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Congestion Control Mechanism In GSM Telecommunication: A Review

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Abstract – The level of patronage being experienced in Global System for Mobile Communication (GSM) in Nigeria is overwhelming, this is due to the fact that GSM is been used by anyone , anytime and everywhere .This led to a lot of congestion in network resulting to bandwidth degradation and decrease in quality of services. This research has developed a management algorithm for the management of the GSM congestion and evaluated the algorithm based on their performance, Call admission control was combined with other GSM congestion control mechanism to achieve a good and better result. The work integrates all the algorithms together in order to manage the congestion considering all the strengths and constraints of each algorithm.

Keywords – Congestion control, Telecommunication, GSM.

I. INTRODUCTION

The ever-growing demand for mobile services provided by GSM communications has resulted in making network congestion a real problem to contend with [1]. The performance of mobile network is one important issue that concerns service provider and telecommunication. To achieve best performance, service providers have to manage the congestion. Congestion is the unavailability of network to the subscriber at the time of making a call. It is the situation when the blocking occurs and no free path can be provided for an offered call [2]. That is, when a subscriber cannot obtain a connection to a call. When a user makes a phone call, a channel is seized for communication thereby generating traffic. The load handled by a system varies a lot based on the time of day and days of the week. Most systems are heavily loaded for a few hours in a day so there is need for congestion control. Congestion control is of utmost importance and GSM congestion need to be controlled or minimized.

Several attempts had been made to forestall and manage the congestion in mobile networks like the GSM network. Congestion control refers to the actions taken by the network to minimize the intensity, the spread and duration of the congestion. [3]

The problem of congestion and lack of proper capacity planning strategy by the network providers are often regarded as critical issues that demand serious attention due to their potential havoc.

In this work, we will point out the several algorithms and mechanism used to manage congestion in GSM telecommunication, evaluate them by performance and find out the best mechanism based on the performance evaluation.

1.1 Background Of Study

The Global System for Mobile (GSM) communication has become a household term in our present world. This is due to the fact that communication in the life of man is so important and the use of the GSM network is not being limited to the rich alone but to all human beings be it rich, poor, old or young [4]. Several attempts had been made to forestall and manage the congestion in mobile networks which includes channel borrowing, cell-splitting, cell sectoring, development of micro-cells, dynamic channel allocation and deployment of soft handover schemes.

II. Related Works

Considerably amount of works has been carried out in this area the few once are reviewed as follows, the first work was on Automatic Call Gapping (ACG) and the Token Bank. [5]. The idea of the Automatic Call Gapping (ACG) is to reduce call attempt rate by allowing only one call attempt per a specified gap interval. This call attempt reduction occurs when the ACG mechanism is activated due to congestion and last for specified gap duration; possibly the congestion period. The Token Bank (TB) on the other hand is used for input regulation to protect an entity from becoming overloaded. It uses the parameters of token bank capacity C and the token bank rate . Tokens are generated periodically by an infinite source at a rate into the bank. The token bank is associated with each source that generates call requests and when the token bank is full, then tokens are blocked and lost. Another work used routing algorithm to solve congestion control. Routing Algorithm uses a variety of metrics that affect calculation of optimal routes, which could serves as control to the congestion in any GSM Network [6].The Dijktra's algorithm was used to determine the shortest route between a particular nodes in the network. Another work was based on Dynamic pricing scheme which have already been applied successfully in several domains, but has only recently been considered for use in cellular networks, the work looked at whether or not a combination of dynamic pricing and more traditional approaches can give better results. For this purpose, a detailed traffic model for both GSM and GPRS networks was given and implemented in an event-driven simulator [7] The effect of several dynamic pricing and admission control combinations is then analyzed, and the importance of some incoming traffic parameters is highlighted. At the end dynamic pricing mechanism was termed efficient [8].

