MEASURING THE CHARACTERISTICS OF DG CAC ALGORITHM

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Abstract: Users today expect email and instant messaging access, surf, video games and other services through mobile broadband access networks. In order to support this increasing data traffic, advanced resource management has to be implemented. As CAC (Call Admission Control) algorithm plays an important role in this resource management, comparing of two proposed call admission control algorithms has been done in this paper. Algorithms are tested in simulation environment, for two different periods of time. They showed expected characteristics in both 1000 and 10000 seconds periods, and newly proposed DG CAC algorithm showed better results than other algorithm, in number of handover requests, and in the way of returning resources to degraded connections.

Keywords: CAC, QoS, UMTS, Wireless.

INTRODUCTION

Most contemporary and future wireless networks support data and voice services. Wireless data traffic is expected to grow significantly in the next period. Cisco forecasts that mobile data traffic will increase 39 times between 2009. i 2014 [2]. 66% of that traffic will be video traffic. Portable devices and smartphone will carry 91% of data traffic. The reason for this is in the nature of device which is easy for use for high quality video.

With the increasing number of requests for mobile multimedia services (audio, video, data transfer), it is expected that the next generation of wireless networks ensures QoS for multimedia services. Those multimedia services are required by many users, and most of them are in constant movement, on the whole territory. In heterogeneous wireless networks, users requires service transparency, distributed service quality and seamless handover. In that sense, user in handover should not experience any significant data loss or latency.

In most cases the best effort that QoS has is enough for simple data transfer service. For advanced multimedia services, which are great resource for consumers, however, the best effort is not sufficient, and better QoS mechanisms have to be implemented in this type of wireless network. Scarce spectrum resources are often the major problem in wireless multimedia networks. Spectrum is always limited, and network responsibility is to efficiently ensure resources on the fair basis to different users. Network controller should ensure that different QoS requests are enabled for each type of service.

For this purpose Call Admission Control algorithms are used, which were active research area in the last two decades, and are still being researched [4, 11, 10, 9, 1]. Many different types of CAC algorithms are developed in the last few years. For the WCDMA network, we receantly proposed a DG CAC algorithm and published it in [4]. DG CAC algorithm is based on the idea of dynamic resources management and dynamic guard margin. Since static reservation schemes often results with not so advanced resource utilization, dynamic adjustment of optimal guard bandwidth is proposed by many authors [11, 10, 9, 1, 6].

In this paper we test this algorithm for different simulated conditions and compare it to last proposed algorithm, in order to examine the behaviour characteristics in congestion environment.

Spectrum is a limited natural resource, and it is a common practice to share it among many users of wireless system.

The rest of the paper is organized as follows. In section II resource utilization and system model for simulation are explained. In section III degradation rate is defined and simulation method is explained. In section IV simulation results are presented, followed by conclusion.

RESOURCE UTILIZATION PLANNING AND SYSTEM MODEL

Planning resources in a fixed network is a relatively simple task, and it is possible to prepare it in advance. Mobility in wireless networks except having the freedom of movement and using services, also brings some unpredicted movements and user groupings. This means new responsibilities for operator, like preserving the service continuity through high handover quality. No service shall stop during the change of a cell.

In order to ensure the quality to the users, and to keep wireless network beyond congestion level, most advanced call admission control algorithms have to be used. This means using different class of services, and using algorithm which will ensure the least number of rejected requests during handover, and which will respect used class of service. In 2G network, situation was quite simple, since controlling of hard capacity is easy, and CAC algorithms always were algorithms considering only voice. Soft capacity in 3G networks requires more advanced resource control algorithms. Rate-adaptive multimedia applications can adapt to different bit rates and to different network conditions, e.g. MPEG-4 [7], and H.263+ [8] can support various bit rates.

In this paper, in order to test A2 algorithm characteristics and degradation properties as well, which was proposed in [4], we have tested it in simulation and compared it with earlier proposed algorithm A1 [3]. In order to test the degradation level released through restitution of required resources, as well as duration of degraded user's statuses in DG CAC algorithm proposed in [4], we conducted extended measures during 10 000 s on the algorithm. In that way we expect to get a better insight in user's status after enough resources are free, and to expose the restitution mechanism to test it in simulated activities.

