Different Resource Sharing Policies under a General Channel Management Strategy for Multi-Class Traffic in LEO-MSS

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Abstract

An analytical framework for the efficient evaluation of the performance of complete sharing (CS) and complete partitioning (CP) resource sharing policies under a newly proposed general channel management strategy for multi-class traffic in Low Earth Orbit-Mobile Satellite Systems (LEO-MSS) is presented.
This strategy gives a higher priority to handover calls over new calls by combine the guard channel scheme, the queuing priority scheme and the sub-rating scheme in such a way to reduce the forced termination probability of handover calls with little impact on other system performance measure, such as new call blocking probability and unsuccessful call probability.

Keywords: *Complete Sharing, Complete Partitioning, Sub-rating, Multi-class traffic, LEO.*

1. Introduction

The communication revolution in the last decade has increased the demand for wireless personal communication services (PCS). Satellite communication Systems, especially Non-Geostationary Satellite Systems made it possible to form a mobile telephony and data transmission network for providing communication services globally without the need for complex ground-based infrastructures which is one of the key components of existing land-based cellular schemes [1].
By using satellites at low altitudes, Low Earth Orbital (LEO) Satellite Systems can reduce power requirements on-board and on the ground. This results in light weight low power radio telephones with small low profile antennas. Besides of these, low altitude means minimized transmission delay nearly equal to land-based networks [2]. As a result, LEO satellites are better suited for providing real-time interactive and multimedia services than geostationary satellites.
Two classical policies for resource sharing are complete sharing (CS), which allows all classes to share the resource indiscriminately, and complete partitioning (CP), which statically divides the resource among the classes, allowing each class the exclusive use of its allocated capacity. Based on the user standpoint that maintaining an ongoing call is more important than admitting a new call, the admission of new and handover calls have to be treated differently in channel (resource) management strategies. Different resource management schemes have been proposed and can be classified into the following categories:

- *Guard Channel* (GC) Scheme (also called *Reserved Channel* Scheme): In this scheme, a number of resources are reserved for the exclusive use of handover calls in order to minimize forced termination probability [3].
- *Sub-rating* (SR) Scheme: In this scheme, certain channels are allowed to be temporarily divided into two channels at half of the original rate to accommodate handover calls. This subrating occurs when all the channels are occupied at the moment of handover call arrival. When a subrated channel is released, it forms into an original full-rated channel by combining with another subrated channel [4, 5].
- *Queuing Priority* (QP) Scheme: In this scheme, the handover calls requests are queued in case there is no channel available in the destination cell wait for an occupied channel to be released. The call will be forced termination if no channel is made available within the defined maximum time limit [6, 7].

The guard channel, queuing priority and the two scheme combination performance analysis for multi-class traffic have been discussed for the two resource sharing policies complete sharing (CS) and complete partitioning (CP) in [9, 11] respectively.
In this paper, we propose an analytical framework for evaluating the performance of LEO-MSS multi-class traffic using complete sharing (CS) and complete partitioning (CP) with the following more general channel management strategy, which combines the idea of a guard channel, handover request queuing and sub-rating schemes. The results are compared with the channel management schemes developed in [9, 11].

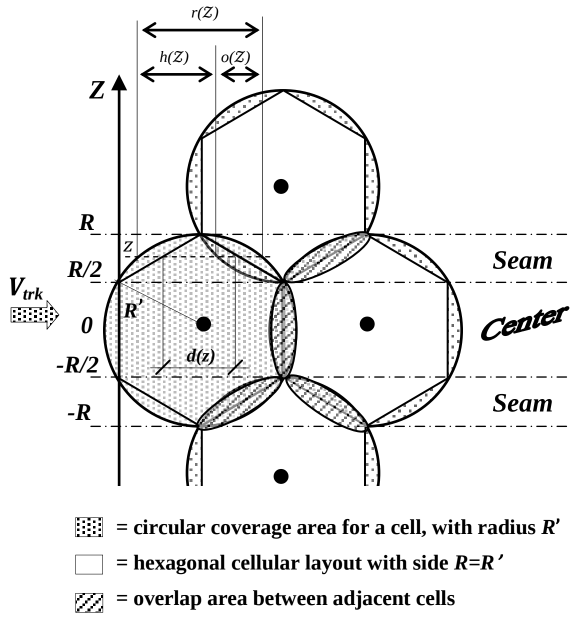


Fig. 1. The shape of the cells and the distance crossed in the cell in the overlap area for a given height z.

This paper is organized as follows: Section 2 introduce the system model and assumptions used in this paper. An analytical study for the CS policy and CP policy with our channel management strategy are presenting in Section 3 and Section 4 respectively. Finally, Section 5 deals with the analytical results for the performance analysis.

2. System Model and Assumptions

Although the proposed analytical framework can be applied to any LEO-MSS's based on moving cells approach, the Iridium model has been considered [9]. As well known, the Iridium system consists of 66 satellites are uniformly distributed over six near polar circular orbits at about 780 km of altitude and the satellite ground-track speed, V_{trk} is about 26600 km/h. Since V_{trk} is much greater than the user's motion relative to the earth, the relative satellite-user motion will be approximated by the vector V_{trk} [6].
To achieve efficient frequency reuse, the satellite footprint is divided into smaller cells or spotbeams. The spot-beams as shown in Fig. 1 are disposed on the earth according to a hexagonal regular layout (side R) with circular coverage of radius R' (equal to 212.5 km in the Iridium case) [6] and a distance between the centers of adjacent cells equal to $\sqrt{3}$R. The possible values for the ratio $R`/R$ range from 1 to 1.5, let us assume minimum possible extension for the overlap area such that $R'= R$.