2.1 Evaluation Of Various Control Mechanism For GSM Congestion

2.1.1 Call Admission Control Mechanism

The main function of call admission control algorithm is to limit the interference by controlling the number of new call accepted in the network. Call Admission Control (CAC) is a strategy that emphasizing on limiting the number of mobile networks users so as to reduce traffic congestion, call drop, call blocking, as well as providing a good quality of service (QoS) to network subscribers **[9].** It works in such a way that assuming there are (N-1) ongoing calls in the network when the N^{th} new user approaches the network, it considers the available resources in the network. If there is enough resources to admit the N^{th} user such that it will not compromise the QoS requirement status of the ongoing (N-1) users as well as the incoming N^{th} user, then N^{th} user will be admitted into the network. Otherwise N^{th} user will be blocked and denied connection to the network.

CAC distributes network resources to users in order to produce a reasonable QoS [10]. CAC algorithm limits the interference level in the network by observing the number of new calls and handoff calls that are being accepted or rejected. The call dropping happens in the network in most of the case when accepted call that has not completed in the current cell may have to be handed off to another cell. During the process, the call may not be able to gain a channel in the new cell to continue its service due to the limited resource in the networks . Since users tend to be much more sensitive to call dropping than to call blocking, handoff calls are normally assigned higher priority over the new calls [11]. It is very simple and reliable and it reduces programming difficulties and handoff calls. CAC works well when combined with buffer, degrade and upgrade mechanism which was shown in this work [18].

2.1.2 Dynamic Channel Allocation

Global system for mobile communication (GSM) uses wireless channel to communicate between a mobile stations (MS) to others mobile unit. In GSM there is need to allocated channels effectively so as to maximize throughput and prevent co-channel interference. Channel-allocation schemes follow one of two types of strategy, it can be fixed or dynamic algorithm. Fixed Channel Allocation (FCA) suffers from the effective channel utilization whereas Dynamic Channel Allocation (DCA) offers the possibility of capturing unused channel by allocating unused resources [12].When a MS (Mobile system) wants to communicate with another user, it must first obtain a free channel provided by BS. If the BS has no free channel, the call will fail. So there is need for channel allocation and that brings us to dynamic channel allocation mechanism (DCA) which offers the possibility of capturing unused channel. The switch then allocates a channel to the requested cell based on some criteria's. Like the likelihood of future blocking with in a cell, the frequency of use of the candidate channel, the reuse distance of the channel, and other cost function.

When the channels of BS are fully occupied, the MS will encounter the situation of call drop or call block. If the MS wants to communicate with another MS, it must request a free channel from the BS to generate a new call. [13].If a channel is free, it is assigned to the MS. If the BS has no free channel to allocate to the MS, the BS will drop the new call request from MS. If the communicating call moves from the old cell to the new cell, it has to request from the new cell a free channel. If the new cell has no free channel, the call block occurs. The call block causes more loss than the call drop because it stops the ongoing call. This mechanism solves the problem through reserving channels for Handover in BS. The dynamic channel allocation can decide whether to accept a call or not depending on the available number of channels [14]. DCA reduces the possibility of being a channel idle while a call is waiting to establish. Channel Allocation (DCA) captures unused channel by allocating unused resources to achieve gain capacity. GSM uses fixed channel allocation scheme to assign channels to the users, but call blocking and wastage of channels are the major drawbacks.

2.1.3 Priority Allocation Mechanism

In this method. Each individual is entitled to one SIM card with a level of priority. Once you purchase a SIM card and activate it, the priority level is registered automatically. The priority level will be used throughout the period of subscription of the subscriber to the network. The level of priority will be determined by the nature of your service. This model will be able to take care of the executive essential duties officers like President, Governors, fire fighters, police and so on. [15]

The principles of arithmetic operation preferences will be used where the highest priority will gain access to the channel before the lower priority. So this model is meant especially for higher officials. The user access to the network will not be terminated until they terminate it themselves. The advantage of this model is that it will allow the essential duties calls to complete their calls without any interrupt and thereby prevent casualties that might occur if the attention was not given. The disadvantage of this method is that so many calls will be denied access during the time when the essential duties are on. Also, some calls that may be very important to some subscribers might be dropped and immediate reconnection may not be possible easily [16].

2.1.4 Block Time Sharing Mechanism

In this mechanism, each call is given a specific block of time and until the time expires no other call can use the channel. Each call is given full access to the system according to the time allocated but as soon as the time expired, a control is passed to pre-empt the call so as to allow other call to have access to the channel [16]. The benefit of the model is It does not allow any call to a channel more than the allotted time. It also gives access to the call without interruption from any other call within the time limit and gives access to the call allows equal sharing among the call.