DEGRADATION RATE AND SIMULATION METHOD

As a measure of user satisfaction, we defined a degradation rate. Degradation rate DR is here calculated as follows:

$$DR = \frac{DR_{total}}{N_{active}}, \quad (1)$$

where

DR_{total} is the total number of degradations (of all classes together), where the first level of degradation is calculated as one degradation, and second level of degradation is calculated as two degradations,

N_{active} is the number of active users.

For the simulation environment we developed a system with two overlapping cells, one UMTS and other being WLAN, and users distributed randomly through the cells. In simulated user movements, all the output parameters are measured and acquisitioned in each time step during the whole simulated time.

For the simulation input parameters, following parameters were used:

1) Populations of WLAN and UMTS users (250 WLAN and 1 UMTS in the beginning);
2) Powers of UMTS B-Node and WLAN Access Point (21 dBm, 20 dBm);
3) UMTS B-Node gain and Access Point gain (18 dB, 5dB);
4) Gains of UMTS and WLAN user antennas (0 dBi, 5 dBi);
5) Carrier frequencies for UMTS and WLAN (2100 MHz, 2400 MHz);
6) Handover thresholds for UMTS and WLAN users (-120 dBm, -84 dBm);

7) Moving speeds of UMTS and WLAN users (10 m/s, 2 m/s);
8) x and y positions of B-Node and Access Point (B-Node: x=1885.9 m, y=1885.9 m, AP: x=3836.9 m, y=1885.9 m);
9) Simulation duration (1000 s, and 10000 s);
10) Time step size (5 s).

The simulation software then calculates B-Node radius, and with our given parameters it gives 1642,6 m.

Simulation Results

For defined input parameters, simulation gives the results as presented in this section.

Fig. 1 Total number of handover requests during 1000 seconds

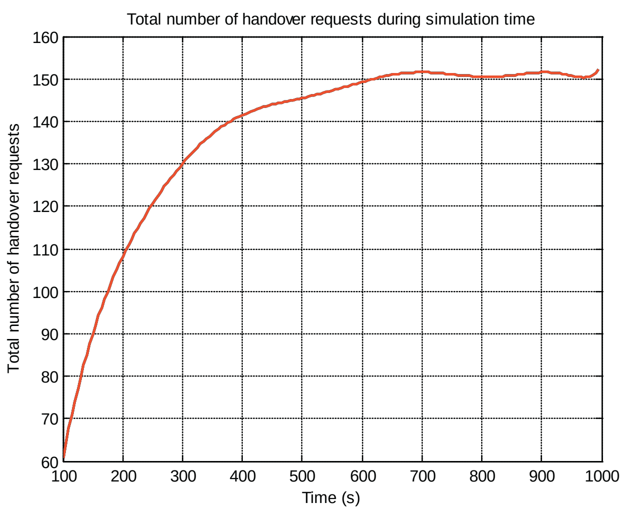


Fig. 1 shows the total number of handover requests. This number is independent of algorithm type, since it is connected to user's movements in simulated environment. For that reason this number is the same for each algorithm. Figure shows cumulative status, meaning that in each exact time point, the total number of requests until that moment is shown. We can see that the number of requests range from around 60 up to some 150 requests in total.

