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Combined Strategy for Cellular Traffic Congestion Management

Avinash Singh*, Surya Pratap Singh, Arvind Kumar Maurya, Upendra Nath Tripathi
Department of Computer Science, DDU Gorakhpur University, Gorakhpur,
Uttar Pradesh, India

***Abstract*—**

In wireless media, congestion is usual phenomenon that arises due abruptly raised subscribers demand to establish connections congruently in particular cell at mean real time. Generally, the congestion problem occurs in cellular network traffic and almost persists in every generation. Every mobile network operators is facing this problem every day and struggling to resolve this issue but not being success yet. As more advance cellular devices are being in demand and its users are also being increasing which turns to demand larger bandwidth requirements from cellular subscriber. Presently for cellular network, both at infrastructures level and manual configuration, the network management strategy founds to be inefficient to resolve these issues effective way. While trying to resolve, at certain critical peak hours and occasions, situation gets worse. Since, every cellular operator are being facing strong criticism from both user and regulating authorities on this issue. An effort from subscriber's end is to done only minor infrastructural changes to operate and maintain the network at low cost which found to ineffective and being failed to handle the communication demands of higher Quality of Service (QoS). One way of handling congestion would be through hardware amendment like sectorial design, cell partition, or some software enabled functions use to organize to automate the configuration, optimize and maintenance of cellular networks, But these changes involves heavy investment by subscriber which in turns to cost from user for its services. Concerning on this unresolved issue, our prime motive is to forward innovative effort work that could effectively and sustainable to manage the congestion for long duration. In this paper, we first review the various load sharing and balancing techniques those are used to resolve traffic congestion occurrences in mobile networks. And further presents an algorithm design that would helpful to develop a reliable, flexible, highly efficient load balancing and sharing system. The system based on proposed schema could manage the cell network resources with special emphasis techniques having suitable self optimization feature for future wireless cellular networks.

***Keyword*: Traffic efficiency, cellular network, spectrum, optimization, call routing.**

I. INTRODUCTION

Recent decades, there is extensive use of wireless technology for communication and it getting very popular among the mobile user as various services offered by them on a common platform under wide network coverage[1], [2]. Due to its great importance they are developed to make technologically more advanced as well as robust to deliver manageable, stable and reliable services to meet the ever-growing demands for improved quality of service (QoS). Since, as the number of users and the size of the network are increases, users are likely to experience increase in response time with any call drop or other performance degradation arises due to traffic congestion. Rapidly as the users and their application demands are increasing day by day with the pressure to increase the resource capacity to match the user requirements [3], [4], [5]. The cellular infrastructure of global system for mobile (GSM) has ability to provide facility with full utilization of radio resources[6], [7], [8]. But, at peak time occasion's resources are need management efficiently from preventing any congestion to be occurs because this would not only degrades the quality of services and even being packets loss or call dropped. Congestion control is a critical issue to be ensure the efficient and fair allocation schema of network resource among communication have to be flows[9].

Various approaches have been forwarded in handling and solving the mobile GSM congestion problem through channel guard bands, sectorial cell division, cell partition, micro-macro logical structuring, dynamical frequency band allocation and intelligent call handover methods. Lots of research have been done in this field to manage congestion problem[10],[11],[12]. The traditional resource utilization based approaches for managing the network congestion either by preventing the excessive traffic reaching to overloaded through rejection or to prevent overload from occurring; or avoiding the excess load through diverting before overload occurs. All the propose of research is to deal with the congestion managements are basically divided within two approaches prevention and avoidance of network traffic to reach at congestion level. Here we have been proposed a combined methodology scheme that consists of load balancing and sharing techniques in order to reduces the traffic congestion and maintain the (QoS).

II. LITERATURE REVIEW

Load balancing and sharing are generalized congestion management scheme for network traffic that implied those systems where stabilization needs dynamic adjustment decision policy. They are widely used to schedule various associated resources to process their jobs in multitasking or multiprogramming environments[13],[14]. The concerning problem related to traffic congestion is a wireless network related to managerial level issue that collectively affects the (QoS) and network totally collapse within short duration. Basically excessive utilization of resources of the network could leads to shortage and exhaust; or mismanagement of resources which generate serious problem of network congestion. Thus, for congestion control we need some prevention and avoidance schema inspired from load sharing and balancing they having important ability in maintaining the sustainability of the wireless communication system[15],[16],[17],[18],[19],[20],[21]. Previously, various load sharing and balancing technique are coined like token banks, automatic call gapping, dynamic channel borrowing, cell partition, development of logical min-micro cells and some others traditional approaches as involves in managing the call congestion problem.

