluation Modeling Method for The 3rd Generation Mobile Communication Network.

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ABSTRACT

The 3rd generation mobile telecommunication fields are being standardized and developed in two parts, 3GPP and 3GPP2. These two parts have established each Network Architecture Models to achieve the goals basically required in the 3rd generation and to make it progress to IP network in the future. To achieve these goals many system architectures are proposed. Not only functional aspects but also performance aspects are considered as major factors. This paper proposes a new method of performance evaluation modeling and simulation that improved the existing way. The method proposed in this paper is Aspect oriented logical performance analysis Modeling and Simulation method. This proposed method is expected to improve efficiency of performance analysis modeling and simulation on the 3rd generation mobile telecommunication system.

1 INTRODUCTION

There is keen competition in the 3rd generation mobile communication field. For example, Europe is now trying to preoccupy the global market of the 3rd generation mobile communication system, centering Ericsson and Nokia. And Japan, centering NTT DoCoMo, is providing the 3rd generation mobile communication trial service called 'Forma' in 23 districts in Tokyo and Kawasaki, and Yokohama region from May 2001. Korea, centering LG and Samsung, is investing a large amount of money and human resources to develop the system to start the trial service at May 2002 world cup soccer game.

For the reason of this precondition, some major issues about developing the 3rd generation mobile telecommunication system can be summarized below.

1. Each manufacturer designs different system architecture.

2. The update of international standard specification(3GPP, 3GPP2) is being accelerated. (3 months in average)
3. Insufficient performance evaluation equipment environment.
4. Insufficient actual data about the 3rd generation mobile communication network traffic.

This situation comes to every manufacturer in common. There are some technical environments mentioned below in the background of this situation.

1. System control based on extremely complex and delicate protocol stack (See Figure 1)[1][2]
2. System performance variable changed from circuit traffic only to mixed traffic such as circuit and packet
3. Lack of standard system input data pattern due to the appearance of multimedia Domain based on VoIP.

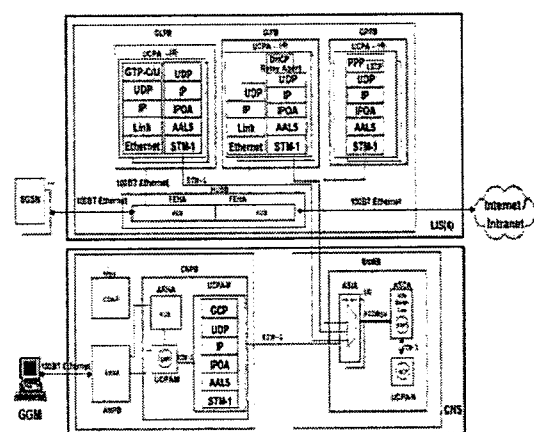


Figure 1. The sample of the 3rd generation system protocol stacks

Taking into account of this entire situation, systematic and practical methodology is needed to prove the 3rd generation mobile system performance.

2 THE LEGACY PERFORMANCE MODELING AND SIMULATION METHODOLOGY

To analyze the performance of the system, the following processes that are commonly applied to most large-scale systems are required.

1. Define the "Lumped Model" with focusing on the major factor that is required to measure the performance of the real system.
2. Modeling of the algorithm and the functional processes that are related with Sequence Chart, State Transition Diagram, and Major signal processing, affecting the performance of the system.
3. Modeling of the input Data based on the probability.
4. Development of simulator software.
5. Extract the variant output after inputting the various data into the simulator.
6. Analyze the performance of the system and major issue, based on the extracted output data.
7. Fix the functional problem and improve the performance of the system.

We can summarize the application of the methodology, which is used commonly so far, to the mobile communication system.

1. Model the mobile communication system whose performance you want to analyze. In this case, the method that models the architecture of system from the viewpoint of the hardware has been commonly used, decomposing the hardware of the system into several modules or subsystem, modeling each decomposed ones and assemble them.
2. In general, the mobile telecommunication system takes the architecture that basically composed of two parts, one is the part that controls the function of the system and the other is the part that passes the traffic.
3. In the modeling of the system operation, it is commonly used to apply 'Queuing Model' to each unit that composes the system. (See Figure 2)
4. In the modeling of the system functions that controls the entire system, most functions are operated, based on the protocols. So the protocols of the each layer are defined, and interoperability mechanism of the each protocol is modeled.