For class-k traffic, in order to characterize the user's (relative) mobility in multi-class traffic LEO-MSS's, we introduce the dimensionless parameter α_k as

$$\alpha_k = \frac{\sqrt{3}R}{V_{trk}T_{dk}} \quad (1)$$

where
T_{dk} is the average duration time of class-k calls.

The proposed model for LEO mobility is based on the following assumptions [9]:

1) C channels are assigned per cell.
2) The maximum number of the traffic classes in the system is K.
3) The new call origination is uniformly distributed over the network.
4) New call arrivals and handover attempts of class-k traffic are two independent Poisson processes, with mean rates λ_{nk} and λ_{hk} respectively. And with λ_{hk} related to λ_{nk} by [9]:

$$\frac{\lambda_{hk}}{\lambda_{nk}} = \frac{2}{3}(1-P_{bk})\left\{\frac{P_{h1k}}{1-(1-P_{fk})P_{h2k}} + \frac{1-P_{h1k}+(1-P_{fk})(P_{h1k}-P_{h2k})}{\alpha_k-\alpha_k(1-P_{fk})^2P_{h2k}}\right\} \quad (2)$$

where

$$P_{h1k} = \frac{1-e^{-\alpha_k}}{\alpha_k} \quad , \quad P_{h2k} = e^{-\alpha_k} \quad (3)$$

5) The destination cell for handover call will be the neighboring cell in the direction of the relative satellite-user motion.
6) The channel holding time in a cell (for both new call arrivals and handovers) is approximated by a random variable with an exponential distribution and mean $1/\mu_k$.
7) Waiting time is approximated by a random variable exponentially distributed, with expected value equal to $1/\mu_w = E[t_{w\,max}]$, where $E[t_{w\,max}]$ is the average value of the maximum queuing time. More details are given in [9].

The following Qualities of Service (QoS) parameters [9, 11] are used to evaluate the performance of channel resource sharing policies examined in this paper:

1) P_{bk}, blocking probability of class-k new call attempts;
2) P_{fk}, handover failure probability of class-k calls;
3) P_{dk}, call dropping probability of class-k calls; representing the average of new class-k calls that are not blocked but eventually forced into termination due to the handover failure;
4) P_{usk}, unsuccessful call probability of class-k traffic, representing the new class-k calls that are not completed because of either being blocked initially or being dropped due to the failure of subsequent handover requests.

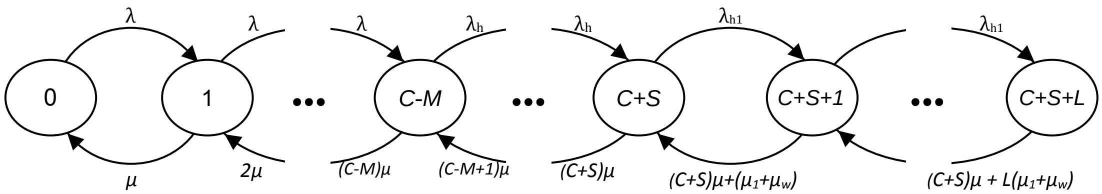


Fig. 2. State Transition Diagram of CS Policy under the General Channel Management Strategy

3. Complete Sharing Performance Analysis

In this section, an analytical approach for evaluating the Complete Sharing (CS) performance for multi-class traffic is presented. The analysis proposes the following more general channel management strategy, which combines the idea of a guard channel, queuing and sub-rating priority schemes. In this priority scheme, the priority between new and handover calls not only considered, but also the priority between the different traffic classes. This can be described as follow:

1) Each cell consists of a total C channels, M channels reserved for handover calls and a queue with length L for the handover calls requests of the highest priority class of traffic (Class-*One* traffic) only. Each of S channels can be split into two channels with the half-rate, when a class-*k* handover call arrives and finds i ($C \leq i < C + S$) calls in the cell.

2) A class-*k* new call will gain a full rate channel for service when it arrives and finds there are only i ($0 \leq i < C-M$ calls in the cell. Otherwise, the class-*k* new call will be blocked and cleared from the system.

3) A class-*k* handover call will also gain a full rate channel for service when it arrives and finds the total number of calls in the cell is less than C. However, if a class-*k* handover call finds all channels are busy upon its arrival and the number of split channels in the cell is less than S, one of the full rate channel will be split into two split channels, one keeping the original call and the other one being assigned for the coming class-*k* handover call. If the number of split channels is S upon the class-*k* handover call arrival, it is forced into termination except class-*one* traffic which assume to be the highest priority.

4) The class-*one* handover requests are queued in the queue of length L for a maximum time $t_{w\,max}$, waiting for a free channel. If the queue is full, class-*one* handover calls are dropped. A class-*one* handover request leaves the queue for one of the following reasons:

a) The handover procedure is successful: The handover request is served, before the call is ended and its maximum queuing time has expired.
b) The handover procedure has been useless: The call ends before the corresponding handover request is served and its maximum queuing time has expired.
c) The handover procedure fails and the call is dropped.

According to the proposed priority strategy described, it can be modeled as an M/M/C/S queue. Its state is defined as the sum of the number of class-*k* calls in service and the number of queued class-one handover calls requests. The state transition diagram is shown in Fig. 2. The transition between states can be explained as follows:

• A transition from state S_j to state S_{j+1} for $0 \leq j < C - M$ occurs when a class-*k* call (either new call or handover call) arrives, thus it occurs with rate $\lambda = \lambda_n + \lambda_h$ (where λ_n is the total new call arrival rate $\{\sum_{i=1}^{K} \lambda_{ni}\}$, and λ_h is the total handover call arrival $\{\sum_{i=1}^{K} \lambda_{hi}\}$).

• A transition from state S_j to state S_{j+1} for $C - M \leq j < C + S$ occurs when a class-*k* handover call arrives, thus it occurs with rate λ_h.

