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A CONSERVATIVE APPROACH TO ROUTING OPTIMIZATION IN TELECOM MEGACONSTELLATIONS

Abstract

The global telecom market continues to grow rapidly even though nearly every human on Earth is already connected to the latest generation network available in their respective communities. New applications, such as Internet of Things, machine-to-machine connection, unmanned vehicle guidance, etc., are driving the demand for new generation telecommunication hardware that would provide faster connections, higher reliability and lower latency. Latencies as low as 1-4 msec. are required for certain particular use-case scenarios by the 5G standard. At the same time, many companies have announced their intent to provide mobile broadband connection by moving some of the infrastructure to space. These networks are designed in a way to provide similar service quality as the latest ground-based networks, but that is not always possible for various reasons. This work discusses the inability of hypothetical space-based telecom constellations to reach the latencies comparable to 5G. Mainly, this is due to the core differences in the architecture of the space networks compared to the ground-based ones: while the ground station always “knows” the way to the nearest hub, the connectivity patterns in space simply change too fast. This results in the need for many satellites to spend plenty of time calculating, which hinders their ability to provide low-latency connections. This problem might be partly solved by eliminating most of the “unexpected” route changes. This work describes a design pattern for such a system, where the heaviest calculations would be done on the ground using supercomputers. Firstly, the so-called “patchwork method” is suggested to predict the behavior of the connectivity matrix of the whole constellation, which implies rapid local amendment of the connectivity graph in cases when the changes in the connections are identified to be of a certain predefined type. Secondly, a solution to the routing problem is presented that would track minor changes in the graph from one time step to another, to determine whether the whole routing pattern must be recalculated, or it is sufficient to use the existing data. Finally, a way is demonstrated to upload routing tables thus aquired to the satellites and make sure that all of them have updated data. We argue that the algorithm described above, given modest (in terms of ground-based computers) calculating capabilities and secure uplink to the satellites, can provide a solution more precise and reliable, and much faster than it would be done by the satellites themselves.