Its drawback is that it wastes service time. For those calls that do not finish their allotted time before they leave the channel, the remaining time will be considered wasted.

2.1.5 Buffer Mechanism

This method works well with Call admission control method. The work of CAC is to reject or accept calls, however, for this new model design, instead of blocking such call, a buffer is introduced which stores the call until a channel is available to transmit the call. The advantage is it gives priority to the most denied calls to grab the channel when they appear within a specified time. It does not allow any call to occupy the channel more than necessary when calls are waiting [17]

III. Performance Evaluation Of Various Algorithms For Gsm Congestion Control According To Literature.

Combined Algorithm For Gsm Congestion (Cac + Degrade And Upgrade Algorithm

3.1. Algorithm for the Adaptive Call Admission Control (Ad_CAC) Scheme of Sanabani et al (2006)

If BW_{Aval}>=BW_{Max})

Allocate(BW_{Max}MaxLevel)
AcceptConnection
ElseIf(BW_{Aval}>=BW_{Max})

```
(
FindtheBWAllocateandBWLevel… .............................. forconnection
(WhereBWMax<=BWAllocate……………………………………..
Allocate(BWAllocateBWLevel)
AcceptConnection
}
Else{
 If(incomingcallisnewcall)
DegradeBW(BWAvalAvgLevel,Application_Priority)
Else//IncomingcallisHandoffcall
DegradeBW(BWAvalMinLevel,Application_Priority)
If(Success)
{
Savealldegradedonexistingcallswithnew AllocationBW
Allocate(BWAvalAvgvLevel)
AcceptConnection
}
ElseIf(BWAval>=BW........)
{
Savealldegradedonexistingcallswithnew Allocation
FindtheBWAllocateandBWLevelthatcanbetakenforconnection
(WhereBW….<=BWAllocate<BWAvalMinLevel<=BWLevel<AvgLevel
Allocate(BWAllocateBWLevel)
AcceptConnection
}
Else
{
ReturnalldegradationonexistingcallswitholdAllocationBW
BlockConnection
}
```

3.2. Algorithm for degrade algorithm

```
DegradeBW(BWneededDegradedLevel,App_Priority)
{
PriorityIndex=1
While(PriorityIndex<=App-Priority)
{
For(LevelIndex=MAxLeveltoDegradeLevel)
```

```
{
        Ifexistingcall(A-Priority=PriorityIndex&&BWlevel=LevelIndex)
            {
                /*degradetheallocateBWbyonelevel*/
                BWAllocate=BWAllocate–
                BWDegradeLevel BWLevel=BWLevel–1
                }
                If(BWAval>=BWneeded)
                Return(Success)
            }
    PriorityIndex=PriorityIndex=1
    }
    Return(!Success)
```

3.3. Algorithm for upgrade algorithm

```
UpgradeBW(BWfree)
{
BWAval=BWAval+BWfree
For(HighPrioritytoLowPriority)
    {
If(BWAval>0)
For(LevelIndex=MinLeveltoMaxLevel)
{
            If(BWAval>0&&BWAval>=BWupgraded………..
                {
            /*UpgradetheallocateBWbyonelevel*
BWAval=BWAval-BWUpgradeLevel
BWAllocate=BWAllocate+BWUpgradeLe
vel BWLevel=BWLevel+1
}
Else
Break
        }
Else
    Break
    }
}
```

3.4. The Combined Model Algorithm (CAC + Buffer)

```
Start()
Initiate_call()

Add_call_to_Queue()

AddcallerID
if((counter<=n)&&(callerPriority==higher)){

assign_Channel()

}else{      if(Call==Handoff){//handoffstart
if(Channel==Free){Assign_Channel

}else{
if(Buffer==Full){

End_Call

}

Else{
Buffer_Call_to_M1()

}

}

}else{//handoffend
if(Call==Waiting){

Get_Caller_With_Highest_Waiting_Time()

}else{
if(Channel==Free){
Assign_Channel()

}else{
Buffer_Call()

}

}

}

}
```

This method uses a buffer which stores the call until a channel is available to transmit the call.

