On Bandwidth and Inter-Satellite Handover Management in Multimedia LEO Satellite Systems

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Abstract—Low earth orbit (LEO) satellite systems gained considerable interest towards the end of the previous decade owing to some of their appealing features, such as low propagation delay, global coverage and their ability to communicate with handheld terminals. However, one of the main factors that degrade the quality of the provided services is the handover of a call between contiguous cells or satellites. In this paper, we propose and evaluate an inter-satellite handover technique for multimedia LEO satellite systems with overlapping coverage areas among their satellites. The proposed scheme relies upon the queuing of handover requests in order to achieve low dropping probabilities. Moreover, the main mechanism behind the proposed scheme that allows it to attain an enhanced performance is based on dynamic bandwidth deallocation. According to the proposed mechanism capacity reservation requests are canceled when the capacity that they strive to reserve is unlikely to be used. The good characteristics of the proposed scheme were confirmed via simulations, where significant gains in the performance were witnessed for all the scenarios examined.

I. INTRODUCTION

Low Earth Orbit (LEO) satellite networks offer a number of benefits: wide coverage area, unique broadcasting capability, the ability to communicate with mobile users, etc. They are expected to support a wide range of multimedia services and applications and provide their users with the appropriate Quality of Service (QoS), including bandwidth, Call Blocking Probability and Call Dropping Probability. However, the limited bandwidth of the satellite channel, LEO satellites’ rotation around the Earth and the Earth’s rotation make QoS provisioning a challenging task. Two noticeable problems are bandwidth management and intra/inter-satellite handover.

The main resource in the satellite network is the radio bandwidth. Due of the fact that the total link capacity has to be divided among several carriers, bandwidth management in LEO satellite networks plays a very important role. It ensures the ability of the network to provide the appropriate QoS, protecting at the same time both the network and the end-systems from congestion in order to meet the QoS objectives. However, bandwidth is a commodity at a premium and appropriate schemes capable of dynamically allocating the bandwidth among satellite terminals, while fulfilling the QoS requirements, are of paramount importance. Unfortunately, efficient bandwidth utilization and QoS provisioning are two competing goals; therefore Dynamic Bandwidth Allocation (DBA) schemes seek for a trade-off between QoS provisioning and bandwidth saving.

The coverage area of a LEO satellite, referred to as its footprint, is partitioned into slightly overlapping cells called spotbeams. As their coverage area changes continuously, in order to maintain connectivity, end-users must switch from spotbeam to spotbeam and from satellite to satellite, resulting in frequent intra- and inter-satellite handovers attempts. This fact causes technical problems in which fair sharing of bandwidth between handover connections and new connections is required. Thus, bandwidth management becomes a very important task in order to achieve high bandwidth utilization for both handover and new connections. This problem is alleviated by implementing sophisticated bandwidth allocation schemes and new handover control techniques that aim to achieve an enhanced QoS performance.

Several approaches for bandwidth and handover management have been studied in the recent literature for mobile satellite systems. Relevant work can be summarized as follows.

In [1], the authors compared some different allocation strategies based on traffic prediction for communications networks with high bandwidth delay product.

In [2], the authors proposed different resource allocation strategies for LEO satellite networks. The queuing of handover requests was introduced, aiming to reduce the handover blocking probability. The dynamic channel allocation scheme is expected to be the best scheme to optimize system performance.

In [3], a probabilistic bandwidth reservation strategy for real-time services was investigated. The concept of sliding windows was proposed to predict the necessary amount of required bandwidth for a new call in its future handover spotbeams.

In [4], the key ingredient was a predictive bandwidth allocation strategy that exploits the topology of the network and attains high bandwidth utilization. By introducing priority queues and a new call admission scheme based on the multiple virtual windows approach, better overall performance is achieved without knowledge of the exact location of user terminals.
In [5], the authors proposed a selective look-ahead strategy, specifically tailored to meet the QoS requirements of multimedia connections, where real-time and non-real-time service classes are treated differently. The handover admission policies introduced distinguish between these two types of connections. Bandwidth allocation only pertains to real-time handover connections. To each accepted connection, bandwidth is allocated in a look-ahead horizon of \( k = 2 \) cells along its trajectory, where \( k \) is referred to as the depth of the look-ahead.

