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Author: Dr. Yingnan Zhang
China Aerospace Science and Technology Corporation (CASC), China, zhangyingnan_cast@163.com

Prof. Shenghua Zhai
China Academy of Space Technology (Xi'an), China, zhaishenghuacast@163.com
Mr. Peng ZHANG
China Academy of Space Technology (CAST), China, zhangyingnan_cast@163.com

CAPACITY ANALYSIS AND EVALUATINON FOR HIGH THROUGHPUT SATELLITE SYSTEMS

Abstract

High Throughput Satellite (HTS) provides customers a wide range of high-speed services ranging from broadband broadcasting to Internet access. This is because the use of HTS significantly improves system capacity via adopting multiple narrow spot beams at Ka band and employing frequency-reuse among them. Therefore, HTS has attracted much considerations among satellites payload manufacturers and system operators, and since 2004, many HTS satellites have been launched to satisfy the increasing capacity demands.

Considering the booming applications, this paper proposes a framework to calculate HTS system capacity, and based on simulations, it evaluates the techniques to further improve capacity.

Firstly, the procedures to calculate the capacity of forward link (from gateway to user via satellite) and return link (from user to gateway via satellite) are suggested respectively. For the forward link, the procedure is straightforward since all beams transmit signals with fixed power and patterns. Hence, at any geographical position within satellite coverage, the interferences from other beams are definite and the receiving C/(N+I) is easy to calculate. However, for the return link the procedure is quite difficult, because each user causes interference to the rest of others, and users at different geographical positions will introduce different interference levels. The return link capacity is related to the maximum overall interference, which occurs only when all users are at a specific location distribution. Considering the unachievable complexity to find the specific distribution, a sub-optimal algorithm is proposed to calculate the maximum overall interference, and thus the return link capacity.

Then, based on the proposed procedures, this paper analyses the mechanism of factors that impact system capacity, and shows their influences via simulations. The simulations are based on several HTS examples that cover China with different configurations of number of beams, beam patterns, frequency/polarization reuse schemes, and bandwidths. DVB-S2 and DVB-RCS2 are assumed for the forward link and return link, respectively. Following the proposed procedures, the capacities of all examples are calculated and compared. From a system design perspective, capacity is not the only performance metric, and should be considered along with spectrum efficiency. The proposed capacity results verify that there exists an optimal bandwidth and frequency-reuse scheme that corresponds to the maximum spectrum efficiency. Therefore, HTS system design should be in a framework of reaching the maximum spectrum frequency as well as satisfying the capacity demands.

Finally, this paper concludes the techniques to further improve HTS capacities and highlights the future directions.