The most popular methods used for dealing the network congestion specially employed to the mobile calls that puts extensive load on network resources are automatically call gapping and tokenized banking, The motivated forces behind the auto call grapping is to reduce the new mobile call setup rate through permitting new call origination in limited timer interval gap only. By this method it reduces the congestion only up to a certain limit and within that duration of call gap method is being active. And the tokenized banking method regulates mobile calling system from reaching overload state. It only permitting specific numbers of seems having ability to maintain congestion load up to a saturation capacity level by beyond which the system have to be drop down all the new calls[22],[23]. These techniques involve only such mechanism that either reject excessive traffic, prevent system from overloading stage or diverting excess traffic load to other few loaded system after being network gets overload.

Some other soft computing enabled schemes are mostly employed to deal the network congestion problem. And one of them primarily used for congestion management scheme is Adaptive Call Admission Control (ACAC) that regulates the handoff call and new originated call through some intelligent blocking polices even maintaining ongoing calls (QoS). This one is a simple and reliable method that performance are mostly depends on the efficiency and effectiveness of system resource assignment in balancing call admission with the frequency bands adjustment. The scheme block the new originating call if number of call reached to a saturation point and system is unwilling to service new call and handoff calls further. In this policy after reaching saturation stage the handoff call are service on priority basis and other new originated call are being drop so the scheme shows reduction rate in handoff calls with increase in new call drop rate[24],[25],[26].

The various congestion resolving schema that inspired from buffer management techniques only accept the incoming handoff calls for temporal period unless the free services frequency channel and guard bands are available to reduces the handoff call drop rate[27]. These types of schema try to accept the handoff call but drops the new originating calls in cell when no any extra free resource available to serve. Some research work has been conducted to combine these schemas together to manage the traffic congestion effectively. Basic approach is to combine frequency guard band reuse method with an adaptive dynamic call admission controlling method so that combined strategy would work effectively. In this combined strategy the frequency resource are reused through dynamic adjustment and selective policy for accepting the new originated along with maintaining pervious calls and their quality of services[28], [29].

III. COMBINED APPROACH SCHEMA

A combined strategy based schema that has been proposed is have a combined dynamic call admit control schema with a load balance policy to accept new originating call without dropping any pervious or handoff calls.

The input conditional parameters are feed to a dynamic call admit control system at initial stage of combined schema in which a call acceptation and rejection were decided on behalf of availability of bandwidth capacity within cellular network system. This combined schema has two parts load sharing and load balancing. The load balancing part is encapsulated by methods like dynamic admit control, updating methods and load balance policy[30], [31].

```
Ad_CAC () {

If (BW_Avail >= BW_Max)
            {
            Allocate (BW_Max, MaxLevel)
            Accept Connection
            }
Else If (BW_Avail >= BW_Min)
            {
            Find the BW_Allocate and BWLevel that can be taken for connection
            (Where BW_Min <= BW_Allocate < BW_Max, MinLevel <= BWLevel < MaxLevel)
            Allocate (BW_Allocate, BWLevel)
            Accept Connection
            }
            Else {
                        If (incoming call is new call)
                            DegradeBW (BW_Avg, AvgLevel, Application_Priority)
                        Else // incoming call is Handoff call
                            DegradeBW (BW_Avg, MinLevel, Application_Priority)
                        If (Success)
                          {
                          Save all degraded on existing calls with new Allocation BW
                          Allocate (BW_Avg, AvgLevel)
                          Accept Connection
                         }
                        Else If (BW_Avail >= BW_Min)
                                    {
                                    Save all degraded on existing calls with new Allocation
                                    Find the BW_Allocate and BWLevel that can be taken for connection
                                    (Where BW_Min <= BW_Allocate < BW_Avg, MinLevel <= BWLevel < AvgLevel)
                                    Allocate (BW_Allocate , BWLevel )
                                    Accept Connection
                                    }
                            Else
                                    {
                                    Return all degradation on existing calls with old Allocation BW
                                    Block Connection
                                    }
                  }
            }
```