Fig. 2 Total number of handover requests during 10000 seconds

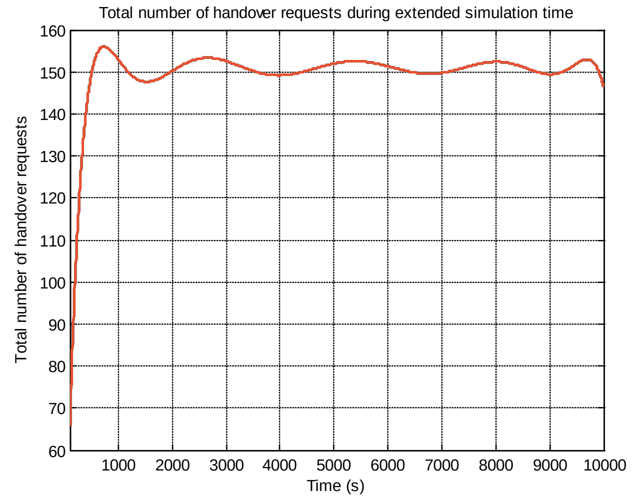
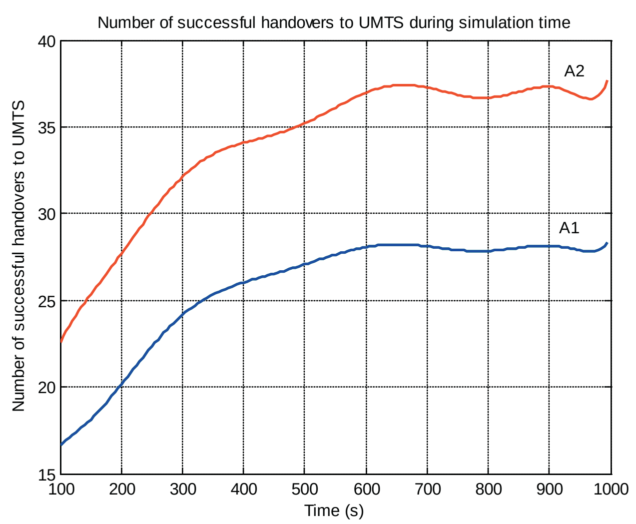


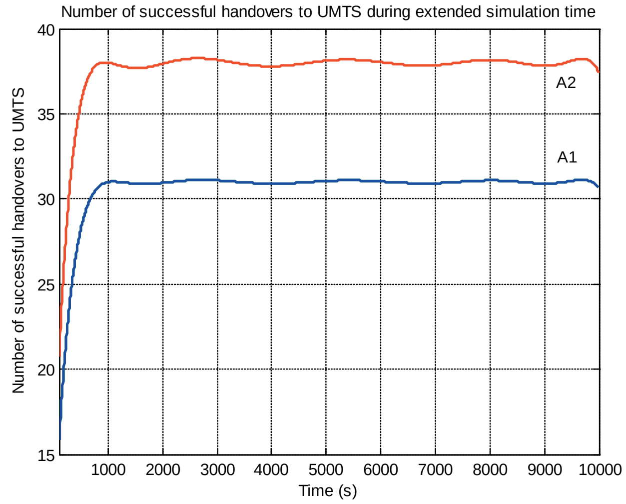
Fig. 2 shows the total number of handover requests during extended simulation time to 10000 seconds. It can be seen that after 1000 seconds the number of handover requests is stabilizing. The reason is that users are more and more leaving the observed cell, and the number of handover requests is decreasing after 1000 seconds.

Fig. 3 Number of successful handovers to UMTS during 1000 seconds



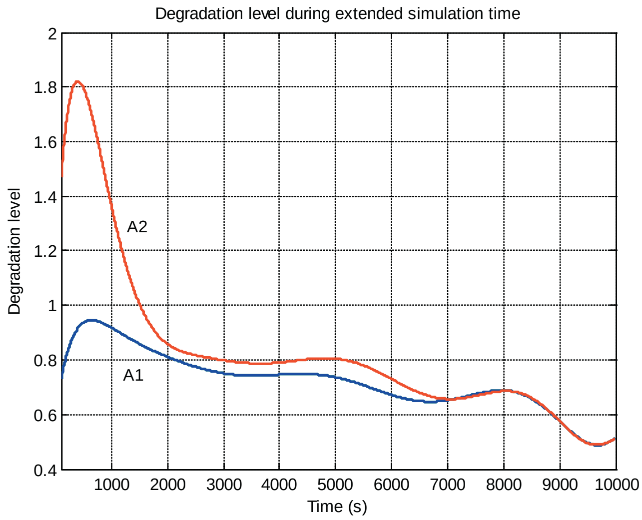
In Fig. 3 the number of successful handovers to UMTS during simulation time is shown. Algorithm A2 accepted more handover requests than algorithm A1 during simulation time. For the reason of testing algorithms' behaviours during longer time, simulation time is extended ten times.

