Performance Analysis for Base Station Controller in Mobile Communication Networks

Seog Ku Lim*
Division of Information and Communication Engineering
Cheonan University, Cheonan, Korea

ABSTRACT

Base Station Controller which belongs to IMT-2000(International Mobile Telecommunication - 2000) network has several types of structure for efficient control protocol. This difference of structure occurs two different protocols for call handling. Recently the need of IMT-2000 is highly increasing, so it is important to analyze the performance of processors and IPC(Inter-Processor Communication) module with structure of BSC and protocol difference. This paper presents the performance comparison of different types of BSC in view of processor utilization, waiting time, queue length and QoS(Quality of Service) through the simulation model.

***Keywords**: Author Guide, Article, Camera-Ready Format and Paper Specifications.*

1. INTRODUCTION

It is envisaged that IMT-2000(International Mobile Telecommunication – 2000) networks will evolve from the existing wireless and/or fixed networks by adding the necessary capabilities to support IMT-2000 services and features[1]. Generally mobile communication network consist of MS(Mobile Station), BTS(Base Station Transceiver subsystem), BSC(Base Station Controller), MSC(Mobile Switching Center), and so on. To handles the increasing traffic in IMT-2000, it is required to analyze the performance of BSC.

The BSC is located between BTS and MSC that uses CDMA(Code Division Multiple Access) digital mobile communication technology and controls up to 48 BTSs. The BSC has a lot of functions - BTS maintenance, radio channel maintenance, control of several types of handoff, converting the voice packet data with Q-CELP method to PCM data. It controls calls that are set up through BTSs and carries out maintenance on BTS and BSC.

The following two types of BSC are prepared for the effective support of BTS establishment according to the scale of service areas. Each BSC designed to interface flexibly according to the distance between MSC. This difference of structure influences protocol architecture and performance. The non-collocated BSC type is a BSC for medium and small sized cities that are remotely located from the already established MSC and EIA/TIA IS-634 standard protocol is applied. The collocated BSC type is a BSC for metropolitan areas and uses internal IPC(Inter-Processor Communication) and its protocol uses internal specification. These protocols have different number of message and processing time of processor per message.

The rest of the paper is organized as follows. Section 2 describes briefly the structure of non-collocated BSC type and collocated BSC type, each call flow and protocol. Section 3 presents the simulation model and parameter for analysis. Section 4 shows the simulation results by simulation tool(SLAM II) and compare the performance of call processing power of processor in view of GoS(Grade of Service). Finally, we summarize the result of comparison, followed by a summary of the paper.

* *Corresponding author. E-mail: sklim@infocom.cheonan.ac.kr*
Manuscript received Sep. 15, 2005 ; accepted Oct. 10, 2005

2. STRUCTURE AND PROTOCOL OF BSC

2.1 Structure of BSC

The BSC consists of high-speed traffic packet router, selector/vocoder for handling voice data, processor for call control and digital trunk connection part. The type of BSC is decided by configuration of connection part with MSC e.g. non-collocated BSC type and collocated BSC type[2].

First the configuration of non-collocated BSC type is shown in Fig. 1. This type is a BSC for medium and small sized cities that are remotely located from the already established MSC. The MSC and BSC are connected through No.7 protocol using E1/T1 links. All the BSCs in the different places are designed to interwork with each other in certain areas. Accordingly, soft handoff process is possible between BTSs and the interworking BSC. EIA/TIA IS-634 standard protocol is applied to the high level protocol between the MSC and the BSC for non-collocated BSC. One BSC can control maximum 48 BTS and has packet bus for control of traffic data and vocoders for protocol conversion of PCM data.

Second the configuration of collocated BSC type is shown in Fig. 2. This type is a BSC for metropolitan areas. All the BSCs are interfaced each other. Therefore, even though they use different BSCs, the calls among all the BTSs belonging to the MSC are processed as soft handoff in handoff control. For this process the interface between MSC and BSC uses internal IPC and its protocol uses internal specification. The collocated BSC is designed to interface with the G-bus(Global Bus) between ASS-W(MSC) and BSC, and has a function of protocol conversion(GW). The vocoder block is connected with time switch in MSC subsystem by sub-highway.