• A transition from state S_j to state S_{j-1} for $0 < j \leq C + S$ occurs if a class-*k* call in progress finishes its service and releases the channel, thus occurs with rate $n\mu$ (where μ is the total call departure rate which equal to $\{\sum_{i=1}^{K} \mu_i\}$).

• When all S channels are split, a transition to the next states occurs if there is a class-*one* handover call arrival and the queue is not full. Hence, a transition from state S_{C+S+i} to state $S_{C+S+i+1}$ for $0 \leq i < L$ occurs with rate λ_{h1}.

• A transition from state S_{C+S+i} to state $S_{C+S+i-1}$ for $0 < i \leq L$ occurs if a channel is released and the class-*one* handover call request gets service or the class-*one* handover call finishes its call while its request in the queue, or the waiting time in the queue for the class-*one* handover call is over before a channel is released, thus occurs with rate $(C + S)\mu + i(\mu_1 + \mu_w)$.

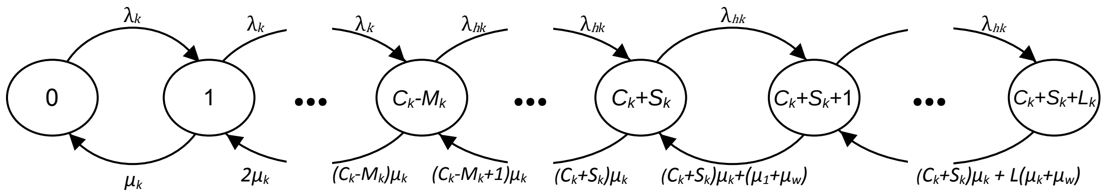


Fig. 3. State Transition Diagram of CP Policy under the General Channel Management Strategy

Based on the above descriptions and Fig. 2, the steady state probability of the state j, P_j can be derived as

$$P_j = \begin{cases} \frac{\lambda^j}{j!\,\mu^j} P_0, & 0 < j \le C - M \\ \frac{\lambda^{C-M}\ \lambda_h^{j-(C-M)}}{j!\ \mu^j} P_0, & C - M < j \le C + S \\ \frac{\lambda^{C-M}\ \lambda_h^{S+M}}{(C+S)!\ \mu^{C+S}} \prod_{i=1}^{j} \frac{\lambda_{h1}}{(C+S)\mu + i(\mu_1+\mu_w)} P_0, & C + S < j \le C + S + L \end{cases} \quad (4)$$

where the idle system probability P_0 is

$$P_0 = \left\{ \sum_{j=0}^{C-M} \left[\frac{\lambda_k^j}{j!\ \mu^j}\right] + \sum_{j=C-M+1}^{C+S} \left[\frac{\lambda^{C-M}\ \lambda_h^{j-(C-M)}}{j!\ \mu^j}\right] + \sum_{j=C+S+1}^{C+S+L} \left[\frac{\lambda^{C-M}\ \lambda_h^{S+M}}{(C+S)!\ \mu^{C+S}} \prod_{i=1}^{j} \frac{\lambda_{h1}}{(C+S)\mu + i(\mu_1+\mu_w)}\right] \right\}^{-1} \quad (5)$$

Class-k new call arrivals are blocked; when there is C-M channels are in use. Therefore, the steady state blocking probability for the class-k new call (P_{bk}) can be expressed as

$$P_{bk} = \sum_{j=C-M}^{C+S+L} P_j \quad (6)$$

Since class-*one* traffic is considered as the highest priority traffic class, class-*one* handover call failure occurs if a class-*one* handover call arrival finds all available channels are occupied and its respective request queue is full or the class-*one* handover call request is queued in its respective queue; however, it is dropped before getting service because its waiting time in the queue is expired before the handover call gets served or finished its service. The steady-state class-*one* handover failure probability is given as

$$P_{f1} = P_{C+S+L} + \sum_{i=0}^{L-1} P_{C+S+i} P_{f1/i} \quad (7)$$

where the first term is describe the event that the class-*one* handover request queue is full. While the second term describes the event that the class-*one* handover call request is queued, but it is dropped before getting service because its waiting time is expired before a channel is released. The term $P_{f1/i}$ gives the probability of handover failure for a class-*one* handover call request in the queue given the handover call request joined the queue as the (i+1) call. This is found as [8]:

$$P_{f1/i} = \frac{(i+1)\mu_w}{(C+S)\mu + i(\mu_1+\mu_w)} \quad (8)$$

However, class-k (except class-*one*) handover call failure occurs if a class-k handover call arrival finds all available full or sub-rated channels are occupied. So, the steady-state class-k handover failure probability is

$$P_{fk} = \sum_{j=C+S}^{C+S+L} P_j \quad (9)$$

The probability of an admitted class-k handover call being forced into termination during the i^{th} handover can be expressed [9] as

$$P_{dki} = P_{Fk}\left[P_{h1k}(1-P_{Fk})^{i-1} P_{h2k}^{i-1}\right] \quad (10)$$

By summing over all possible values of i, P_{dk} can be obtained as follows

$$P_{dk} = \sum_{i=1}^{\infty} P_{dki} = \sum_{i=1}^{\infty} P_{Fk}\left[P_{h1k}(1-P_{Fk})^{i-1} P_{h2k}^{i-1}\right] = \frac{P_{Fk} P_{h1k}}{1 - P_{h2k}(1-P_{Fk})} \quad (11)$$