Figure 1. The Main Algorithm for Adaptive Call Control in Decision Resource


```
UpgradeBW (BW_free)
{
BW_Avail = BW_Avail + BW_free
For (HighPriority to LowPriority)
    {
        If (BW_Avail  > 0)
        For (LevelIndex = MinLevel to MaxLevel)
            {
                If (BW_Avail  > 0 && BW_Avail >= BW_UpgredeLevel)
                  {
                  /* Upgrade the allocate BW by one level */
                  BW_Avail = BW_Avail -  BW_UpgredeLevel
                  BW_Allocate = BW_Allocate +  BW_UpgredeLevel
                  BWLevel = BWLevel + 1
                  }
                Else
                  Break
            }
        Else
          Break
    }
}
```

Figure 2. The Algorithm for Bandwidth Upgradation Decision

The dynamic admit control method regulate the admit policy for calls in subscriber network system by adjusting the allotted frequency bands enable him to accept more calls to process them. It utilizes the guard bands to accept the handoff call and release guard bands when call accepted or successfully terminated in subscriber cell.

```
DegradeBW (BW_needed, DegradeLevel, App_Priority)
{
PriorityIndex = 1
While (PriorityIndex <= App_Priority)
        {
        For (LevelIndex = MaxLevel to DegradeLevel)
            {
                If existing call (A-Priorty = PriorityIndex && BWLevel = LevelIndex)
                 {
                  /* degrade the allocate BW by one level */
                  BW_Allocate = BW_Allocate – BW_DegradeLevel
                  BWLevel = BWLevel – 1
                  }
                 If (BW_Avail >= BW_needed)
                   Return (Success)
            }
        PriorityIndex = PriorityIndex + 1
        }
        Return (! Success)
}
```

Figure 3. The Algorithm for Bandwidth Degradation Decision

```
Call() {
        If (TypeofCall = 'New Call') {
         accept call into DAC_CALL
         }
          If ( successful){
                          return
                         } else
          if(failure){
                    call NetworkCLB
                    }else
         If (TypeofCall = 'Handoff') {
         accept call into DAC_CALL
         }
          If ( successfull){
                          return
                          } else
          if(failure){
            call NetworkHNR
            }
          }

NetworkCLB(){
   Check availability of free cells BSC area
   If ( any less busy cell) {
      Route and process the call
      }else
   if (all cells are busy){
      drop call
   }
}

NetworkHNR(){
  Check  adjacent neighbor target cell
  If ( cell rearrangement  possible bycells) {
     accept the handoff call
     }else
  If (no further cells rearrangement possible ){
    drop call
   }
}
```

Figure 4. The Combined Dynamic Adaptive Call Control Schema Algorithm

The guard bands are a range of frequency acts as separator between frequency bands so that override the frequency overlapping and enable frequency reuses. In adaptive call control module smartly utilize these guard bands just to not be act as frequency separator but also as carrier that also accept the handoff and new call. The adaptive call control module inspired from previous research work consist of a series of three algorithm rules main adaptive call control algorithm that decide the resource condition and with two sub algorithm upgrade the band in which bands are accumulated with remaining resources to accept new load and degrade band in which after stress on load decreases they are relaxed [29] where modules are given in figures 1, 2 and 3. The load balance part consist of three module first is policy decision, second is selection procedure and third migration decision for controlled way load balance strategy[31],[32].