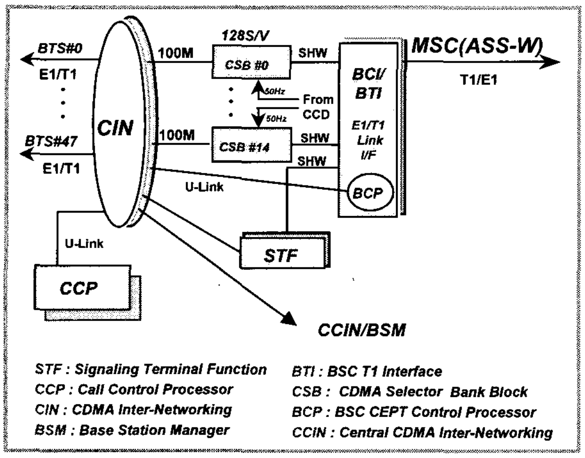


Fig. 1. The configuration of non-collocated BSC type

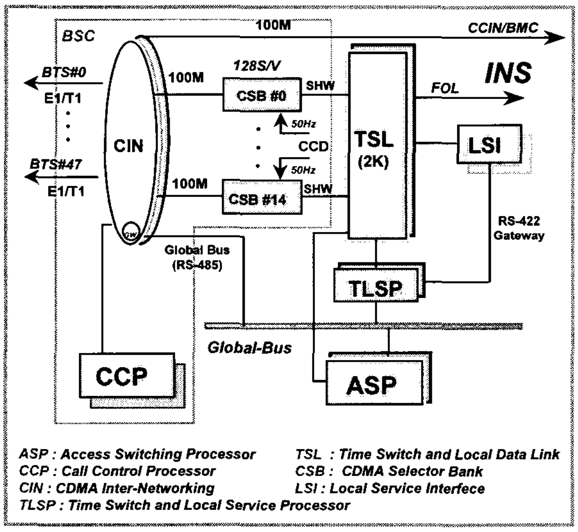


Fig. 2. The configuration of collocated BSC type

2.2 Call Flow and Protocol

To ensure that this can be done with one camera setting for Mobile call flow is the process for connection of speech channel to give the system resource to mobile subscriber. And the flow consists of two steps - mobile call setup and mobile call release[3]. The Fig. 3 and Fig. 4 show the layer 3 protocol messages which are used as call flow in BTS, BSC and MSC.

The resources allocated in call setup are the channels of BTS and selector/vocoder of BSC and main processors which control call flow and resources are BSP(Base Station Processor) in BTS, and CCP(Call Control Processor) in BSC.

The protocols for call control are applied to three processes. First protocol which is applied between MS and BTS is CAI(Common Air Interface) protocol ANSI J-STD-008 based on CDMA, second protocol which is applied between BTS and BSC is internal protocol, and last protocol which is interfaced between MSC and BSC is used the different protocol according to structure of BSC - EIA/TIA IS-634 using SS No.7 used for in case of non-collocated BSC type, otherwise internal protocol is used for collocated BSC type.

The following Fig. 3 and Fig. 4 show mobile call flow in the case of non-collocated BSC type. In the collocated BSC type more messages are added.

