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DGCA Scheme for Differentiated Services in Wireless Cellular Networks

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Abstract

Modern wireless cellular networks (WCNs) carry different types of services, including voice, video, data, web traffic, etc. In order to provide high-quality multimedia services to anyone, anywhere, at any time with the consideration of user mobility, network designers need to implement optimal mechanisms that can trade off between Quality of Service (QoS) and Channel Utilization (in other words, Resource Utilization). This paper presents a dynamic guard channel allocation (DGCA) scheme, which can adaptively adjust the number of reserved channels for handoff calls to achieve this goal. Heavy-tailed distributions are used to represent the multimedia traffics. SimPy is used to build the simulation model [1].

Keywords: *DGCA, Handoff, Multiple Traffic*

1. Introduction

Interconnection of different types of wireless networks with the wired networks calls for a new generation of wireless networks [2]. Future wireless cellular networks will prevail with heavy traffic and diverse QoS requirements to revolutionize the user's wireless experiences. They will achieve high data rates and support differentiated service quality, providing users with new, converged services such as streaming video, mobile Internet browsing and VoIP. However, to support QoS-aware channel allocation for different kinds of media traffic under such heterogeneous wireless network infrastructures is not an easy task. In order to realize this vision, the improvement of optimal CAC algorithms is needed, as it is always the key management function in future cellular networks.

Traditional traffic models such as Poisson do not consider Long Range Dependence; thus they are inadequate for modeling network traffic traces. Silva and Mateus [3], in their research paper, define heavy-tailed distribution when modeling differentiated network traffics such as voice, data and video, and the resource occupation time for these services. Their simulation results provide one of the considerations for future network planning.

Traditional guard channel (GC) scheme in cellular networks reduces handoff call-dropping probability (PDH) at a higher expense of new call-blocking probability (PBN). DGCA Scheme is pursued to dynamically adjust GC reservation under some thresholds. In this paper, we present a handoff calls control scheme with adaptive guard channels according to different users' multimedia requests so as to keep balance between PDH and PBN. In order to mimic more actual multimedia services, different distributions are used to simulate the data traffic and the resource occupation time.

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2. System Model and Methods

We consider two kinds of schemes in a wireless cellular network model. Both new calls and handoff calls may have multimedia requirements, and the modeling system should provide differentiated services according to these requests. The first scheme runs with a fixed number of GCs for handoff calls, which mean that handoff calls have fixed priority than new calls. The second model adopts self-adaptive DGCA scheme, which according to current PDH automatically adjusts the number of reserved GCs. The aim is to improve the system performance through keeping the PDH within some thresholds' restriction, which correspondingly reduce the PBN comparing with the first scheme.

Assume each cell in the network has the same architecture and capacity with 60 free channels. If the PDH is below the given minimum threshold *Thr_1*=0.5, which means we needn't keep so many g (GCs) for handoffs, then g will decrease until the current PDH is exceeding the given maximum threshold *Thr_2*=0.8. The number of GCs needs to be increased to make sure it is below the *Thr_2*. There are also limitation threshold values for g. The value of g is between [0, 12]. Heavy-tailed service time has proved that the service time is lighter than the tail of Weibull distribution with parameter β=0.5 [4].

SimPy is the simulation tool adopted. It is a Python-based discrete event simulation system [5]. The simulation is process-oriented and it provides a number of tools including processes to model active entities, resource facilities, and results recording. The simulation time is set to be 10000.0 for better accuracy.

Table 1. Distributions for Differentiated Services

Services	Call Arriving Process	Call Duration
voice	Poisson	Exponential
Web traffic	Pareto	Weibull
image	Poisson	Weibull
video	Pareto	Exponential

3. Measurements

3.1. PDH

We get PDH values by calculating the probability: *PDH = NH_d/ NH_a*

Where *NH_d* is the number of handoff calls dropped, *NH_a* is the total number of handoff calls arrived.