3.5. Dynamic Channel allocation scheme

Begin

1. While (n calls arrive for connection) do
2. if (there exist free channel) then
3. if (calls are from both cells) then
4. if (cold spot call is non-real-time) then
5. compare and serve hot spot calls before cold spot calls

6. else
7. assign ticket to each call
8. randomly pick any ticket and allocate channel to call with that ticket
9. endif
10. endif
11. elseif (calls are from same cell) then
12. if (same call type) then
13. repeat steps 7 and 8
14. else
15. allocate channel to real-time calls before non-real-time call
16. endif
17. endif
18. if (no channel is free) then
19. if (call is real-time or non-real-time handoff) then 20.is buffer full?
20. If No then 22.put call in buffer
21. repeat steps 7 and 8
22. else
23. block the call 26.endif
24. else
25. block the call 29.end if
26. end while End

From the above algorithm, When user calls arrive and calls are from different cells, calls are served between lines 3 and 10 but if the calls are from same cell, each call is given a ticket and decision is made by choosing ticket at random and the call holding that ticket gets the channel, this is called ticket scheduling. But if no channel is free then handoff calls are considered. Real-time and non-real time handoff calls are buffered until we get available channel (lines 19-23). Handoff calls are only blocked when the buffer is full, while new calls are blocked when no channel is idle.

3.6. Block Mechanism Algorithm

START

1. SET THE BLOCK TIME
2. DO WHILE SERVICE = TRUE
3. SET K = 1 // INITIALISING THE TIMESLOT
4. DO WHILE NOT FREE AND K<=8 //TESTING FOR FREE TIMESLOT
5. K = K+1

6. LOOP
7. IF TIMESLOT = FREE THEN
8. LOAD THE CALL TO TIMESLOT (TK)
9. WHILE SERVICE_TIME < BLOCK_TIME OR SERVICE_TIME< AIR_TIME
10. CONTINUE THE CALL
11. WEND
12. ELSE
13. REJECT THE CALL
14. END IF
15. FETCH THE NEXT CALL
16. LOOP

3.7. Priority algorithm

start

1. do while service = true
2. set essential_codes
3. set k = 1 // initialising the timeslot
4. do while not free and k<=8 //testing for free timeslot
5. k = k+1
6. loop
7. if timeslot <> free and call = essential call then
8. drop call with least priority
9. load the essential call to timeslot (tk)
10. while service_time> 0
11. continue the call
12. wend
13. else
14. load the call to timeslot (tk)
15. while service_time > 0
16. continue the call

IV. Performance Evaluation Of All Algorithm Call Admission Algorithm

Comparing Various Mobile Congestion Management Schemes

CONTROL MANAGEMENT SCHEME	HANDOFF CALL BLOCKING	NEW CALL BLOCKING	NETWORK RESOURCES
Call admission Control	Low	low	High
Dynamic Channeled allocation	High	Moderate	Moderate
Block Call mechanism	High	Moderate	High
Priority Call Mechanism	High	Low	Low
Buffer Allocation	High	low	Moderate

The above table shows the new call blocking probability, handoff call blocking probability and network resources management for various mobile congestion management schemes. It is the only mechanism with low as its handoff call blocking and call blocking Call Admission Control (CAC) is confirmed the best because it provides massive reduction in handoff call blocking and new call blocking and it is also simple and reliable. CAC performance depends mostly on the efficiency and effectiveness of resources allocation.

They yield less programming difficulties and allow multiple connection requests to be handled simultaneously. Also it tolerates less power consumption . Use of CAC algorithm indicate that this algorithm reduces the drop of handoff calls and increases the total system capacity and performance; hence the Grade of Service (GoS) of the system can significantly be improved especially in case of high mobility environments.

V. Conclusion

GSM is a digital system designed to meet the need of growing mobile subscribers, which the analog could not handle. It also provides a better quality services as a result of these qualities, GSM has stood to be the most embraced and fastest growing technology in the field of communications. Many that want to have access to this technology end up been disappointed because of network congestion. Congestion is now a big threat to the society that is why there is need to manage or minimize it to the fullest. Since the GSM network operators charge users when the call set-up is successful, the call blocking affect the client and leads to customers' dissatisfaction.