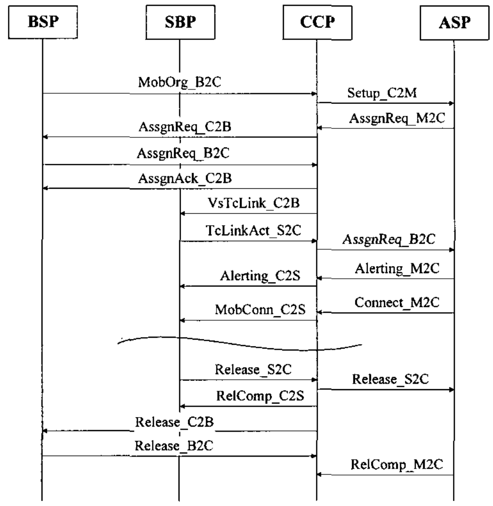


Fig. 3. Setup and Release call flow of calling part

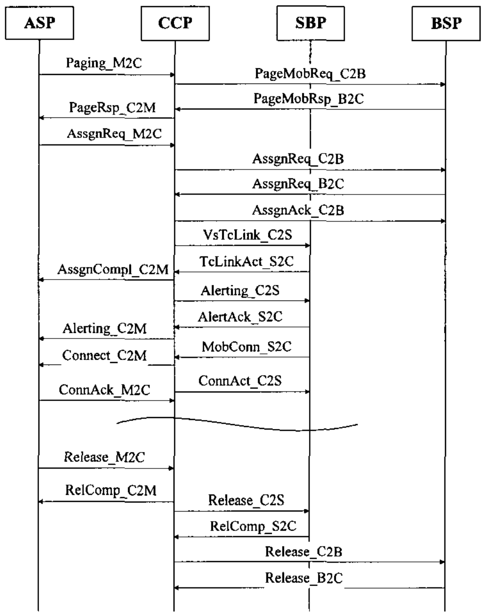


Fig. 4. Setup and Release call flow of called part

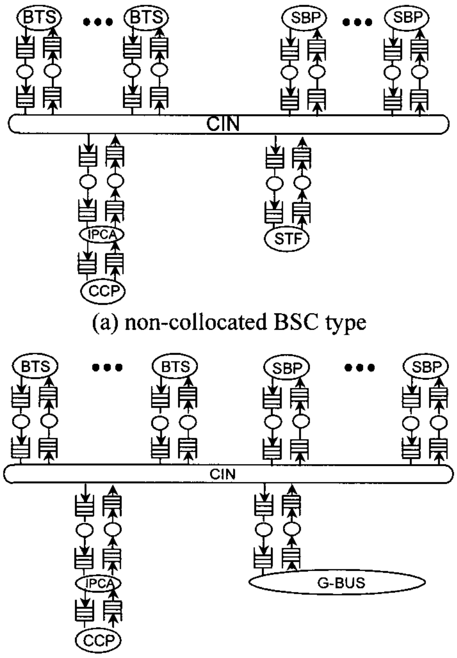
3. SIMULATION MODEL AND PARAMETERS

3.1 Simulation Model

Simulation model consists of queues and servers, as shown in Fig. 5. Each link and bus transmitting the control messages and mobile traffic messages, and each processor processing the messages are modeled as servers. Each server has a TX queue and a RX queue respectively.

Maximum 48 BTS and maximum 15 SBP(Selector Bank processor) are connected to CIN(CDMA Inter Networking) with E1/T1 trunk and TAXI(Transparent Asynchronous Transmitter-Receiver Interface) and CCP is connected to CIN with IPC processor and RS-422 link.

Fig. 5 shows the difference between two simulation models. The different server between MSC and BSC is modeled according to structure of BSC - a processor of SS No.7 is used as a server in case of non-collocated BSC type, otherwise a router node for collocated BSC type.



(a) non-collocated BSC type

(b) collocated BSC type

Fig. 5. Simulation model of BSC for each type

3.2 Input Parameter for Simulation

In simulation modeling of BSC, the principal parameters are as followings[4].

- arrival rate and inter arrival time of call
- processing time per message of each processor
- message transmission time of each link and bus
- the number of BTS and SBP and etc.

The G-bus and CIN are modeled as 1-limited cyclic service and each has bandwidth 2 MHz, 320 MHz respectively. The guard time between nodes are also considered.

The receiving servers are modeled as M/G/1 queue. The vocoders are connected to TAXI which has 80Mbps bandwidth per each TX and RX. The U-Link between CIN and G-BUS is RS-422. The number of node in G-bus is maximum 32, in CIN maximum 128. In simulation model the number of BTS is 12 and SBP is 15. And the voice traffic data generate per 20msec is also considered.

4. PERFORMANCE ANALYSIS

4.1 Structure of Simulation model and Assumptions

In two simulation models, the traffic consists of control traffic between processors and pure voice data. But we do not take into account the maintenance messages. The assumption is followings:

- Mobile to mobile : Mobile to Land : Land to Mobile = 10% : 50% : 40%
- Handover occur one time per call
- softer handover : soft handover = 70% : 30%
- Power on registration : Power off : zone based = 20% : 20% : 60%
- Total Registration in BSC per hour : 20,000
- Voice activity rate : 40%
- Average holding time : 60 sec
- All mobile calls are assumed as complete call and have Poisson distribution.

To estimate the performance of the IPC network and processors, these are modeled for simulation by using the network symbol offered by SLAM II(Simulation Language for Alternative Modeling II)[5],[6]. The simulation program consists of simulation initialization module, message generation module, and message processing module.

4.2 Simulation results

First we compare the call processing capacity of processor and observe the delay time of some interval in call flow.

(1) originating call setup request time : the time in BSC from receiving the setup information of calling part until transmitting the message to MSC

(2) paging setup request time : the time in BSC from receiving the paging request message form MSC until transmitting the message to BTS

The result of comparing the CPU loads of the CCP in two type of BSC(non-collocated and collocated) as traffic increases is shown in Fig 6.

In the analysis, the bottle-neck took place in CCP. When the total registration in BSC per hour is 20000, the maximum of processing power is 45000 calls/hour in the non-collocated BSC type, and 60000 calls/hour in the collocated BSC type.