In [6], the location of users was used for adaptive bandwidth allocation and handover resource reservation. In a spotbeam, bandwidth reservation for handover calls is allocated adaptively by calculating the possible handovers from neighboring spotbeams. A new call request is accepted if the spotbeam where it originated has enough available bandwidth for new calls. The reservation mechanism provides a low handover blocking probability compared to the fixed guard channel strategy.

In [7] a call admission control (CAC) scheme was proposed. This scheme takes account of the user’s location in order to estimate the future Call Dropping Probability that a new call may experience. Additionally, an adaptive dynamic channel allocation scheme was introduced.

In [8], the system was considered to always trace the location of all the users in each spotbeam and update the user’s handover blocking parameters. A new call is accepted only if the handover blocking probability of the system is below the target blocking rate at all times.

In [9], the authors introduced a new metric called “mobility reservation status” which provides the information about the current bandwidth requirements of all active connections in a specific spotbeam in addition to the “possible” bandwidth requirements of mobile terminals currently connected to the neighboring spotbeams. The key idea of the algorithm is to prevent the forced termination of a call by reserving the bandwidth in a particular number \( S \) of spotbeams that the call will be handed over to. The trade-off between new call blocking and handover call blocking depends on the selection of predetermined threshold parameters for new and handover calls.

In [10] a dynamic Doppler based handover prioritization technique (DDBHP) for non-Geostationary (non-GEO) satellite networks was proposed. This intra-satellite handover scheme relies upon the Doppler effect in order to estimate the user’s location and the time instant of the next handover occurrence. A channel reservation request is sent to the forthcoming cell at an appropriate time instant before the handover occurrence.

In [11] an inter-satellite handover scheme for narrowband LEO satellite systems was proposed. In that study the system was considered to provide only one service, that is telephony service. This technique is an extension of the technique that was proposed in [10] and takes advantage of the Doppler effect in order to estimate the terminal’s location and reserve a channel at an appropriate time in the forthcoming satellite. Moreover, that scheme also exploits the satellite diversity that some systems provide, and to this end, three satellite selection criteria were proposed and evaluated.

In [12] a guaranteed handover scheme was proposed. This scheme was evaluated for a fixed channel allocation strategy. According to the proposed method a new call is admitted into the network only if there is an available channel in both the current cell and the first transit cell. When the first handover occurs a channel-reservation request is issued to the next candidate transit cell. If all channels are reserved the request is queued in a list in a FIFO (first in first out) manner until the occurrence of the handover. The call is dropped if a channel has not been reserved in the meanwhile.

In [13] different queuing policies for handover requests were investigated. The handover requests, queued up to a maximum time interval which is a function of the overlapping area of contiguous cells, are served in a FIFO manner or in a last useful instant (LUI) manner. According to the LUI policy, a handover request is queued ahead of any other requests already in the queue that have a longer residual queuing time. The examined schemes were evaluated under the assumption of a fixed channel allocation strategy.

In [14] the authors modeled the user cell changing process during the call lifetime in LEO systems. The impact of user mobility on the call blocking performance of different channel allocation techniques was evaluated taking into consideration the peculiarities of the handover arrival process.

In [15] an inter-satellite handover scheme was proposed for multimedia LEO satellite systems. That scheme is based on the queuing of handover requests in order to attain low Call Dropping Probability. Further, it was evaluated for two different queuing policies and for two different satellite selection criteria.

Except for the studies in [11], [15], all the other studies investigated bandwidth allocation only for the intra-satellite handover management. In our work we propose an advanced bandwidth management strategy providing for bandwidth allocation/deallocation and a novel inter-satellite handover management scheme tailored for multimedia LEO satellite networks with satellite diversity. The proposed scheme relies on the queuing of handover requests in order to achieve low dropping probabilities. In addition, the main mechanism behind the proposed scheme that allows it to attain an enhanced performance is based on the cancelation of capacity reservation requests when the capacity that they strive to reserve is unlikely to be used.