Unsuccessful call probability P_{usk} is also used as an important parameter for evaluating overall system performance and can be derived as

$$P_{usk} = P_{Bk} + P_{dk}(1 - P_{Bk}) \quad (12)$$

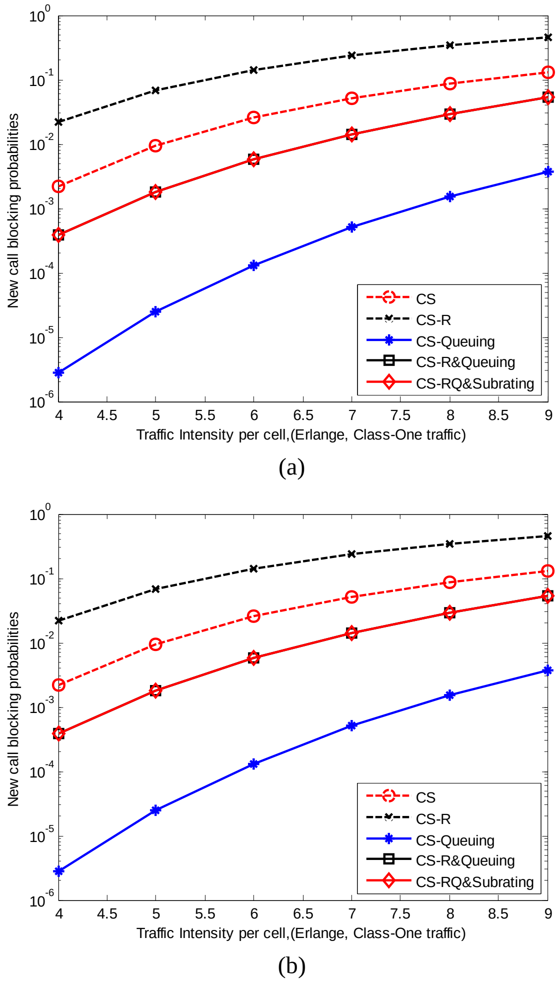


Figure 4. Analytical results for new call blocking probabilities as function of class-one traffic intensity of CS policy with different handover priority schemes
(a) Class-One traffic. (b) Class-Two traffic.

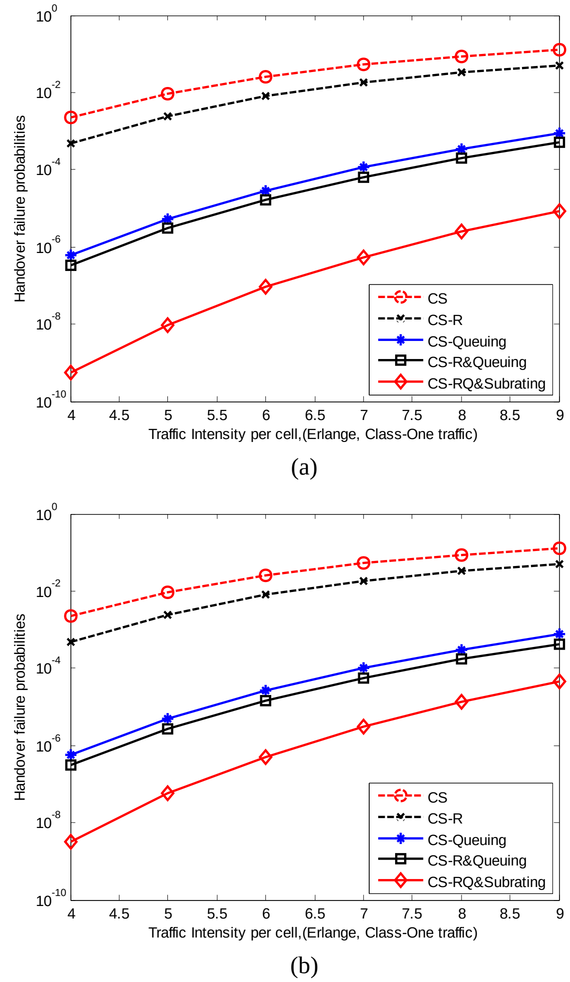
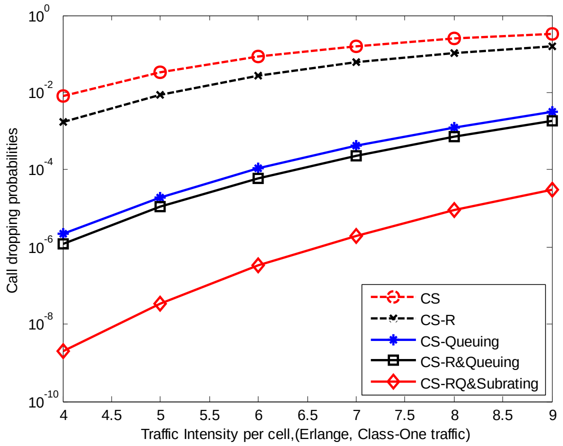


Figure 5. Analytical results for handover failure probabilities as function of class-one traffic intensity of CS policy with different handover priority schemes
(a) Class-One traffic. (b) Class-Two traffic.

4. Complete Partitioning Performance Analysis

This section presents an analytical model for the performance of Complete Partitioning (CP) policy for multi-class traffic with the handover priority schemes combination (guard channel, handover request queuing and sub-rating priority schemes). According to this policy, all C channels available in a cell are efficiently partitioned into independent K subsets, with C_k $(1 \leq k \leq K)$ channels allocated to class-k traffic and $C_1 + C_2 + \cdots + C_k \leq C$ through maximize the channel utilization using an optimal channel partitioning scheme found in [10].
According to this model, it can explain as follow:
1) Each class-k subset consists of total C_k channels, M_K channels reserved for class-k handover calls and a queue with length L_K for the class-k handover calls request. Each of S_k channels can be split into two channels with the half-rate, when a class-k handover call arrives and finds i $(C_k \leq i < C_k + S_k)$ calls in the subset.
2) A class-k new call will gain a full rate channel for service when it arrives and finds there are only i $(0 \leq i < C_k - S_k)$calls in the class-k subset. Otherwise, the class-k new call will be blocked and cleared from the system.
3) A class-k handover call will also gain a full rate channel for service when it arrives and finds the total number of class-k calls in the cell is less than C_k. However, if a class-k handover call finds all C_k channels are busy upon its arrival and the number of split channels in the cell is less than S_k, one of the full rate channel will be split into two split channels, one keeping the original call and the other one being assigned for the coming class-k handover call. If the number of split channels is S_k upon the class-k handover call arrival, it is forced into termination.