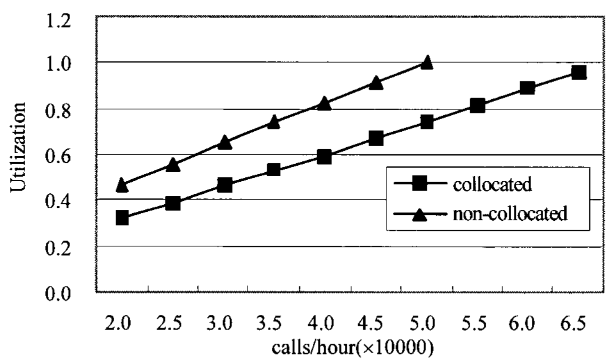


Fig. 6. Processor occupation as traffic increase

The average waiting time and queue length as traffic increase is shown in Fig. 7 and Fig. 8. As the result, in the non-collocated BSC type the over 45000 traffic makes the waiting time and queue length infinite, and in the collocated BSC type the over 60000 traffic makes same.

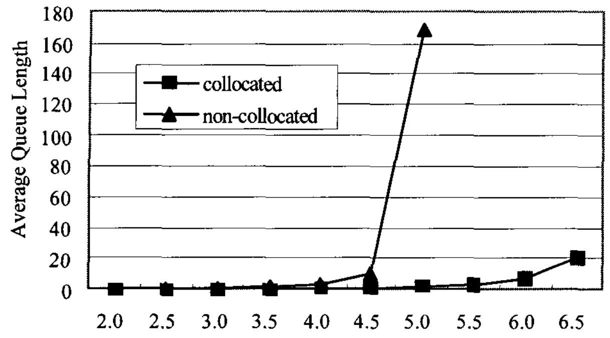


Fig. 7. Average queue length of ready queue as traffic increase

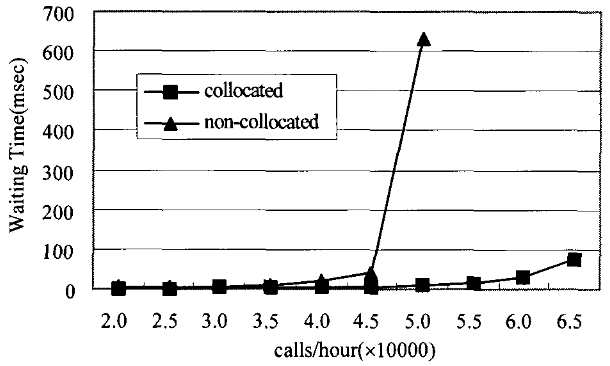


Fig. 8. Average waiting time of ready queue as traffic increase

The originating call setup request time and paging setup request time as traffic increase is shown in Fig. 9 and Fig. 10.

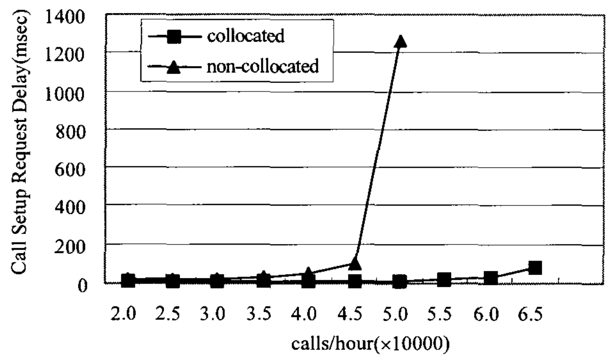


Fig. 9. Call setup request delay as traffic increase

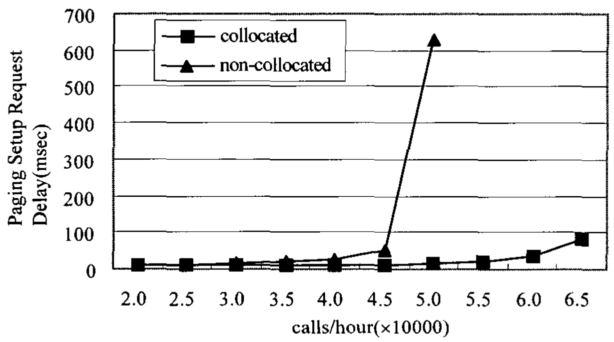


Fig. 10. Paging setup request delay as traffic increase

As the result, in the non-collocated BSC type the over 45000 traffic makes the originating call setup request time in calling BSC and paging setup request time in called BSC infinite, and in the collocated BSC type the over 60000 traffic makes same.