Hence, there is an important need for GSM operator to be conscious of its network performances in other to meet subscribers' demand. Call admission control was found the best mechanism to manage congestion because it considered the handoff calls and new call blocking.

REFRENCES

[1] M. A. Alarape, A.T Akinwale, and O. Folorunso, ‘’ A Combined Scheme for Controlling GSM Network Calls Congestion’’, International Journal of Computer Applications, vol.14, pp 0975 – 8887, 2011.

[2] [2] E. K. Akut and S. M. Sani,,‘‘Identification and modelling of dominant causes of congestion in a fixed-line network’’, International Refereed Journal of Engineering and Science (IRJES), vol.2, pp 09- 17, 2013.

[3] H. Johansson and J. Steensland, A Performance Characteristics of Load Balancing Algorithms for Parallel SAMR Applications. Retrieved on June10, 2012 from.www.it.uu.se/research/publications/l ic/2006-010/paperC.pdf.

[4] J.J poopoola, I.O Megbowen, and V.S.A. Adeloye, ‘ Performance Evaluation and improvement on quality of service of global system for mobile communication In Nigeria’ vol.9, no 2,pp 91-106, 2009j

[5] Karagiannis, G, Scalability and Congestion Control in Broadband Intelligent and Mobile Networks. A Ph. D. Dissertation submitted to the Centre of Telematics and Information Technology, University of Twente, 2002.

[6] IEEE, pp 1183-1186, ‘Microcells in mobile communications http://www.pgsm.hu/english/gsm/more.html, 2012.

[7] Jeffrey K. MacKie-Mason,Hal R. Varian. “*Pricing the Internet*”. April 1993.

[8] A. Gupta, D. O. Stahl, and A. B. Whinston, “*Priority pricing of Integrated Services networks”*, Eds McKnight and Bailey, MIT Press, August 1997.

[9] V.S Kolate ,G.I. Patil, A.S. Bhide, “Call Admission Control Schemes and Handoff Prioritization in 3G Wireless Mobile Network”, International Journal of Engineering and Innovative technology (IJEIT), Volume 1, Issue 3, pp. 92-97, March 2012.

[10] Majid G. and Raouf B "Call Admission Control in Mobile Cellular Networks: A Comprehensive Survey", IEEE Journal on Selected Areas in Communications, 12 (3), 1-46, (2008):

[11] Mohamed Hossam Ahmed, “Calll Admission Control In Wireless Networks: A Comprehensive Survey”, IEEE Communications Surveys, Volume 7, No. 1, pp. 50-69, First Quarter 2005.

[12] Fayaz Ahmed, “Dynamic channel allocation in GSM network”, Master Thesis, Blekinge Institute of Technology Karlskrona, Sweden, December 2008.

[13] V.H. Mac Donald. AMPS, “The Cellular Concept. Bell System Technical Journal”, 58, 1, 1979. Megha G. and Sachan A, (2007).

[14] Gupta and Sachan, Distributed Dynamic Channel allocation Algorithm for Cellular Mobile Network, Journal of Theoretical and Applied Information Technology, (2007)

[15] Kuboye B.M., Optimization models for minimizing congestion in Global System for Mobile Communications (GSM) in Nigeria” Journal of Media and Communication studies Vkol. 2(5), pp. 122- 126, May 2010

[16] Alese B. K.[1], Fajuyigbe O.[1], Adewale O. S., Development of models for managing network in Nigeria’’**,** Department of Computer Science, Federal University of Technology, P. M. B. 704, Akure, Nigeria , May 2011.

[17] A.M Alarape, A.T. Akinwale, and O.Falarunso, ‘A combined scheme for controlling GSM Network Network Congestion’ International Journal of computer Application, vol 14, no 3, pp 47 -53, 2011.

[18] Sanabani, M., Shamala, S., Othman, M., and Desa, J. ‘Adaptive Call Admission Control for Prioritized Adaptive Services in Wireless/Mobile Multimedia Cellular Networks’. IJCSNS, International Journal of Computer, 2006.