5. The simulator is built in accordance with the sequence in which the real system function operates. And the simulation that is very similar to real operation is carried out on the virtual environment of computer.
6. In the case of mobile communication system, the basic concept of input data modeling is mobility relates probability. The typical input data pattern can be defined such as handover, location registration, mobile to land, land to mobile, mobile to mobile.[3]

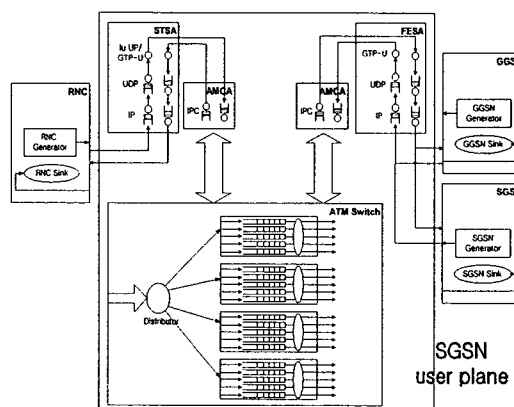


Figure 2. Queuing Model

3 THE PROBLEMS OF LEGACY PERFORMANCE MODELING AND SIMULATION

As described above, the simulation of mobile network system needs enormous efforts and cost because of its large capacity and complicated procedures. With a the 3rd generation mobile communication system, this procedure is more complicated and the cost for the performance analysis is bigger.

If only the exact performance result could be predicted as the result of this method, this could be a meaningful method even with the extra cost. However, when the simulation which use simplifications according to the importance of the hardware module is proceeded without proper considerations of system software a number of system software programs are applied where distributed computing is common in mobile communication system, its result is not reliable.

Including the detailed parts of the system can avoid those problems but the entire process of making the simulator becomes such a big job and a huge amount of cost is inevitable. The problems of the 3rd generation mobile communication system modeling & simulation are below.

1. The usefulness of the simulation result is depreciated.
2. The cost for the simulation becomes more expensive.
3. The understanding of the existing problems of the system and the improvement with the simulation result are unlikely.

4 COMMON CHARACTERISTICS OF THE 3RD GENERATION MOBILE NETWORK

This paper considers several issues to resolve the problem above. The essential and common issues of the 3rd generation mobile network are summarized here. These common issues are providing exclusively operating environment in the system, in proceeding the modeling of the 3rd generation mobile network to measure the performance.

1. Distributed system architectures where a number of processors have their own roles.
2. The entire system's processing power is the total sum of the unit processor hardware performance via IPC (Inter Processor Communication) among processors.
3. Traffic part and Control part are discrete.(this is more emphasized with All IP)
4. A perfect 7 layer protocol stack structure (symmetric protocol processing model between peer layers)[4]

5 INTRODUCTION OF ASPECT ANALYSIS MODEL

The aspect analysis model that this paper is introducing is theoretically based on EA(Entity Aspect) model. EA model is a knowledge expression model with basic concepts and structure principles of system entity structure proposed by Zeigler.[5][6][7] This model is composed of the nodes expressing the entities of real world of consideration, the aspect nodes expressing the aspects of consideration of the nodes, and the links expressing the relationships of the nodes. Three abstract concepts of decomposition (aggregation), specialization (generalization) and multiplicity are used in this hierarchical tree structure.

Base on the theoretical background the 3rd generation mobile network, which is the object this analysis, could be divided by the performance aspects and modeled to have the effect of division and simplification. The target system can be modeled and simulated at the each aspect where the actual measurement of performance is needed, which yields many advantages.

The needed aspects to analyze the 3rd generation mobile network are already decide based on mobile network's traffic characteristics and network architectures, the analysis of the necessary aspects will give in the all the information for the system performance analysis which acquired in total. This could be applied for analyzing specific performance aspect, in some cases.

6 ASPECT ORIENTED LOGICAL PERFORMANCE EVALUATION MODELING (AOLM)

The new methodology for the 3rd generation mobile network performance analysis that this paper is presenting, is summarized below with introduction of aspect oriented modeling and the 3rd generation mobile network common characteristics. The name of new methodology is Aspect Oriented Logical performance evaluation Modeling(AOLM).

1. The modeling is preceded by logically dividing the system with necessary aspects. Logical division of the system with necessary aspects means the modeling is not done with hardware structure but done with logical structure. Especially, traffic and control parts are modeled to separated entities logically. This provides an efficient division of the target system and the system performance can be confirmed in various aspects additionally.
2. System performance parameters BHCA and Earlang, which represent the entire system performance, are changed to logical parameters represent each aspect.

This change of parameters means the result is transformed into proper logical unit where the simulation is proceeded by aspects. In the 3rd generation mobile network, Requirement Specification that the Service Operators all over the world are using, has different traffic models. This proves that they know the falseness of the performance measure results of a whole system. Now, various performance results are required for Internet traffic processing capacity, Voice traffic processing capacity, and forwarding calls processing capacity, etc.

Especially when the service operator provides pure data services only without any voice subscribers, it tends to require the performance of its service domain only and not the total performance including other domains. Existing service operators that provide various services are requiring a specific domain's performance when

they have a strategy to specialize that service area. In those cases, the AOLM technique has its own strength and could be presented as such.