In the meanwhile, the Fig. 11 shows the result that compare call processing capacity by increasing the number of location registration from 10000 per hour to 40000.

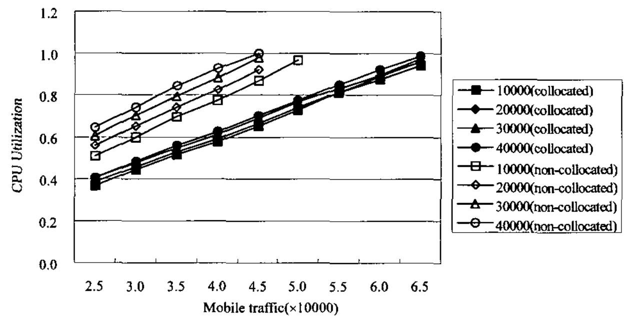


Fig. 11. Processor occupation as registration reference load increase

In the analysis, the maximum call processing capacity of processor is reduced as the registration traffic increase, as shown Fig. 12.

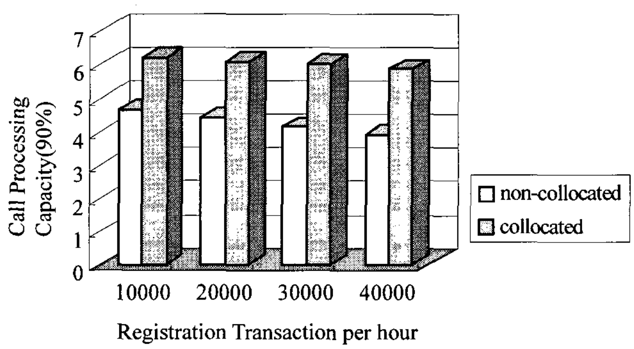


Fig. 12. Performance comparison of call processing capacity as registration reference loads increase

The Fig. 13 shows the CPU capacity of comparison between two type of BSC. The more registration traffic increase, the collocated BSC has more call handling capacity compared to the non-collocated BTS relatively. The difference in quantity is from 33.7% to 50.9%.

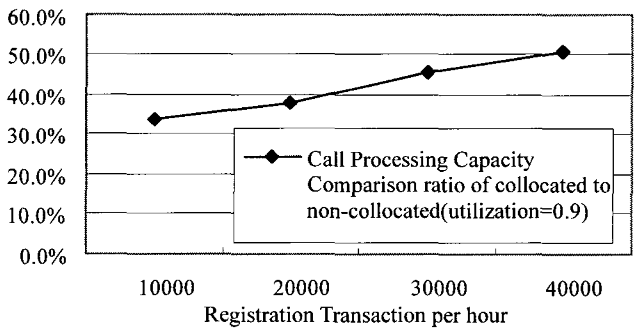


Fig. 13. Call processing capacity comparison ratio as registration reference loads increase

5. CONCLUSION

This paper describes the two types of BSC structure as according to the scale of service and protocols based on structure, and presents the analysis of performance comparison with protocol difference. To add mobile traffic of field, the simulation model considers several types of registration and handover. Through the queuing network model, the call processing capacity and delay time of BSC are analyzed.

In the analysis, the non-collocated BSC type using the IS-634 protocol has processor capacity of 45000 calls/hour under such a condition, and the collocated BSC type has capacity of 60000 calls/hour. So the collocated BSC type has more call handling power at least 33% than non-collocated BSC type. For gap of numbers of message between protocols and bit based processing of IS-634, the collocated BSC type can process more traffic as the registration traffic increase. This is also confirmed from the simulation result of delay comparison.

It is useful in planning IMT-2000 network to consider this performance difference between two types of BSC.

For the future work, the performance analysis of BSC in IMT-2000 considering the real mobile data traffic is required to study.

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Seog Ku Lim

He received the B.S., M.S in electronic engineering from Hankook Aviation university and Seoul National university, Korea in 1983, 1987 respectively and also received Ph.D. in electronic engineering from Hankook Aviation university, Korea in 1999. He joined LGIC and has been engaged in research of TDX digital switching systems during the period from 1987 to 1992. From 1992, he has been a member of engineering staff at the switching method section in ETRI. Since 2001, he is a professor in division of Information and Communication Engineering, Cheonan, Korea. His main research interests include telecommunication system modeling and its performance evaluation. He is a member of KICS, KITE, KISS and KOCON.