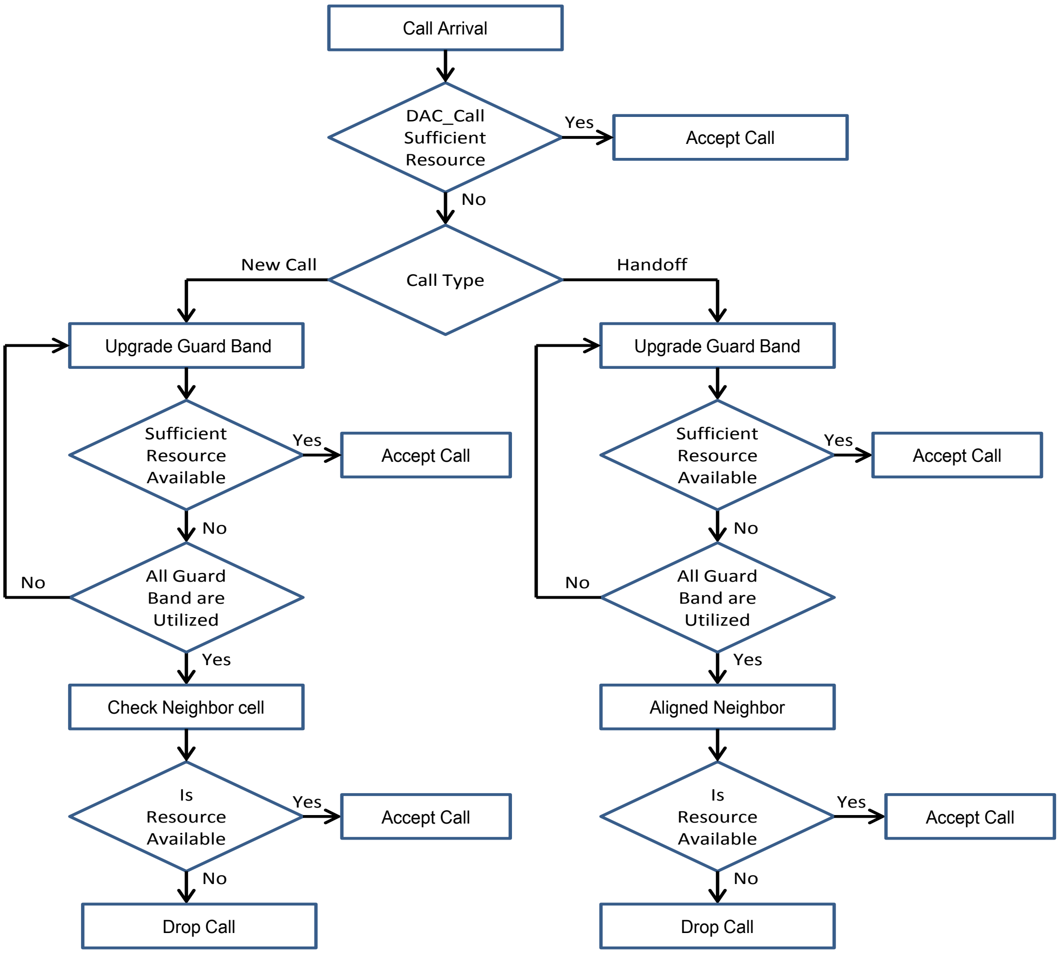

Figure 5. The Combined Dynamic Adaptive Call Control Schema Algorithm

The load sharing part is main policy get implement in last stage when final system going to saturation stage at congestion point after adaptive control unable to accumulate more grown up traffic load as shown in figure 4 & 5. When serving cell get used her guard frequency bands resources and unable to accommodate the new originating call or more handoff and cell reached to saturation stage standing at boarder of congestion point. At this stage we proposed schema to activate the neighbor cells to zoom up their foot prints to share the load at targeted cell. The neighbor cell get active through adjusting to accommodate the handoff call and new originating call of cell that standing at saturation before congestion point[33],[34].

IV. DESIGN AND IMPLEMENTATION

The combined strategy scheme is implemented and simulated NS2 platform. Initially 600 base stations are considered and each has assigned a distribution as low (below 500), medium (average 1000) and heavy (above 1500) traffic load. Then randomly some heavy loaded cells are targeted and monitored with further slowly increased with traffic load of 500 handoff and 500 new originated calls. These heavily loaded cells are slowly simulated for a saturation congestion point for the random selected Base Station Controller area (BSC). The load balancing and sharing is done within each (BSC) comprises of combinational adjacent seven distinguished neighbour cell frequency around targeted cells.