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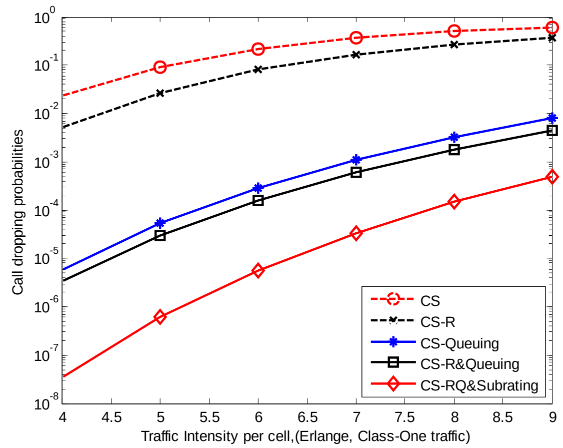

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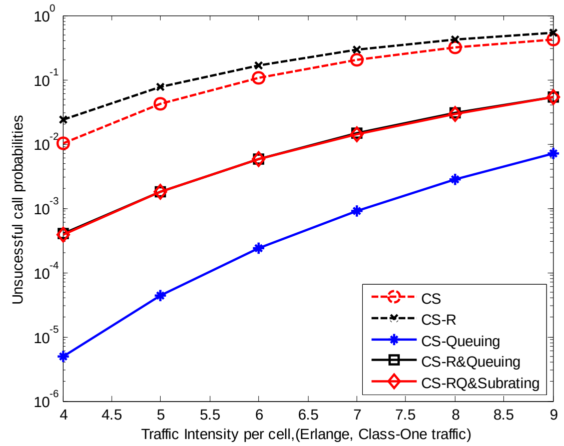
Fig. 6. Analytical results for call dropping probabilities as function of class-one traffic intensity of CS policy with different handover priority schemes
(a) Class-One traffic. (b) Class-Two traffic.



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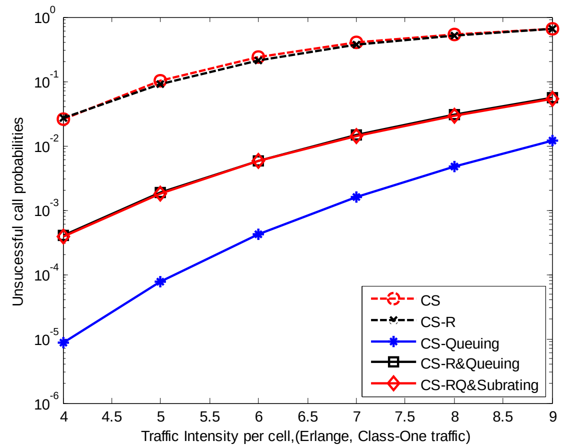

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Figure 7. Analytical results for unsuccessful call probabilities as function of class-one traffic intensity of CS policy with different handover priority schemes
(a) Class-One traffic. (b) Class-Two traffic.

4) When all the S_k channels are spitted, class-k handover call requests are queued in their queue of Length L_k for a maximum time $t_{w\,max}$, waiting for a free channel according to the same scenario discussed in the previous scheme. If the queue is full, class-k handover calls are forced into termination.

As it is shown in Fig. 3, the queuing scheme can be modeled as an $M/M/C_k/S$ queue. Its state is defined as the sum of the number of class-k calls in service and the number of queued class-k handover requests.

Let us analyze the state probabilities for the state transition diagram in Fig. 3, the steady state probability of the state j, P_j can be obtained as:

$$P_j = \begin{cases} \dfrac{\lambda_k^j}{j!\ \mu_k^j} P_0, & 0 < j \le C_k - M_k \\ \dfrac{\lambda_k^{C_k-M_k}\ \lambda_{hk}^{j-(C_k-M_k)}}{j!\ \mu_k^j} P_0, & C_k - M_k < j \le C_k + S_k \\ \dfrac{\lambda_k^{(C_k-M_k)}\ \lambda_{hk}^{j-(C_k-M_k)}}{(C_k+S_k)!\ \mu_k^{(C_k+S_k)}\ \prod_{i=1}^{j-(C_k+S_k)} [(C_k+S_k)\mu_k + i(\mu_k+\mu_w)]} P_0, & C_k + S_k < j \le C_k + S_k + L_k \end{cases} \quad (13)$$

where the idle system probability P_0 is

$$P_0 = \left\{ \begin{array}{l} \sum_{j=0}^{C_k-M_k} \left[\dfrac{\lambda_k^j}{j!\ \mu_k^j}\right] + \sum_{j=C_k-M_k+1}^{C_k+S_k} \left[\dfrac{\lambda_k^{C_k-M_k}\ \lambda_{hk}^{j-(C_k-M_k)}}{j!\ \mu_k^j}\right] + \\ \sum_{j=C_k+S_k+1}^{C_k+S_k+L_k} \left[\dfrac{\lambda_k^{(C_k-M_k)}\ \lambda_{hk}^{j-(C_k-M_k)}}{(C_k+S_k)!\ \mu_k^{(C_k+S_k)}\ \prod_{i=1}^{j-(C_k+S_k)} [(C_k+S_k)\mu_k + i(\mu_k+\mu_w)]}\right] \end{array} \right\}^{-1} \quad (14)$$

