Joint Controller Placement and Assignment in SDN-based LEO Satellite Networks

**Key words**

LEO satellite network. Joint controller placement and assignment. Convex-guaranteed network partition. Time-varying topology.

**Motivation**

Software-Defined Networking (SDN) paradigm significantly promotes networks’ flexibility by decomposing control plane and data plane. In SDN-based networks, data are transmitted according to the flow table produced by controllers. Therefore, the controller placement and assignment strategies fundamentally limit networks’ performance.

As an important part of the next generation network, SDN-based LEO satellite network (SDSN) becomes a research hotspot in recent years. Comparing to widely discussed WANs and data center networks, construct an efficient SDSN is much more challenging. On the one hand, suffers from the extremely harsh operating environment and limited energy power, the satellite processor has hundreds of times lower processing capacity than ground high-speed processors. On the other hand, placing controller on a fixed satellite result in long and highly-varying response time because of the time-varying network topology.

To cope with the limited processing capacity, a hierarchical multi-domain architecture is needed. By partitioning the whole LEO satellite constellation into several autonomous domains where the controller in each domain is only responsible for intra-domain routing computation, the computing overhead for handling each request could be controlled at a low level. It doesn’t mean that the size of the domain should be as small as possible. A controller in a small domain has only partial network information and can only produce suboptimal routing strategies. The shape of the domain should also be carefully designed or else a good intra-domain routing path may even not exist.

Considering the dynamic traffic load and the time-varying network topology, the controller placement and the controller assignment should be dynamic recomputed. Necessary control messages are needed when reassigning a switch to a new controller. Greedily finding a current optimal placement and assignment strategy could make such migration cost unacceptably high.

Meanwhile, the controller placement and assignment should be considered jointly. Fixed controller location greatly limits the assignment strategies.

**Contributions**

System cost modelling and Joint Controller Placement and Assignment (JCPA) problem formulation.

Proposing a convex-guaranteed network partition method, which decreases processing overhead of satellite controllers while ensuring network performance.

Proposing an online algorithm for the JCPA problem.