The remainder of this work is organized as follows. Section II discusses the mobility model assumed in this work. Additionally, the satellite selection criteria and the resulting service schemes are described. In section III we describe our bandwidth management strategy and inter-satellite handover management scheme. Section IV introduces the simulation model, dealing also with the performance evaluation of our scheme in terms of Call Blocking Probability, Call Dropping Probability, and mean Bitrate. Finally, conclusion remarks are drawn in section V.
II. MOBILITY MODEL

One of the main features of LEO satellite systems is the movement of satellites with respect to the Earth’s surface. Several mobility models have been proposed in the recent literature which aim to describe the movement of satellite footprints on the Earth’s surface. In almost all the studies one-dimensional models were employed. These are predicated upon the view that the rotation of the Earth is negligible compared to the satellites’ movement. This model is a simple model to work with, however, it is valid only for services that have a short mean duration. In this work, the two-dimensional mobility model that was proposed in [15] is employed, which takes account of the Earth’s rotation. This mobility model is illustrated in Fig. 1, where \( V_s \) and \( V_r \) denote the satellite’s ground track speed and the speed that corresponds to the Earth’s rotation respectively.

\[
\begin{array}{c}
V_s \\
V_r \\
V_s
\end{array}
\]

Fig. 1: Mobility Model

It becomes apparent from Fig. 1 that the satellite to which a call will be handed over is not always the following one in the same orbital plane. If a user is located in the overlapping area, then it is likely that due to the Earth’s rotation he/she will be handed over to a satellite of the contiguous orbital plane. For more details on this model, the reader is referred to [15].

A. Satellite Selection Criteria

Satellite selection criteria should be defined when there exist overlapping coverage areas among satellites. In [11] three criteria were defined. For the sake of completeness, these criteria are described in brief below.

- **Maximum Available Capacity criterion** - This criterion is based on the rule that the satellite that has the maximum available capacity should be selected. It aims to uniformly distribute the traffic over the LEO satellite network.
- **Maximum Service Time criterion** - This criterion is based on the rule that a terminal should be connected to the satellite that provides the maximum serving period. The aim of this criterion is to minimize the number of handovers experienced by a user.
- **Minimum Distance criterion** - This criterion is based on the rule that a terminal should be connected to the satellite that offers the highest elevation angle, that is, the closest satellite. This criterion aims to mitigate channel impairments.

However, in this work we focus only on the Maximum Available Capacity and Maximum Service Time criteria. These criteria can be applied to either new or handover calls, thus we result in four different service schemes which are presented in Table I. We do not examine the Minimum Distance criterion since it is not suitable for services with a long mean duration. Besides, as was shown in [11], the schemes that are based on that criterion do not perform well.

<table>
<thead>
<tr>
<th>TABLE I: Service schemes</th>
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<td>Service scheme</td>
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<tr>
<td>CT scheme</td>
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<td>TT scheme</td>
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<tr>
<td>TC scheme</td>
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III. RESOURCE AND HANDOVER MANAGEMENT

In this section, we spell out the details of the proposed technique. Our approach is similar to the one in [15]. Nevertheless, the proposed technique aims to provide an enhanced management of the limited bandwidth of the satellite channel. Towards this end, it deletes capacity reservation requests when the capacity that they try to reserve is unlikely to be used. In the following subsections the proposed scheme is delineated. For the sake of clarity, in each subsection we first describe the technique that was proposed in [15], and then we proceed with the description of the proposed technique.

Hereinafter, we consider that the applications that the LEO satellite network provides are categorized into two service classes. *Service Class I* represents real-time multimedia applications with stringent QoS requirements, whereas *Service Class II* corresponds to non-real-time data applications with loose QoS constraints.

A. Call admission control

The CAC procedure of the proposed technique is similar to the one described in [15]. A new *Class I* call will be admitted into the network only if at least the minimum capacity required by the source is available in the visible satellite. Concerning user terminals that are located in the overlapping area that contiguous satellites share, they will first check the available capacity in the satellite that is indicated by the satellite selection criterion that is employed for new calls. If they do not manage to reserve the required capacity in that satellite, then the second visible satellite will be checked. The call will be blocked only if the minimum capacity that is required for this type of service cannot be reserved in one of the visible satellites. If a call is admitted into the network, then a handover request is immediately sent to the satellite (or satellites) to which the call may be handed over. Concerning *Class II* calls,
the procedure is slightly different since these calls are subject to looser QoS constraints. A new Class II call is admitted into the network provided that there exists some residual capacity, even lower than the minimum required capacity, in one of the visible satellites.

At this point we should stress the importance that the knowledge of the terminal’s location has to the proposed technique. The satellite should be aware of the terminal’s location in order to be able to estimate the time instant of the forthcoming handover occurrence and the candidate satellites for serving the call. In [10], [11] a low-complexity technique based on the Doppler effect was employed in order to estimate the terminal’s position and the time instant of the upcoming handover occurrence. This technique, nevertheless, necessitates satellites with on-board processing capabilities, a requirement that should be met by most of the future satellite networks.