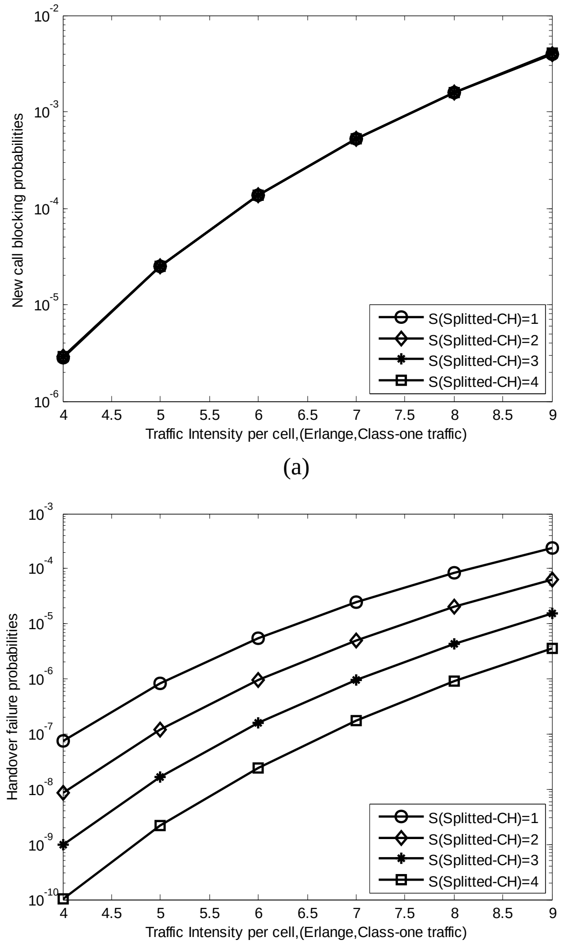


Figure 8. The effect of the *S* (number of Spitted-Channel) value on the class-one traffic

a)New Call Blocking Probability b)Handover Failure Probability

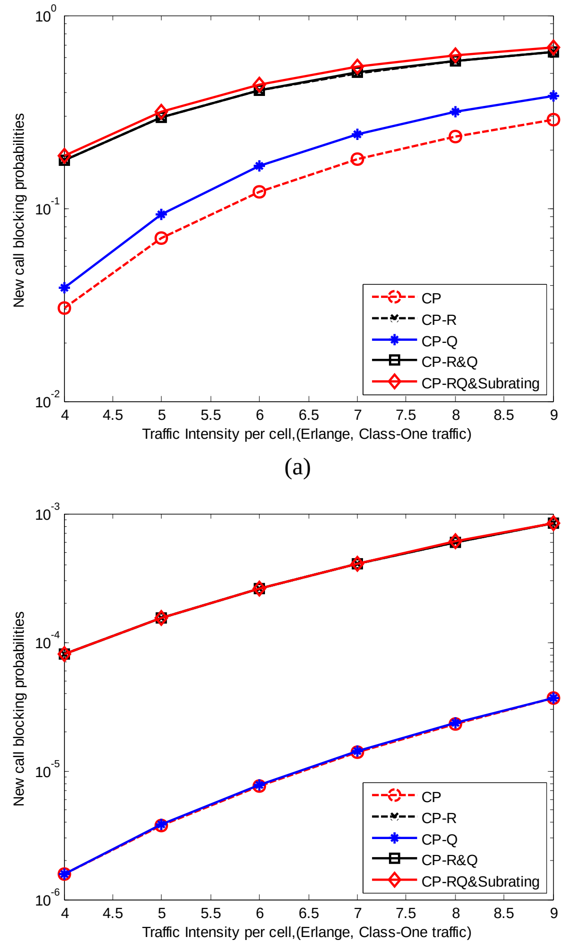


Figure 9. Analytical results for new call blocking probabilities as function of class-one traffic intensity of CP policy with different handover priority schemes

(a) Class-One traffic. (b) Class-Two traffic.

Class-*k* new call arrivals are blocked when $(C_k\text{-}M_k)$ channels are in use. Therefore, the steady state blocking probability for the class-*k* new call (P_{bk}) can be expressed as

$$P_{bk} = \sum_{j=C_k-M_k}^{C_k+S_k+L_k} P_j \qquad (15)$$

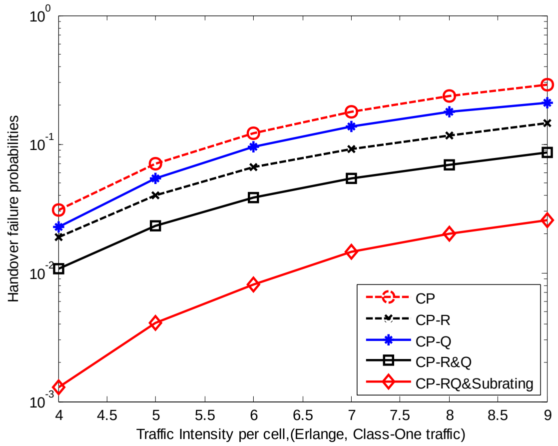
class-*k* handover call failure occurs if a class-*k* handover call arrival finds all available channels are occupied and its respective request queue is full or the class-*k* handover call request is queued in its respective queue; however, it is dropped before getting service because its waiting time in the queue is expired before the handover call gets served or finished its service. The steady-state class-*k* handover failure probability is given as

$$P_{fk} = P_{C_k+S_k+L_k} + \sum_{i=0}^{L_k-1} P_{C_k+S_k+i} P_{fk/i} \qquad (16)$$

where the first term is describe the event that the class-k handover request queue is full. While the second term describes the event that the class-*k* handover call request is queued, but it is dropped before getting service because its waiting time is expired before a channel is released. The term $P_{fk/i}$ gives the probability of handover failure for a class-*k* handover call request in the queue given the handover call request joined the queue as the (*i*+*1*) call

$$P_{fk/i} = \frac{(i+1)\mu_w}{(C_k+S_k)\mu_k + i(\mu_k+\mu_w)} \qquad (17)$$

Using (11) and (12), P_{dk} and P_{usk} can then be computed, respectively.



