Tenant-Based Network Slice Embedding with Service Function Chaining

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***Abstract*—This document presents a project outline focused on virtual network slice embedding with service function chaining. The objective is to develop a holistic methodology for both tenants and operators to request and provide network slices.**

***Index Terms*—network slicing, embedding, virtual networks**

The paradigm of virtualizing network resources has led to the problem of how to embed virtual resources into the physical network, attracting increasing research interest. The problem is addressed in many forms, such as Virtual Network Embedding (VNE) and Service Function Chain Embedding (SFCE). Another long-standing research problem is achieving network slicing, where embedding virtual resources is an important sub-problem. In [1], the authors investigate embedding for a more holistic view of achieving network slicing, combining concepts in VNE and SFCE, called slice-based service function chain embedding (SBSFCE).

This project develops a novel methodology for embedding slices onto the substrate network. In modern digital ecosystems, we assume that a diverse set of tenants will require networks with vastly different QoS requirements. Slicing could be a means for network operators to provide such networks to tenants. The objective is to enhance the realism of current network models, aiming to develop a holistic methodology for both tenants and operators to request and provide network slices. An outline of the proposed methodology is illustrated in Figure 1 and can be described as follows:

A tenant pays a network operator to provide a network slice. The tenant supplies the locations of its endpoints, Quality of Service (QoS) requirements for its flows, and an SFC describing the functionality of the requested network slice.

The network operator embeds the slice by interconnecting all tenant endpoints, ensuring that each flow receives the appropriate SFC while satisfying QoS requirements such as maximum delay, guaranteed throughput, and availability. The embedding output is a virtual network comprised of physical resources, including switches, servers, VNF instances (hosted in virtual machines), and interconnecting links. The extent of physical resource usage in the established virtual network determines the tenant's cost.

A simple initial experimental setup involves a homogeneous case where each node pair within a slice supports one flow. In this setup, all flows adhere to the same SFC and share uniform QoS requirements (e.g., delay within 10ms, throughput of 100Mbps, or availability of 99.9 %).

A simple heterogeneous scenario is one in which each node requires Internet access in addition to the flows. This scenario

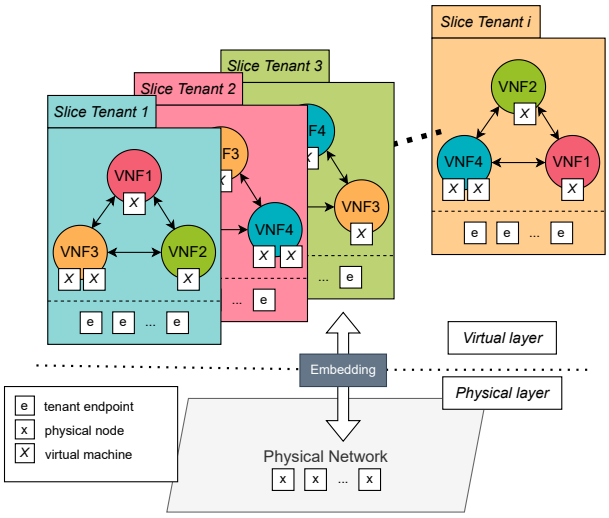

Fig. 1. SFC-based slice embedding structure. Tenants provide endpoint nodes and service requirements. The operator embeds the slice onto the physical network to fulfill these requirements.

introduces another type of flow, originating or terminating at a node, that necessitates a specific network function (i.e., Internet access) and is subject solely to throughput constraints.

Furthermore, we will leverage existing resource allocation and flow routing optimization algorithms to achieve more effective slice embeddings. For instance, ClusPR [2] allocates VNFs and routes flows while balancing resource usage for the operator and the tenant's QoS requirements (delay and throughput). Alternatively, Coshare [3] may be employed when availability and throughput are the QoS requirements. A combined approach may also be explored to meet a broader set of QoS criteria.

References

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