V. SIMULATION RESULT AND PERFORMANCE COMPARISON

There are two sets of results from the implementation of the design and finally their performance matrixes are analyzed. The both scheme the selected base stations have been allocated with equally fair amount of resources these resources frequency are separated through gourd bands. The guard band dynamical adjusted to make sure availability of resources for user and traffic condition demands to handle the new call and handoff. When this resources get exhausted the base station coordinate with its neighbors to contribute to share here traffic load and neighbors cells zoom to bear the increase load. The first result was obtained from the previous (ACAC) only scheme while the second was from the combined scheme. The results incorporated the computation of the New Originate Call Blocking Probability (NOCBP) and the Handoff Request Call Dropping Probability (HRCDP) in which comparison was made between the two sets of results under varying traffic load stress on resources.

The results of simulation shows that the system assured guarantied on connectivity issue on (QoS) lowering handoff call dropping probability for rapid changing traffic load. This stabilized performance levels under heavy traffic load for longer duration able satisfied its cellular user.

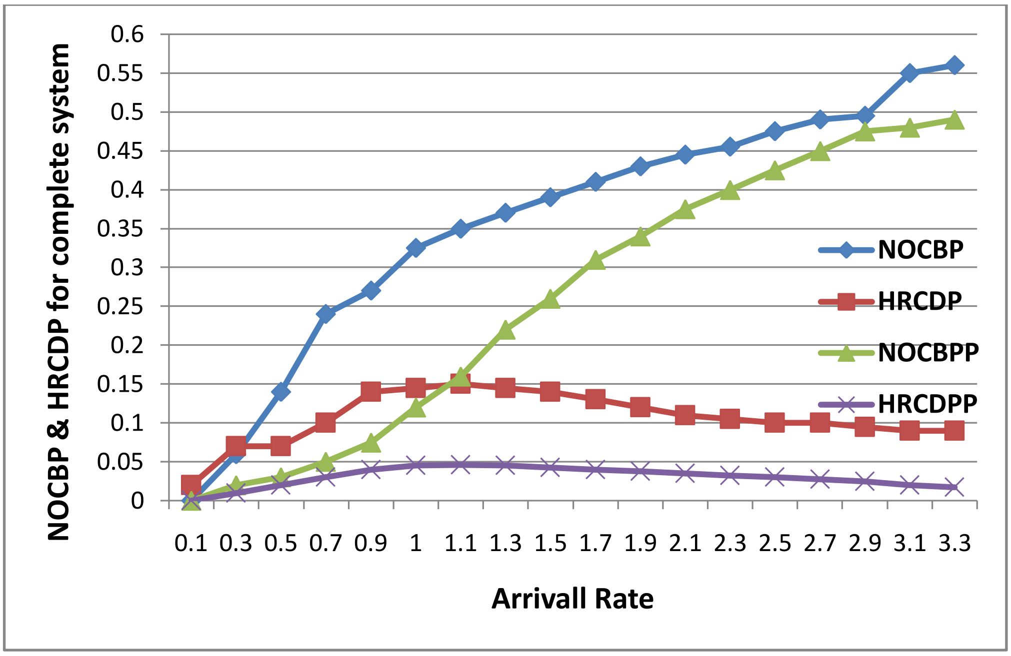

Figure 6. NOCBP and HRCDP versus the traffic load for various user services

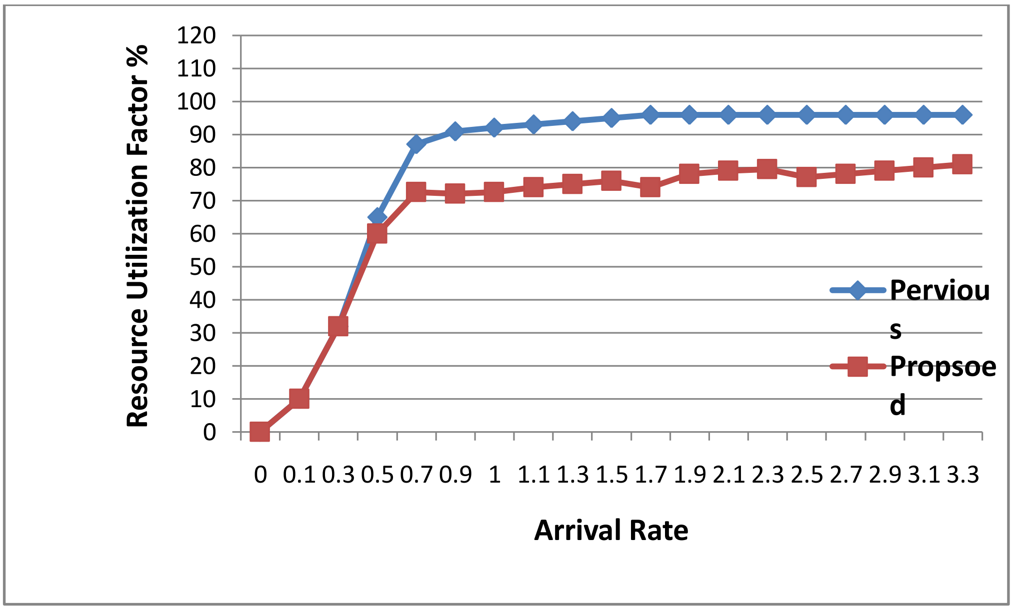

Figure 7. Bandwidth utilization factor versus the traffic load for various user services

Furthermost, the combined dynamic adaptive control scheme provides smart resource utilization and management scheme that lower call blocking probability for new originating calls along with handoff call dropping probability resulting lower call drop rate. Figure 6-7 shows that the (NOCBP) and (HRCDP) versus the traffic load for whole system under simple adaptive control scheme and proposed combined dynamic adaptive control scheme. It is clearly indicates that (NOCBP) and (HRCDP) performance for combined dynamic adaptive control scheme are far better than simple adaptive control schema. When traffic changes from low to high the algorithm could handle the growing traffic condition where further combined dynamic adaptive control scheme show better position than pervious adaptive control scheme methods. In figure 8-9 the (NOCBP) and (HRCDP) versus the traffic load for whole system under simple adaptive control scheme and proposed combined dynamic adaptive control scheme for heavy traffic load. If traffic load is increased the proposed combined dynamic adaptive control scheme still has ability to handle traffic load while maintaining (QoS) without call drops.

