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AN EFFECTIVE ROUTE CONTROL METHOD ON MULTI-LAYERED SATELLITE NETWORKS

Abstract

Non-Geostationary Earth Orbit (NGEO) satellite networks such as Low Earth Orbit (LEO) satellite networks and Medium Earth Orbit (MEO) satellite networks are suitable solutions to provide global communication services with low power consumption and short delay. Additionally, Multi-Layered Satellite Networks (MLSN) consisting of layered NGEO satellite networks have recently attracted attention due to their increased amount of capacity and number of available multipaths. However, in MLSN, we have to take into account the features of each layered network, i.e., lower layer networks provide a short delay connection with high risk of occurrence of network congestion, and vice versa. While several existing schemes have been developed to efficiently use layered networks that adopt an adaptive routing algorithm based on flows' characteristics, e.g., destination areas, Quality of Service (QoS) requirements, and so on, these methods can cause network congestion. It is necessary to take measures to prevent the occurrence of network congestion before the network reaches congestion. To cope with this issue, we propose a route control method which attempts to stabilize link utilization in a lower layer network at the desirable level. In general, long distance connections tend to provoke network congestion because they pass through a lot of links. Therefore, in the proposed scheme, long distance connections having a large end-to-end delay more than a threshold are forced to go through the upper layer network in order to avoid network congestion in the lower layer network which has to handle traffic from earth stations. The computation of the threshold is performed by each upper layer satellite based on the network utilization information at the lower layer satellites within its coverage area. The value of the threshold is periodically updated to follow the timely change of the network condition by using the feedback control mechanism so as to match the link utilization to a desirable level. In other words, the proposed scheme can avoid network congestion without cutting down the aggregate throughput of all connections more than necessary by efficiently utilizing the capacity of the upper layer network. To assess the validity of the proposed scheme, we ran computer simulations by using a two-layered MLSN constructed by a combination of a LEO and a MEO satellite networks. The results showed improved performance of the proposed scheme especially in terms of packet drop rate and total throughput in the network.