Service Component Mobility Enabled by Network Virtualization

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I. INTRODUCTION

Today's Internet provides access to many services like email, web, and file transfers, but its structure is inflexible. Further, it is hard to introduce new network services with individual quality of service (QoS) requirements. The future Internet will be faced with additional challenges like a rising number of mobile users connected via wireless links or real-time services with high bandwidth demands. Therein, transport of information underlies several hard constraints, regardless of the type of information or its data volume. However, the Internet architecture is still bound to its best effort basis and thus is not able to satisfy these demands.

Network virtualization (NV) is the key technology to keep up with this development by reducing the time and overhead required to introduce new services, change the reach of existing networks, or support new applications like cloud computing services. NV can be used to consolidate networks on a functional level and differentiate them on a service level. In such a future Internet, a multitude of virtual networks (VNet) will coexist and complement each other. These coexisting networks allow specialization but require isolation of functionalities to provide dependable and predictable networks.

The objective of the Control and Management of Coexisting Networks (COMCON) project is to design novel control and management mechanisms that support the provisioning, operation, and teardown of VNets in a future networking scenario and to illustrate their economic advantages. To that end, COMCON addresses a couple of challenges that have not been sufficiently considered by existing approaches. This includes network operation issues, the support of arbitrary network technologies, technology migration and reuse considerations, and traffic management with respect to the perceived service quality. In this demonstration, we show the interaction between the different involved parties in our reference architecture for NV. It details the operation, control, and monitoring of VNets considering different functional roles and their information exchange. The reminder of this paper is structured as follows. In Section II we discuss our proposed reference architecture. Section III details control and monitoring patterns and Section IV describes the set up of our demonstration.

II. ARCHITECTURE

Network virtualization techniques are considered to change the classic ISP model and comprise new functional roles. The roles in such an architecture are illustrated in Figure 1. Basically, we distinguish the following functional roles:

- The physical infrastructure provider (PIP) owns and operates the hardware and offers virtualized resources.
- The virtual network provider (VNP) gathers these virtual resources and constructs virtual networks.
- The virtual network operator (VNO) requests networks with special requirements and brings them to life, i.e. it installs the hosts, defines the protocols, and controls the network.
- At the edges of the network, the end customer (EC) and the application service provider (ASP) request and offer services, which are delivered in high quality by the virtual network.

Figure 1 provides an overview of the stacking of the functional roles. A more detailed summary of these roles can be found in [1].
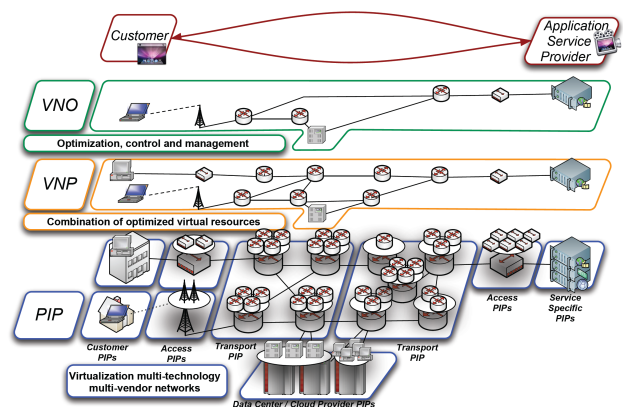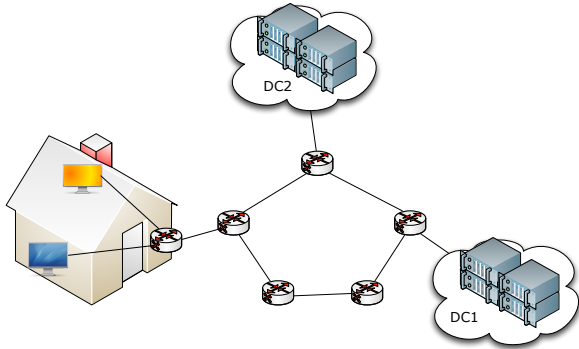

Fig. 1. Functional roles within the COMCON architecture

Fig. 2.   Considered Demo Scenario

III. Control and Monitoring Patterns

During the operation phase of a VNet, the VNet needs to be monitored, controlled, and adapted to changing requirements and changing environments. To that end, each functional role comprises measurement agents within its components. These measurement agents gather information about the component state and accumulate this knowledge into a monitoring database. A decision component (DC) decides on that information whether the quality of the service is acceptable or not. Hence, further action may be triggered, like ordering additional resources, changing the network operation or claiming SLA violations. In previous work [2] we discussed three different control and monitoring patterns that can be hierarchically combined:

Horizontal Control Loops: In the operation phase, each functional role (PIP, VNP, VNO, ASP) has at least a control component, a DC and a monitoring component. With these components the role is able to manage its resources and fulfill the agreed SLAs. Based on obtained monitoring data, the DC can instruct the control component to trigger certain actions. The result of the actions is perceived by the monitoring component. For example, if the monitoring component measures high packet delays, the DC can decide to increase the bandwidth on one link, which is performed by the control component. This results in reduced packet delays confirmed by the monitoring component.

Vertical Control Loops: Vertical control loops show the interworking between two adjacent roles. In case one role is not able to solve the detected issue alone it has to cooperate with an adjacent role.

Vertical Control Loops triggered by upper layer: The monitoring of the upper layer detects a problem and informs its DC. The DC cannot solve the problem by means of horizontal control and informs the DC of the lower layer, which triggers appropriate control actions. The result of the control actions is perceived by the monitoring component of the lower layer as well as by the monitoring layer of the upper layer.

Vertical Control Loops triggered by lower layer: In contrast to the previous case, the monitoring of the lower layer detects a problem and informs its DC which escalates the problem to the DC of the upper layer. The control loop is not necessarily closed. For instance, a VNP might decide to replace a misbehaving PIP by another PIP.

The main aspects of our architecture and operation model have been implemented for the demonstrator. In the following section, we describe the demonstration in more detail.

IV. Demonstration Scenario

In the demonstration, we focus on a small network scenario with three edge nodes and five intermediate virtualized network nodes, cf. Figure 2. We consider a video-on-demand ASP delivering its content to the end customers from a data center providing cloud platform-as-a-service infrastructure. The ASP contracts a data delivery service with a VNO, which therefore requests and reserves a virtual network between the data center and the customers. Due to an increase in the customer base, the virtual network extends its resources on the same links and later on also acquires virtual resources on other links to meet the demand of the service. At the point, the customer base in the target location exceeds a certain threshold, it is economically reasonable to move the service closer to the customers and save virtual network resources.

Please note, that all changes of the virtual network are automatically triggered by the control plane based on the monitoring data. This differs from nowadays network management which requires a high degree of human interaction. The provisioning of the links is performed via GMPLS signaling. QoS monitoring data and QoE measurements are generated by the network nodes and end systems. This information is collected via the agent system of StableNet[3], and processed to provide meaningful network status updates to the control plane. For the video transmission we deploy scalable video codec streaming between the cloud service and the customer. Based on the conducted measurements, the control plane automatically decides to perform flow migration. In order to optimize the network and satisfy the user needs this can also lead to a concurrent multipath transmission over links with different QoS parameters.

V. Acknowledgments

References

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