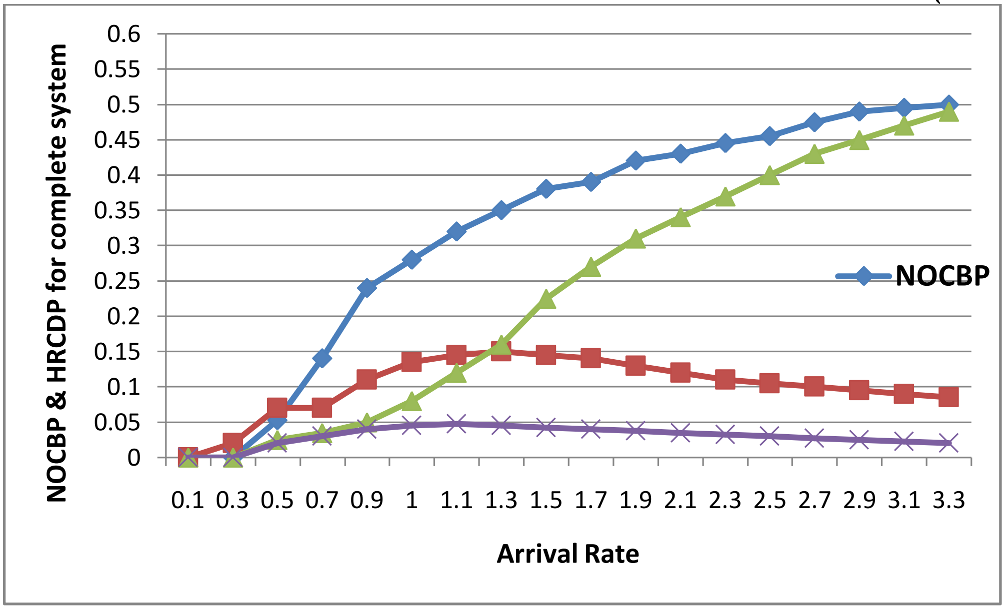

Figure 8. NOCBP and HRCDP versus the traffic load for various user services

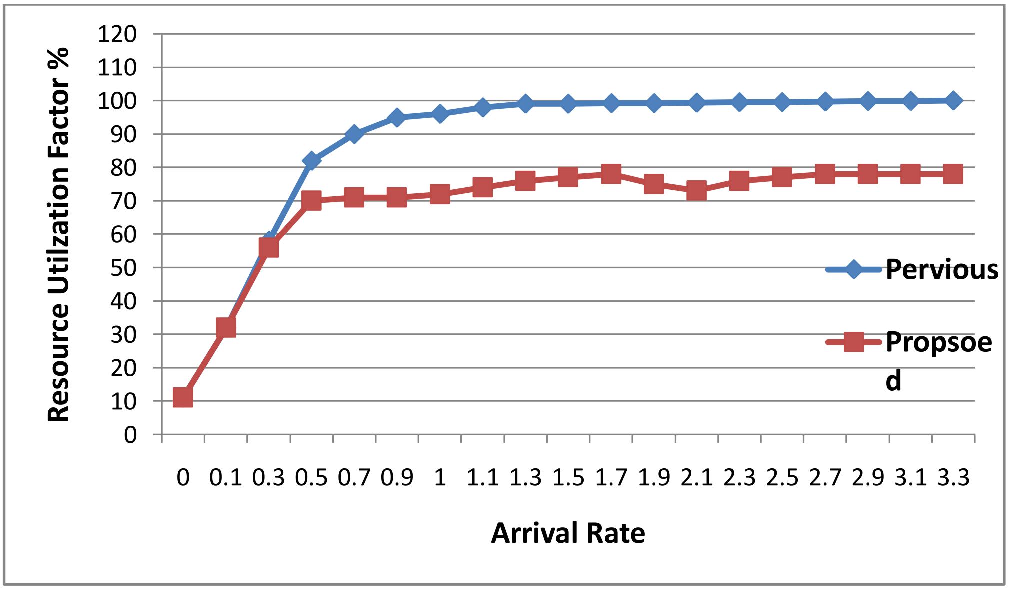

Figure 9. Bandwidth utilization factor versus the traffic load for user services

VI. CONCLUSIONS

In desire to handle the low (QoS) by wireless cellular network, operators needs for deployment of congestion management scheme that could effectively deal traffic congestion and user's service demands on real time. The proposed model predicate through the analysis that new combined policy could able to deal effectively in controlling the traffic congestion in wireless mobile network. Smart effort has been applied on every issue so combined effect helps in reducing handoff request and new call admission blocking possibility. Although research efforts in dealing the traffic congestion management issue are done in stepwise, first consideration is to adjustment resources and then cell adjustment. Instead of deteriorating the quality of service on increase of new fresh load both the handoff calls and new originating calls are not only permitted but it also increases entire throughput of the network. The implementation on proposed scheme provides a quality of service guarantee to both new and handoff calls at the same. At same this scheme has capability resources exploitation through adjustment that accommodates new load with improve the network performances. This scheme is an extremely have low complexity while making it practical for real wireless cellular mobile networks and further policy could enhance its performances.