3.2. PBN

We get PBN values by calculating the probability: *PBN = NN_b/ NN_a*

NN_b is the number of new calls blocked, *NN_a* is the number of new calls arrived.

3.3. Grade of Service(GoS)

GoS represents QoS provisioning: *GoS = PDH*W+PBN*

W is the weighting factor. Here, we let *W*=10 in order to focus heavily on HCs dropping rate, so lower *GoS* means better performance.

3.4. Channel Utilization (CU)

Channel utilization ratio is calculated as following: *CU = TOT/TRT*

Where *TOT* is the total channel occupied time, and *TRT* is the total running time.

4. Results and Conclusions

4.1. Results

In this section, we conduct intensive simulation runs to empirically evaluate and compare the performance of the two schemes. Figure 1~2 shows the corresponding simulation results.

4.1.1. Grade of Service Comparison: different GoSs with different Hrate, as shown in Figure 1. We can see that under different network traffic Scheme 2 gets better GoS than Scheme 1.

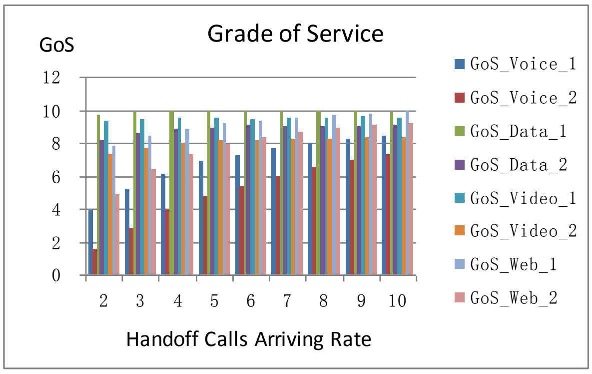

Figure 1. Comparison of GoS with Increasing Arriving Rate Hrate

4.1.2. Channel Utilization Comparison: channel utilization percentage when all channels occupied is shown in Figure 2. We can see that when the number of calls increases, this means more calls being held by each cell, leading to a better channel occupancy.

The simulation results show that different types of data transfer have different PBN and PDH values. As we can imagine, Scheme 1 with fixed GCs reserved gets lower PBN, but with the expense of higher PDH. Scheme 2 gets lower PDH values under the given threshold, while the PBN values are correspondingly higher (totally keeping better GoS than Scheme 1). Scheme 2 with adaptive guard channels gets higher RU values for all traffic types.

4.2. Conclusions

Accurate differentiated traffic models could lead to better resource allocation and optimization algorithms in WCNs. In this paper, two schemes for channel allocation control in multiservice WCNs have been considered. We simulate four traffic type services such as voice, data, video, and web traffic using heavy-tailed distribution. Four measures: PDH, PBN, CU and GoS are analyzed, respectively. The simulation results show that the adaptive DCAC scheme with thresholds keeps tradeoff between PDH and PBN, which therefore gets better QoS and higher channel utilization.

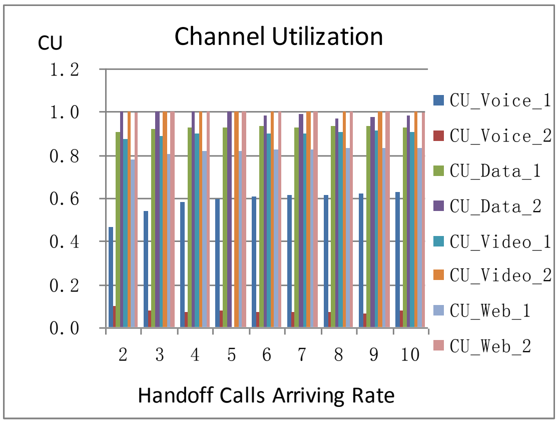

Figure 2. Comparison of CU with Increasing Arriving Rate Hrate

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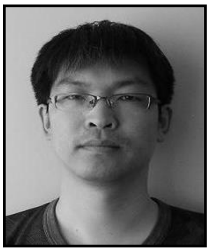

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