3. The unnecessary HW & SW modules are excluded

The situation that is applicable to this AOLM happens to be the exception of hardware modules (including processor and devices), which perform functions not related to the aspects. This could be the logical basis of Lumped Model with the existing performance modeling view. This approach causes effect of division and simplification of target system.

Protocol is another field that this AOLM can be applied. The protocol layers that already approved could be removed from the logical model in real. In case of the 3rd generation mobile communication system, the usage of commercial software protocol to construct system is a general tendency of many vendors due to innumerable appearances of protocols. Because the measurement of efficiency for each protocol was essential for configuration of entire system in legacy method, every protocol had to be included for modeling and simulation. And it was concerned as core element of configuration of entire system.

But it is meaningless to certify the commercial software protocol, which has been sufficiently certified by supplier, for simulation of system efficiency. Accordingly, It is possible to remove resolutely unnecessary part using AOLM.

4. Independent processing of logical modeling and simulation by each aspect.
5. When the result of each aspect simulation satisfies each logical aspect target of efficiency, the target system efficiency satisfies the total target system performance.

7 THE EXAMPLE OF APPLICATION

The target system that suggested as AOLM is MSC for Circuit Domain and SGSN for Packet Domain, which are the core systems of IMT-2000 mobile communication network the base of the 3rd generation GSM network.

The reason we selected these systems as a sample of AOLM target is that those are the core equipment in the 3rd generation mobile communication network in Figure 3.

Especially, these also will be the core equipment in All IP Network.

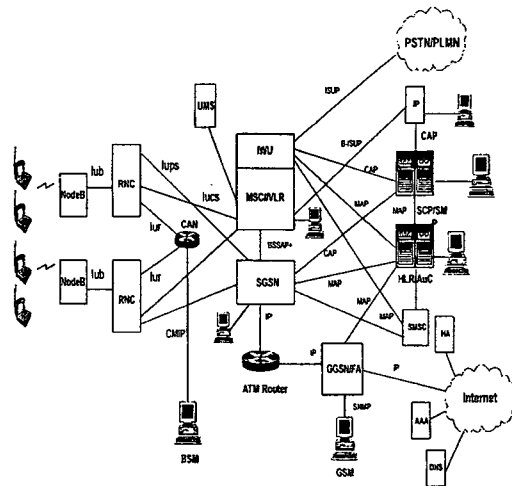


Figure 3. the 3rd generation mobile communication system

So through the sample application, we can confirm the possibility of AOLM application in the All IP network.

System	Performance analysis aspect
MSC	Voice local call
	Broad band voice trunk call
	Narrow band voice trunk call
	Subscriber Mobility (MAP)
	Routing & billing
	No.7 signal
SGSN	Packet call
	Packet traffic handling
	Subscriber Mobility (MAP)
	Routing & billing
No.7 signal	

Table 1. Example of aspect based AOLM.

In order to simulate the narrow-band trunk call performance, the logical model is restricted to the special processor (ex: SSP) and the narrow-band trunk call performance will be 0.55 million BHCH, though the total system call performance is 1.3 million BHCA.

When the narrow-band trunk call is logically modeled, the related software modules are reduced four blocks, related hardware processors are reduced three specific processors, and other device components are reduced three modules. The Figure 4 shows the result of application of logical performance analysis modeling method based on aspect.

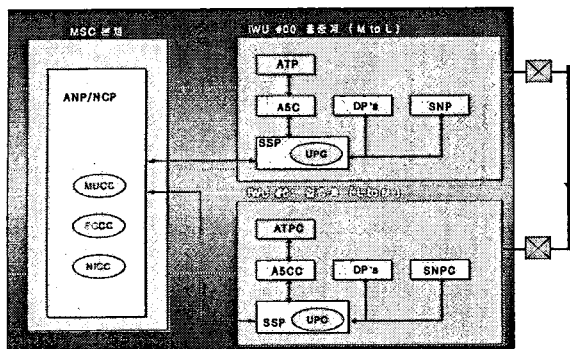


Figure 4. The example of AOLM for narrow band voice trunk call

The above example shows that the result of AOLM modeling is very simple in comparison with the modeling of total system. Although the result of modeling looks simple, it includes every system components needed to evaluate the performance of narrow-band trunk call aspect.

8 FUTURE WORKS

General methodology of aspect classification, the criteria for selection of entity, formal expression of AOLM need to further study.

9 CONCLUSION

This paper verifies the existing problems of the modeling and simulation for the 3rd generation mobile network performance evaluation, and propose the new aspect oriented logical modeling(AOLM) methodology to solve those problems. The actual fields and effects of the AOLM methodology are also presented for applying it to the 3rd generation mobile network with several actual cases that confirmed this methodology's availability in real situation.

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