FIG.4 NUMBER OF SUCCESSFUL HANDOVERS TO UMTS DURING 10000 SECONDS



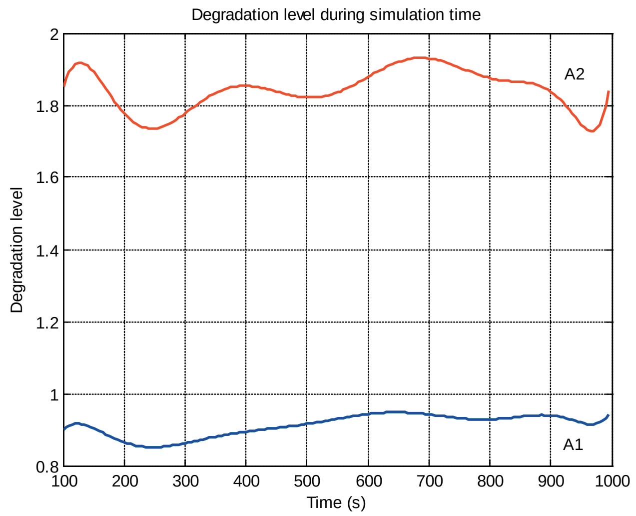
In Fig. 4 the number of successful handovers to UMTS during extended simulation time is shown. Algorithm A2 accepted more handover requests than algorithm A1 during extended simulation time as well.

FIG.6 DEGRADATION LEVEL DURING 10000 SECONDS



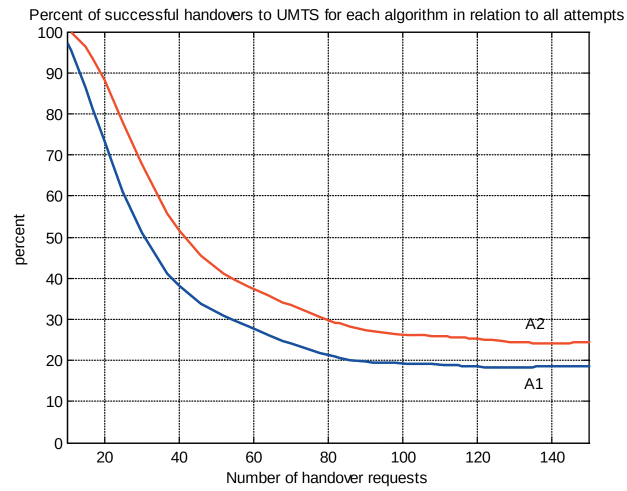
In Fig. 6 degradation level for A2 and A1 algorithms is shown. It is clear that algorithm A2 is doing a quick restitution of degraded resources to degraded connections with congestion decrease. Measures here represent real degradation rate in every time step, and not a cumulative value.

FIG.5 DEGRADATION LEVEL DURING 1000 SECONDS



In Fig. 5 degration levels for A2 and A1 algorithms are measured. Algorithm A2 uses more degradation in congestion situation than algorithm A1. This is due to the involved critical bandwidth for incoming requests in A2 algorithms. Measures here represent real degradation rate in every time step, and not a cumulative value.

FIG.7 PERCENT OF SUCCESSFUL HANDOVERS IN RELATION TO ALL ATTEMPTS



In Fig. 7 the percent of successful handovers to UMTS for each algorithm in relation to all attempts is shown. Measuring during 1000 seconds gives almost identical results as measures during 10 000 seconds, and because of that reason, here is presented only one graph. It can be noted from the graph that algorithm A2 shows always bigger percent of successful handovers for all values of handover requests.

Conclusion

In this paper new measures on DG CAC algorithm have been done in order to test algorithm's behavior in extended time and to compare it to our previous algorithm A1. The number of successful handovers to UMTS during extended simulation time remained bigger for algorithm A2. Measures showed more intensive use of degradation force by algorithm A2 in 1000 seconds period. However, in extended measures it showed quick degradation level released through restitution of required resources to earlier degraded connections. The percent of successful handovers to UMTS for each algorithm in relation to all attempts showed better results for A2 algorithm.

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