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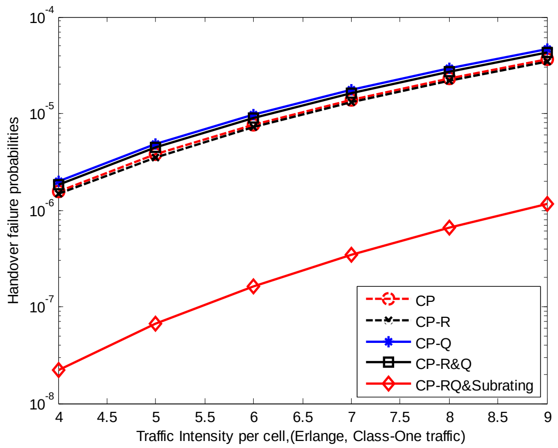

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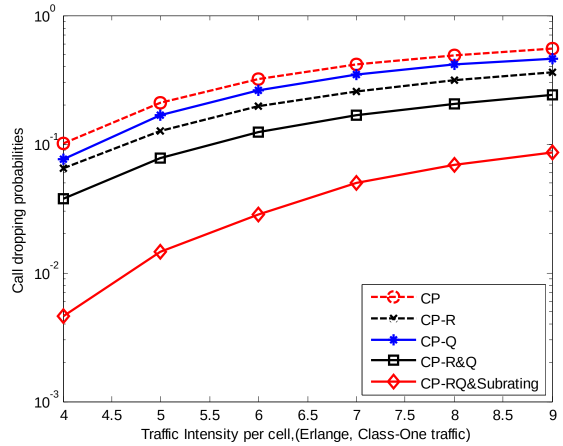
Figure 10. Analytical results for handover failure probabilities as function of class-one traffic intensity of CP policy with different handover priority schemes
(a) Class-One traffic. (b) Class-Two traffic.



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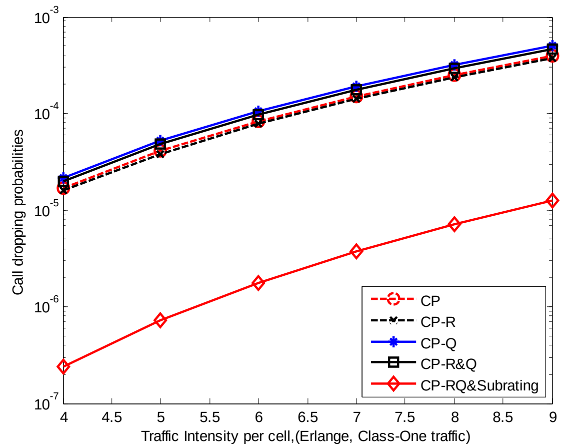

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Fig. 11. Analytical results for call dropping probabilities as function of class-one traffic intensity of CP policy with different handover priority schemes
(a) Class-One traffic. (b) Class-Two traffic.

5. Analytical Result

In this section, we present analytical results on the performance of the CS and CP sharing policies with the general channel management strategy (named as RQ&Subrating) for multi-class traffic discussed in section 3, 4, respectively.
Two different classes from K different classes of traffic are consider with the following parameter values: the total number of channel assigned for the cell (C = 12), reserved 25% of the total channel for handover, the average duration time of class-k calls (T_{d1} = 180, T_{d2} = 540) and the traffic intensity of class-two traffic is 0.02 of the traffic intensity of class-one traffic ($\rho_2 = 0.02\,\rho_1$).

The other different types of channel management strategies used for multi-class traffic in LEO-MSS have been also considered. The no priority scheme, fixed channel reservation (guard channel) priority (named as R) scheme, queuing priority (named as Q) scheme and the combination of guard channel and queuing priority (named as RQ) scheme examined for CS and CP policy [9, 11, 12] are compared with our proposed scheme.
For Complete Sharing (CS) policy, Figs. 4-7 have shown the performances of this policy under different priority schemes in terms of P_{bk}, P_{fk}, P_{dk} *and* P_{usk}, respectively. The subrated channel is set at (S = 3), guard channel (M = 3) and the class-*one* handover request queue length is (L = 6).

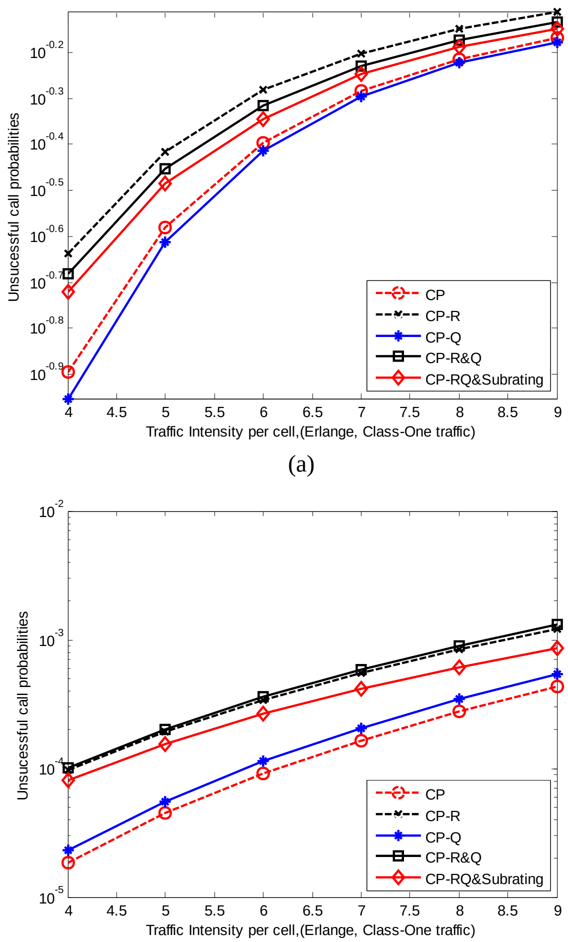

Figure 12. Analytical results for unsuccessful call probabilities as function of class-one traffic intensity of CP policy with different handover priority schemes
(a) Class-One traffic. (b) Class-Two traffic.

