Teletraffic Advances in LEO Mobile Satellite Systems

Tutorial by Ioannis D. Moscholios

*Dept. of Informatics and Telecommunications, Univ. of Peloponnese,
221 00, Tripoli, Greece. Tel. + 30 2710 372283, E-mail: idm@uop.gr

Synopsis

Low earth orbit mobile satellite systems (LEO-MSS) are ideally suited for providing multiservice real time applications to a diverse population in large geographical areas. Compared to geostationary MSS (GEO-MSS), their requirements in terms of transmit power and transmission delays are lower at the cost of introducing frequent beam handovers (that occur due to the high speed of LEO satellites) to in-service mobile users (MUs) during their lifetime in the system.

To assure quality of service (QoS) in the complicated multirate traffic environment of contemporary LEO-MSS it is essential to develop QoS mechanisms, with efficient and fast QoS assessment, that: i) provide access to the necessary bandwidth needed by the services of the MUs, ii) ensure fairness among different "competing" mobile services/applications and iii) reduce handover failures for in-service MUs. On the other hand, the incorporation of the emerging technologies of software-defined networking (SDN) and network function virtualization (NFV) in next-generation satellite networks, provides new opportunities for fairer QoS assignment among service classes.

Considering call-level traffic in a LEO-MSS which accommodates different service-classes with different QoS requirements, such a QoS mechanism is a channel sharing policy, since it affects call-level performance measures, like call blocking probabilities (CBP) and handover failure probabilities. The QoS assessment of LEO-MSS under a channel sharing policy can be accomplished through teletraffic loss or queueing models.

The teletraffic models presented in this tutorial have as a springboard either the Erlang B or C formula or the Kaufman-Roberts recursive formula, used to accurately determine the link occupancy distribution and consequently CBP in the so called Erlang Multirate Loss Model (EMLM). In the EMLM, calls of different service-classes have fixed bandwidth requirements, arrive to a link of certain bandwidth capacity according to a Poisson process, and compete for the available link bandwidth under the complete sharing policy (a new call is accepted in the link if its required bandwidth is available - otherwise the call is blocked and lost). The recursive calculation of the link occupancy distribution leads to the efficient determination of the various performance indexes in the EMLM.

In addition to the teletraffic advances in LEO-MSS, a framework for the applicability of teletraffic models in LEO-MSS based on the technologies of SDN and NFV is provided.

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Potential audience and prerequisite knowledge

This tutorial will enable network planning engineers and researchers to understand and apply in their work the latest single-rate and multi-rate teletraffic models in LEO MSS. Potential audience may not have prerequisite deep knowledge in probability and stochastic processes. However, elementary teletraffic theory is required (e.g. the notion of traffic load and traffic load properties, call origination processes, service time distribution).

Why the proposed topic is interesting and timely

Teletraffic models aim at providing mathematical tools for the call-level performance modelling and QoS assessment of modern communication networks which accommodate service-classes with quite different traffic and bandwidth characteristics. Such tools can assist network planning, hardware dimensioning, traffic forecasting and provide a solution for QoS differentiation and/or QoS guarantee between different service-classes. Furthermore, we also provide a framework for the applicability of teletraffic models in LEO-MSS based on the technologies of SDN and NFV.