B. Handover management

In this subsection we delineate the proposed handover management scheme. The scheme will be described for the case wherein a terminal is located in the overlapping area and therefore, it is covered by two satellites, because this represents the most complex case. The proposed handover scheme is dissimilar to the one that was spelt out in [15]. Each satellite has two queues where handover requests, that is, capacity reservation requests, are placed. The first queue is named NR and contains the requests of Class I calls, while the second queue, which is called NQ, contains the requests of Class II calls.

Let us first assume a new Class I call that has been admitted into the network. Immediately after the admission of the call the serving satellite derives the time instant of the first handover occurrence as well as the potential satellites to which the call may be handed over. Then, capacity reservation requests are sent to them. These requests are stored in the NR queues of those satellites. In [15] capacity may have been reserved in both candidate satellites for serving the call. The decision on which of them will serve the call is taken at the time instant of the handover occurrence. Thus, the capacity that has been reserved in the other satellite is then released without being used. In this paper we propose a technique that relies on a different approach. Capacity reservation requests are sent to both candidate satellites. Notwithstanding, as soon as capacity has been reserved in one satellite, the capacity reservation request that is stored in the NR queue of the other satellite is deleted. Hence, the proposed scheme does not waste the limited bandwidth of the satellite channel.

In [15] it was shown that system performance is dominated by the criterion that is applied to new calls rather than the criterion that is used for handover calls. This holds true to a greater extent for the proposed technique. In essence, it is highly unlikely that capacity will be available at the same time instant in both satellites, therefore the employment of a satellite selection criterion for handover calls is not required. In our scheme, in the rare case that capacity is available in both satellites, the satellite to which the call will be handed over is randomly selected.

As far as the management of Class II handover requests is concerned, the procedure is more or less similar to the one that is followed for Class I handover requests. As soon as a Class II call is admitted into the network, or successfully handed over to a satellite, the serving satellite estimates the time instant of the next handover occurrence and derives the candidate satellites for relaying the call. Then, capacity reservation requests are sent to them. Each one of the requests is placed in the NQ queue of each satellite. The only difference between the two procedures lies in the amount of bandwidth that should be reserved so that the call is not dropped. A Class II call will not be dropped as long as some residual capacity, which can be lower than the minimum capacity that is required by the source, has been reserved in a satellite. Evidently, if capacity has been reserved in one satellite, then the handover request is removed from the NQ queue of the other candidate satellite.

C. Management of queues

As mentioned before, Class I calls have more stringent QoS requirements than Class II calls and thus, priority should be given to requests of Class I calls over requests of Class II calls. Towards this end, the satellite first serves the requests of the NR queue and then the requests that are contained in its NQ queue. Moreover, we also had to decide on the queuing policy on which the management of the requests in these queues will be based. As in [15], in this work we investigate two different queuing disciplines. The first is the well known FIFO (first in first out) policy. In this policy, the requests are served according to their arrival time. The second queuing policy that we examine is called LUI (last useful instant) [2], [13]. In this policy, the requests are served based on the remaining time interval till the handover occurrence. Hence, a request is placed before all the other requests in the queue that have a greater remaining queuing time.

IV. Simulations Results and Discussion

In order to evaluate the performance of the proposed technique a simulation tool was developed in C++. Four orbital planes with four satellites in each one were simulated. The coverage area of a satellite footprint was set to 1790 × 1790 km², which is roughly equal to the area that a satellite of the Teledesic system (the Boeing design with 288 satellites) covers. Additionally, the velocity of each footprint was set to 5.89 km/sec, while the satellite capacity was considered to be 32 Mbps.

In the simulated scenarios we considered six different types of services, three for each service class. Each one of these applications is subject to different QoS requirements, which are presented in Table II along with the simulation parameters. New calls are generated according to a Poisson distribution with mean arrival rate λ. The call duration of each type of service is exponentially distributed with mean value $T_d$. 
In the experiments conducted in this work we compared the proposed scheme to the one that was proposed in [15]. Moreover, we examined the impact of the overlapping percentage on system performance. The overlapping percentage is defined as the percentage of the footprint’s area that is overlapped by footprints of contiguous satellites. The performance metrics are the Call Blocking Probability ($P_B$), the Call Dropping Probability ($P_D$) and the mean Bitrate. In [15] four service schemes were studied. In this work we focus only on the two best service schemes, that is, the CC and CT schemes. For the sake of clarity, we describe the examined schemes below.

