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Rapid Topology Design based on Shortest Path Betweenness for Virtual Network Construction

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Abstract

Recently, a network virtualization technology has attracted considerable attention as one of new generation network technologies. In this paper, in order to permit the rapid changing for a topology of a virtual network, we propose a new virtual network construction method based on the shortest path betweenness. In our proposed method, at first, a service provider receives a user's request for the reconfiguration of the constructed virtual network. In this case, the service provider reconfigures the topology of the constructed virtual network rapidly based on shortest path betweenness. We evaluate the performance of our proposed method with simulation, and we show the effectiveness of our proposed method.

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Keywords: Virtual networks, Shortest path betweenness, Robustness, Topology design, Reconfiguration;

1. Introduction

Recently, a network virtualization technology has attracted a considerable attention as one of new generation network technologies. In the network virtualization technology, a virtual network can be constructed on a physical network by using a part of physical network resources such as CPU, memory, and bandwidth. Here, for the network virtualization, it is important to consider how multiple virtual networks should be constructed on a physical network. This is because the amount of available network resources is limited in the physical network and virtual networks have to share the limited resources. Therefore, some methods for constructing a virtual network have been studied [1].

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In order to construct more virtual networks, [2] has proposed a virtual network construction method that can maintain a load balancing on nodes and links. Moreover, [3] has proposed another virtual network construction method. In this method, virtual networks are constructed over a physical network where conventional data transmission services such as existing Internet services have been utilized. Here, the conventional services have a high priority and it has to be avoided that qualities of those services are degraded. In such a case, virtual networks are expected to be constructed over the physical network so as not to degrade those qualities. Therefore, the proposed method in [3] utilizes an admission control for the virtual network construction. With this admission control, a new virtual network can be constructed only when the robustness of the physical network satisfies a construction condition.

Note that some constructed virtual networks are returned to the physical network when its utilization is finished. Moreover, new virtual networks may be constructed continuously by using network resources which were returned from users. Therefore, the amount of available network resources on each node and link changes in time.

Hence, in order to maintain the efficient use of the network resources, some methods that perform the topology redesign of the virtual network are studied. [4] has proposed a construction method for a virtual network by using a path splitting and a path migration. In this method, virtual networks are constructed over a physical network so that the remuneration from users becomes the maximum by using the path splitting and the path migration. In particular, by using the path migration, the topologies of constructed virtual networks are redesigned periodically. [5] has proposed a virtual network construction method that considers the topology change. In this method, the topologies that have already been constructed are redesigned optimally each time a virtual network is returned to a physical network. Because the method considers the cost about a topology change, the topology whose service period is short is not changed.

Here, the method in [3] has not considered the topology changing of the virtual network that has already been constructed. In this conventional method, if the user requests the topology change of the virtual network, the topology has to be constructed as a new request. This is because the reconfiguration of the virtual network is not considered. As a result, it takes a long time to change the topology due to the utilizing KMB algorithm. This may result in the congestion on some nodes and links by wasting the network resources.

Therefore, in this paper, we propose a new virtual network construction method in order to change the topology rapidly. In our proposed method, when a request about the topology change is received from a user, the service provider tries to change the topology based on a shortest path betweenness. In our proposed method, the topology changing is completed with a partial changing of the virtual network. Therefore, the topology can be changed rapidly by using our proposed method. We evaluate the performance of our proposed method with simulation and compare its performance with the performance of the conventional method [3].

The rest of this paper is organized as follows. Section2 introduces related work. Section3 explains the detail of our proposed method. Section4 shows some numerical examples and Sect. 5 denotes conclusions.

2. Related work

2.1 Virtual network construction based on network robustness

In this section, we explain a virtual network construction method based on network robustness. In this method, at first, a user sends a request to a service provider. Here, this request includes a set of nodes that should be included in the virtual network and the amount of resources that should be needed in the virtual network. After the service provider receives the request from the user, he designs a topology of a virtual network that satisfies the user's request with a KMB algorithm [6]. The KMB algorithm consists of a