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AUTHOR'S PROFILE

Avinash Singh is M.Sc. Computer Science, M.Tech. and M. Phil. and pursuing Ph.D. in the department of Computer Science DDU Gorakhpur University, Gorakhpur (U.P. India) under the supervision of Dr. U.N. Tripathi. The area of research interest is Database Security, Networking. Mr. Avinash Singh has published 25 papers in different national and international conferences/ Journals.

Dr. Surya Pratap Singh is MCA, UGC-NET qualified and Ph.D. from the department of Computer Science DDU Gorakhpur University, Gorakhpur (U.P. India).. The area of research interest is Database Security, Networking. Dr. Surya Pratap Singh has published more than 30 papers in different national and international conferences/ Journals.

Arvind Kumar Maurya is MCA and UGC-NET qualified and pursuing Ph.D. In the department of Computer Science DDU Gorakhpur University, Gorakhpur (U.P. India) under the supervision of Dr. U.N. Tripathi. The area of research interest is Distributed Database Security, Networking. Arvind Kumar Maurya has published 5 papers in different national and international conferences/Journals

Dr. Upendra Nath Tripathi is Assistant Professor in Department of Computer Science DDU Gorakhpur University, Gorakhpur (U.P. India). He has 15 years of teaching and research experience. He has published 50 papers in various National and International Journals/conferences. His area of research interest is database systems, networking.