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A New Connection Admission Control for Spotbeam Handover in LEO Satellite Networks

SUNGRAE CHO * and IAN F. AKYILDIZ
Broadband and Wireless Networking Laboratory, School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA 30332, USA

MICHAEL D. BENDER
Department of Defense, 9800 Savage Road STE 6512, Fort Meade, MD 20755-6512, USA

HUSEYIN UZUNALIOĞLU
Bell Laboratories, Lucent Technologies, Holmdel, NJ 07733, USA

Abstract. Frequent spotbeam handovers in *low earth orbit* (LEO) satellite networks require a technique to decrease the handover blocking probabilities. A large variety of schemes have been proposed to achieve this goal in terrestrial mobile cellular networks. Most of them focus on the notion of prioritized channel allocation algorithms. However, these schemes cannot provide the connection-level *quality of service* (QoS) guarantees. Due to the scarcity of resources in LEO satellite networks, a *connection admission control* (CAC) technique becomes important to achieve this connection-level QoS for the spotbeam handovers. In this paper, a *geographical connection admission control* (GCAC) algorithm is introduced, which estimates the future handover blocking performance of a new call attempt based on the user location database, in order to decrease the handover blocking. Also, for its channel allocation scheme, an *adaptive dynamic channel allocation* (ADCA) scheme is introduced. By simulation, it is shown that the proposed GCAC with ADCA scheme guarantees the handover blocking probability to a predefined target level of QoS. Since GCAC algorithm utilizes the user location information, performance evaluation indicates that the quality of service (QoS) is also guaranteed in the non-uniform traffic pattern.

Keywords: LEO satellite networks, connection admission control, channel allocation, handover management

1. Introduction

Terrestrial mobile cellular networks provide wireless communication services with limited geographic coverage since they are economically infeasible due to rough terrain or insufficient user population. In order to provide global information access, a number of satellite systems have been proposed [11]. The satellite networks are well suited for worldwide communication services and to complement the terrestrial mobile cellular networks because they can support not only the areas with terrestrial networks but also the areas in lack of terrestrial infrastructure. Among the satellite systems, *low earth orbit* (LEO) satellite systems will make an important role in the near-future communication services, because of its less propagation delay, less power requirement in the user terminal and the satellite, and efficient spectrum utilization using smaller coverage area for each satellite than geostationary (GEO) satellite systems. Moreover, it is possible to route a connection between two satellites using inter-satellite link (ISL) without relying on terrestrial resources. However, a number of mobility problems that did not exist for GEO satellite systems should be resolved in order to have feasible implementations of the LEO satellite systems.

In LEO satellite networks, spotbeam handover[1] is the most frequently encountered network function because of the high speed of the satellites [4]. Frequent spotbeam handovers would cause more handover blockings if no resource (or channel) is available in the target spotbeam. Blocking a handover call is generally considered less desirable from user's point of view than blocking a new call [17]. The priority can be given via different treatments of new and handover calls to decrease the handover call blockings. Handover calls can experience a more favorable blocking probability than new calls by prioritizing channel allocation during call admission phase.

One noticeable prioritization scheme is *handover with queueing* (HQ) technique [4]. This scheme utilizes the overlapped area between two spotbeams where the handover takes place. When a user terminal is in an overlapped area, the handover process is initiated. If a channel is available in the new spotbeam, it is allocated to the user terminal; otherwise, the handover request is queued. When a channel becomes available, one of the calls in the queue is served. A handover call is blocked if no channel is allocated for the call in the new spotbeam when the power level received from the current spotbeam falls below the minimum power level that is required for a successful data transfer. The HQ scheme reduces the handover call blocking; however, its performance depends on the new call arrival rate and the size of the overlapped area. In the worst case, high call arrival rates or small overlapped areas would result in a high value of handover call blocking probability.

Another prioritization technique proposed is *handover with guard channel* (HG) scheme [6,7]. In this scheme, guard channels are used to ensure that some number of channels are

* Corresponding author.
[1] The definition of *spotbeam handover* will be discussed in section 2.