- **FCC scheme** - This scheme is based on the technique that was proposed in [15]. Further, the FIFO queuing policy is applied and the CC service scheme is employed.
- **LCC scheme** - This scheme is similar to the aforementioned scheme with the exception of applying the LUI queuing policy instead of the FIFO policy.
- **FCT scheme** - This scheme is based on the technique that was proposed in [15]. That scheme also employs the FIFO queuing policy and the CT service scheme.
- **LCT scheme** - This scheme is similar to the FCT scheme, but it relies on the LUI policy rather than the FIFO policy.
- **DFC scheme** - This scheme is based on the technique that is proposed in this work and on the FIFO queuing policy. Moreover, the “Maximum Available Capacity” criterion is employed for new calls.
- **DLC scheme** - This scheme is similar to the DFC scheme, however, it is based on the LUI queuing policy instead of the FIFO policy.
- **DFT scheme** - This scheme is similar to the DFC scheme,

<table>
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<tr>
<th>Parameters</th>
<th>Service Class I</th>
<th>Service Class II</th>
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<tbody>
<tr>
<td></td>
<td>Type 1</td>
<td>Type 2</td>
</tr>
<tr>
<td>Maximum bandwidth (kbps)</td>
<td>30</td>
<td>256</td>
</tr>
<tr>
<td>Minimum bandwidth (kbps)</td>
<td>30</td>
<td>256</td>
</tr>
<tr>
<td>$\lambda$ (arrival rate in calls/min/footprint)</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>Mean duration $T_d$ (sec)</td>
<td>180</td>
<td>300</td>
</tr>
</tbody>
</table>

Fig. 2: Call Blocking and Call Dropping Probabilities of “Class I - Type 1” calls vs overlapping percentage
Fig. 3: Call Blocking and Call Dropping Probabilities of “Class I - Type 2” calls vs overlapping percentage
however, the “Maximum Service Time” criterion is used for new calls.

- **DLT scheme** - This scheme is similar to the DFT scheme, however, the LUI queuing policy is employed instead of the FIFO policy.

Fig. 2 depicts the Call Blocking and Call Dropping Probabilities of “Class I - Type 1” calls versus overlapping percentage. Apparently, significant gains accrue by the use of the proposed technique. A decrease by half is observed in the Call Blocking Probability when the proposed technique is employed. As regards Call Dropping Probabilities, the differences are apparent only when the FIFO queuing policy is employed, whereas all the examined schemes perform similarly when the LUI policy is applied. Concerning the performance disparity between the FIFO and LUI queuing policies, this is more obvious in the graph that depicts the Call Dropping Probability than in the graph where the Call Blocking Probability is presented. The LUI policy performs better regarding Call Dropping Probabilities, whereas it is outperformed by the FIFO policy with regard to Call Blocking Probabilities. However, we should point out that the Call Dropping Probabilities for both the FIFO and LUI policies are extremely low. Moreover, the best scheme is the DFC scheme, which is based on the FIFO queuing policy and the “Maximum Available Capacity” criterion.

Fig. 3 illustrates some rather interesting results concerning the performance metrics of “Class I - Type 2” calls. As it can be seen, when the scheme that was proposed in [15] is employed, calls of this service type cannot capitalize upon an increased overlapping area. On the contrary, the scheme that we propose in this work can take advantage of the overlapping area in order to provide an enhanced network performance. The performance disparities are apparent not only in Call Blocking Probabilities, but in Call Dropping Probabilities as well. The best performance is presented by the DLT scheme this time.

Fig. 4 depicts the Call Blocking Probability, the Call Dropping Probability and the mean Bitrate concerning “Class I - Type 3” calls. Due to the extremely low arrival rate of this type of calls it was not possible to eliminate the statistical errors in these results, particularly in the results regarding Call Dropping Probability. Nevertheless, the results are indicative of the performance of each scheme. Concerning Call Blocking Probability, the proposed scheme is barely affected by an increase in the overlapping percentage, while the performance of the schemes that are based on the technique that was proposed in [15] aggravates as the overlapping percentage increases. As far as Call Dropping Probabilities are concerned, the proposed technique outperforms the technique that was presented in [15] both for the FIFO and for the LUI queuing policy. In regard to mean Bitrate, the schemes that rely on the proposed technique exhibit the maximum mean Bitrates. Further, the scheme that presents the best overall performance is the DLT scheme.
Concerning Call Blocking and Call Dropping Probabilities of “Class II - Type 1” calls, which are presented in Fig. 5.a and 5.b, the performance of the schemes looks similar to the one that they exhibited for “Class I - Type 1” calls. As illustrated in Fig. 5.c which depicts the mean Bitrate, only the DFC and DLC schemes take advantage of an increased overlapping area. The mean Bitrate that the other schemes attain slightly decreases as the overlapping percentage increases. The DFC and DLC schemes seem to be the best ones among all the examined schemes for this type of service.

