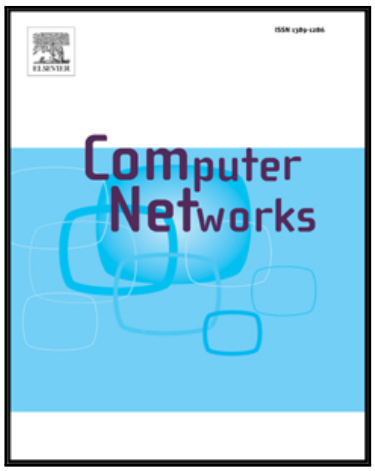

Presto: Towards Efficient Online Virtual Network Embedding in Virtualized Cloud Data Centers

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Presto: Towards Efficient Online Virtual Network Embedding in Virtualized Cloud Data Centers

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Abstract—As an efficient solution to diversify the future Internet for resource sharing in data centers, the network virtualization enables seamless integration of network experiments, services and architectures with different features by allowing multiple heterogeneous virtual networks (VNs) to simultaneously coexist on a shared substrate infrastructure. Embedding multiple virtual networks onto a shared substrate by allocating substrate resources to virtual nodes and virtual links of VN requests under a collection of constrains is known to be an NP-hard problem even for the offline VN embedding. To deal with this issue, this paper formulates the VN embedding problem as a new multiple objective linear programming optimization program, and solves it in a preemptive strategy by decomposing the problem into node mapping and link mapping phases. Furthermore, based on an Artificial Intelligence resource abstraction model, named Blocking Island (BI), we propose an efficient online heuristic VN embedding algorithm called *Presto*. *Presto* operates with quite low computation complexity and greatly reduces the search space, which far outperforms other candidates. The goal of *Presto* is to maximize the economic revenue of infrastructure providers while minimizing the embedding cost. The extensive simulation results further prove the feasibility and good performance of *Presto* in revenue, VN request acceptance ratio, computation efficiency and resource utilization.

Index Terms—Data Center Network, Virtual Network Embedding, Network Virtualization, Resource Allocation

1 Introduction

As highly multiplexed shared environments, cloud data centers are equipped with a large number of physical servers and virtual machines (VMs) hosted in servers to simultaneously offer multiple tenants with on-demand use of computing resources in a pay-as-you-go manner [1][2][3][4][5]. How to efficiently share the physical network resources among multiple tenants that have diversified network topologies with different network characteristics is a key concern. With respect to this issue, network virtualization has emerged as an efficient technology for resource sharing, where multiple heterogeneous network architectures are allowed to coexist on a shared substrate [6][7][8]. Upon on the virtualized shared data centers, the infrastructure providers then make best effort to utilize the substrate resources to serve the users that request customized services with required resources (such as CPU capacities, network bandwidth, etc.) running over different user self-defined network topologies, which are also known as *virtual networks* (VNs). Each virtual network consists of a set of virtual nodes interconnected through a set of virtual links with required capacities. The allocation of substrate resources to the virtual networks is called *virtual network embedding*[1] (VNE). Each virtual node is mapped onto a substrate node, while each virtual link is mapped onto a substrate path connecting the corresponding substrate nodes under a series of pre-defined constraints. Fig. 1 illustrates an example of virtual network embedding, where two embedded virtual networks share the same substrate network.

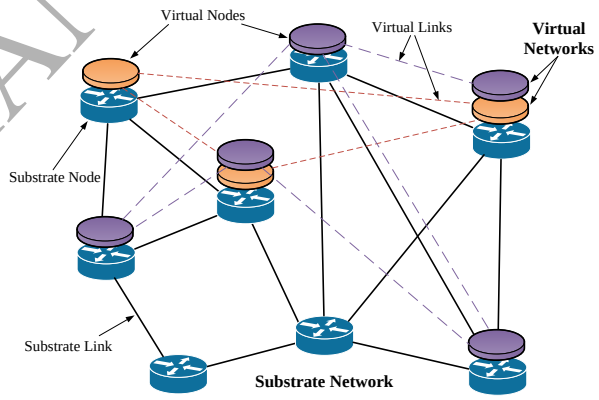

Fig. 1. Virtual network embedding on a shared substrate network.

The main objective of solving VNE problem is to make efficient use of substrate resources through dynamic and effective VN mapping algorithms. Although embedding diversified virtual networks of different users onto the underlying physical network can maximize the benefits

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1. In this paper, "embedding" and "mapping" are used interchangeably.