Thesis Abstract

Virtual Network Functions (VNFs) Placement to Provide Services in 5G Networks

Motivation

Network function virtualization (NFV) is an example of emerging technology that is considered to improve network performance. The problem of resource allocation in network infrastructure for VNFs is an optimization problem in order to reduce costs and increase network efficiency.

The idea of virtualizing network functions is presented with the aim of isolating the performance of software from hardware. Based on the NFV strategy, network functions can be installed on servers with the utilization of virtual machines (VMs) that provide the appropriate environment for the installation of the virtual functions.

Traditional networks have some limitations, such as high capital expenditures (CapEx), high operating expenses (OPEX), lack of flexibility and programmability. Also, network capabilities are limited to the manufacturer's settings; but in the concept of network function virtualization, it is possible to reduce the network costs dramatically and makes the infrastructures more flexible and scalable.

One of the challenges ahead of this technology is the placement of virtualized network functions (VNFs placement) problem. Determining the optimal place for VNFs and data traffic path for a service function chain (SFC) can have a significant impact on network performance in terms of improving quality of service (QoS) requested by users and enhancing energy efficiency.

Research Methodology

The problem of virtualized network function placement can be investigated from a different aspect. A common method is to deploy the network functions on servers and then perform the routing process, but this research project attempted to establish the location of the virtual functions and the route of traffic transmission simultaneously with the goal of reducing the network costs, decreasing the delay of data transmission and increasing the speed of deploying VNFs in servers.

Also, this work addresses one of the challenges in the field of VNF placement, which is decreasing the speed of network function placement by increasing the size of the network and SFC.

It is important to consider some constraints to solve this optimization problem, such as hardware limitations in implementation, delay, resource dispersion, etc.

In this research project, a cost function for placement of VNFs is proposed with the aim of reducing link and node costs and especially minimizing the cost of resource dispersion; then, by using the multi-stage graph method and the heuristic method of the Viterbi algorithm, the VNF placement problem is investigated.

Then another heuristic method is used to increase the speed of VNF placement and make this procedure flexible with network dimensions that are especially very useful for large-scale

networks; this method is implemented by use of the eigendecomposition approach and creating an adjacency matrix for service function chain and infrastructure graph.

Results

After simulating these two methods (multi-stage graph and eigendecomposition) with MATLAB software, the results illustrate eigendecomposition approach decreases convergence time for this optimization problem, and it can determine the optimal location for virtualized functions in networks infrastructure and allocate links to service function chains with the aim of choosing the best route for transferring data. This method is faster compared to the multi-stage graph method in terms of convergence time. Also, the eigendecomposition approach is much more scalable with network size than the multi-stage graph, and with increasing network size, eigendecomposition has less increase in convergence time. In terms of energy usage and cost, the multi-stage graph is a more efficient method in comparison to the eigendecomposition approach, but for large-scale networks, it seems the eigendecomposition is a better strategy due to its shorter convergence time.

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