The performance metrics of “Class II - Type 2” calls are illustrated in Fig. 6. Regarding Call Blocking and Call Dropping Probabilities in Fig. 6.a and 6.b, it is evident that the performance disparities among the schemes are like the ones in Fig. 5. Concerning Fig. 6.c, the mean Bitrate of the schemes that are based on the proposed technique is higher that the one of the schemes that rely on the technique that was proposed in [15]. The best performance is accomplished by the DFC and DLC schemes.

Fig. 7 illustrates the Call Blocking Probability, the Call Dropping Probability as well as the mean Bitrate of “Class II - Type 3” calls. As in the case of “Class II - Type 2” calls, the best schemes are the DFC and DLC. We should also stress that all the schemes that are based on the LUI queuing policy attain zero Call Dropping Probabilities for almost all overlapping percentages.

In order to derive the scheme that presents the best overall performance we employed the cost function that was proposed in [15]. First we have to define a cost function for each type of service, which we call Grade of Service (GoS). This cost function is a combination of the Call Blocking Probability and the Call Dropping Probability and is given by

\[
GoS = 0.1P_B + 0.9P_D
\]  

A greater weighting factor has been given to \(P_D\) due to the fact that dropped calls are more annoying to users than blocked calls. Then, in order to examine the overall system performance we define another cost function, which is called General GoS.

\[
General \ GoS = \sum_{i=1}^{2} \sum_{j=1}^{3} a_{ij} \cdot GoS_{ij}
\]  

where \(i\) indicates the service class, \(j\) denotes the type of service and \(GoS_{ij}\) is the Grade of Service of “Class \(i\) - Type \(j\)” calls. In addition, \(a_{ij}\) is a weighting factor which is equal to

\[
a_{ij} = \frac{B_{min_{ij}} \cdot \lambda_{ij}}{\mu_{ij}}
\]  

where \(B_{min_{ij}}\) denotes the minimum capacity that is required for this type of service, whereas \(\lambda_{ij}\) and \(\mu_{ij}\) are the arrival
and departure rates of “Class i - Type j” calls respectively. In Fig. 8 the General GoS is illustrated.

The results that are presented in Fig. 8 confirm the positive characteristics of the proposed bandwidth management and inter-satellite handover scheme. It is evident that the proposed technique can capitalize upon the partial or full satellite diversity that a LEO satellite system may provide in order to enhance system performance. The best performance is achieved by the DLC and DFC schemes. Also, we observe that the “Maximum Available Capacity” outperforms the “Maximum Service Time” criterion. Under further scrutiny, we are led to another important conclusion. While it seems that the FIFO and LUI queuing policies perform similarly, the FIFO policy is more appealing by virtue of its low complexity compared to the LUI policy.

V. CONCLUSIONS

In this work, we proposed and evaluated the performance of a bandwidth management and inter-satellite handover technique, tailored for multimedia LEO satellite systems. The main mechanism behind the proposed scheme is the queuing of handover requests, which results in extremely low Call Dropping Probabilities. Moreover, in order to provide a good trade-off between Call Blocking and Call Dropping Probabilities, in this work a dynamic bandwidth deallocation scheme is introduced. According to this scheme, capacity reservation requests are countermanded when the capacity that they strive to reserve is unlikely to be used. We also showed that the proposed technique can take advantage of the footprint’s overlapping area in order to enhance network performance. The proposed algorithm was compared to an algorithm that makes the decision about the satellite to which the call will be handed over at the time instant of the handover occurrence. The good characteristics of the proposed technique were confirmed via simulations for two different queuing policies and for different satellite selection criteria.

ACKNOWLEDGMENT

This work was carried out in the framework of the EU funded network of excellence SatNEx (contract No. 507052).

Mr. Stylianos Karapantazis thanks the Bodossaki Foundation for supporting his PhD studies.

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