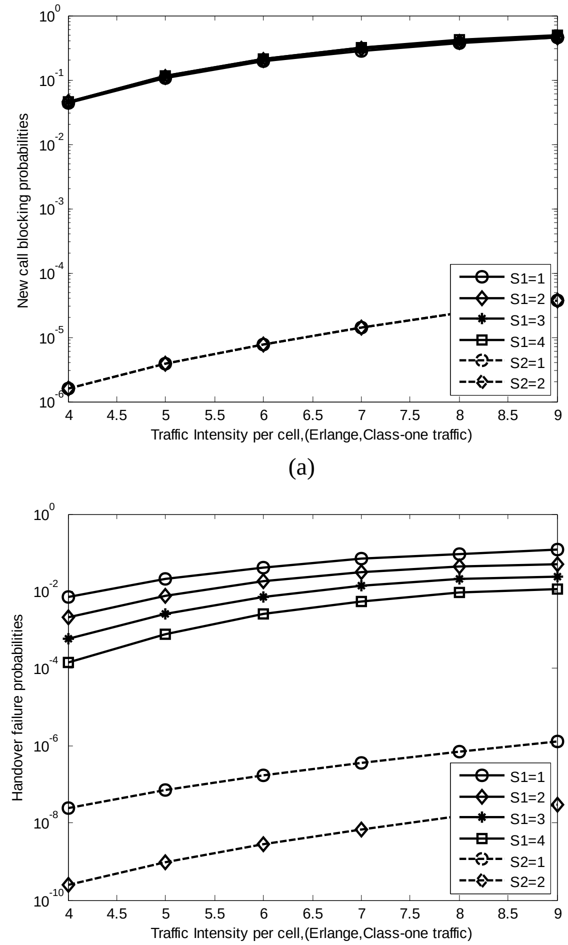

Figure 13. The effect of the S_K (number of Spitted-Channel) value on the class-one and class-two traffic

a)New Call Blocking Probability b)Handover Failure Probability

In Figs. 5 and 6, the analytical results for class-*k* handover failure probability (P_{fk}, see Figure 5) and call dropping probability (P_{dk}, see Figure 6) shown that our proposed (CS-RQ&Subrating) scheme provide a significantly better results over other priority schemes. However, the queuing priority (CS-Q) scheme obtain better in response of class-*k* new call blocking probability (P_{bk}, see Figure 4) and unsuccessful call probability (P_{usk}, see Figure 7) than the combination of guard channel and queuing priority (CS-RQ) scheme and our proposed scheme which have the same response due to use the same reserved number of channels but by controlling both guard channel and subrating channel in our scheme we can make a dramatic improvement in handover failure probability while maintain a good new blocking probability performance.

From Fig. 8, using subrating channels has no effect on new calls as the curves are identical for the same M ($M = 0$) as seen in Figure 8(a). Figure 8(b), show a good improvement in the forced termination probabilities of class-one handover calls as subrating channel increase.

For Complete Partitioning (CP) policy, we consider the following parameter values: the total number of channel assigned for class-k traffic ($C_1 = 8$, $C_2 = 4$), ($M_1 = 2$, $M_2 = 1$), the subrated channel of each class ($S_1 = 2$, $S_2 = 1$) and the handover request queue length for class-*k* traffic are ($L_1 = 6$, $L_2 = 3$). The performance of CP policy under different priority schemes in terms of P_{bk}, P_{fk}, P_{dk} and P_{usk} respectively are shown in Fig. 9-12.

In Figures 9(a) and 9(b), the analytical results for class-k new call blocking probability show that the no priority (CP) scheme and queuing priority scheme (CP-Q) achieves a better performance than our priority scheme for class-one and class-two traffic respectively. However, From the Figs. 10 and 11, we can see that our priority scheme for class-one and class-two traffic in terms of handover failure probability (P_{fk}, see Figure 10) and also of call dropping probability (P_{dk}, see Figure 11) is the best among all other different priority schemes.

From the performance of unsuccessful call probability (P_{usk}) of class-one and class-two traffic shown in Figures 12(a), 12(b) respectively, non-prioritized CP scheme and the handover queuing (CP-Queuing) priority scheme have a good response over our priority scheme. However, as traffic intensity increase the performance begin to close to each other till be very close to each other.

As shown in Fig. 8, the class-*k* new call blocking probability is almost identical for the two different classes as seen in Fig. 13(a), and in Fig. 13(b), the performance of handover failure probability is improved as subrating channel increase.

6. Conclusions

In this paper, we analytically evaluate the performance of Complete Sharing (CS) and Complete Partitioning (CP) resource sharing policies for multi-class traffic in LEO-MSS under a newly proposed general channel allocation scheme.

Analytical results have shown that our proposed scheme effectively obtain the best performance results in terms of handover failure probability and call dropping probability among all other priority schemes for the CS and CP sharing policies, with a little increase in new call blocking probability and the unsuccessful call probability. However, these responses can be improved by optimizing both guard channel and subrating channel values.

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