Managing Software-Driven Networks with a Unified Management Framework

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I. Introduction

The Software-Driven Networks (SDNs) are flexible, scalable, robust and intelligent networks, meeting the requirements coming from users and operators and coping with constraints imposed by heterogeneous underlying network environments (e.g., fixed or wireless). The virtualization of networks, storage and other resources has been adopted in order to improve the flexibility, scalability and robustness of the managed infrastructures. But this evolution has unveiled at the same time the need for management functionality to ensure the governance of multiple autonomic functions that operate simultaneously in the same or interacting domains.

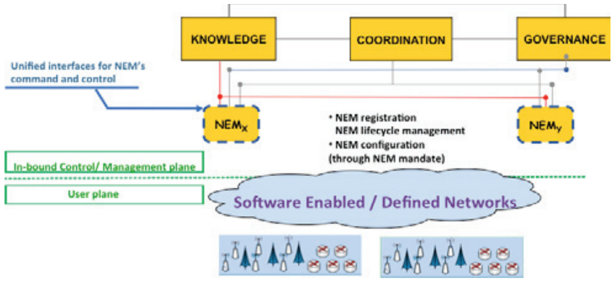

Figure 1: UMF deployed in an SDN environment

We demonstrate an SDN infrastructure that provides flexible communication services over dynamic topologies. Novel management abstractions as well as sophisticated mechanisms and algorithms are tackling the resource allocation and communication flow optimization problems (e.g., [1], [2]). The management operations follow the Universal Management Framework (UMF) specifications [3], an emerging management infrastructure for future networks introduced in the context of the UniverSELF project [4] (see Figure 1).

The UMF was defined in the form of functional blocks and interfaces that ensure the trustworthy integration, operation and interworking (e.g., conflict avoidance and knowledge sharing) of multiple autonomic control loops, encapsulated in management abstractions we call Network Empowerment Mechanisms (NEMs). The NEMs can be embedded into legacy and future networking systems and services in a “plug-and-play” / ”unplug-and-play” way and they require basic services to be provided by the UMF, namely the UMF core services: Governance (GOV) handling high-level management of the infrastructure; Knowledge (KNOW) providing information and knowledge manipulation abstractions; and Coordination (COORD) offering coordination services (e.g., conflict detection and avoidance).

We elaborate the demo and test-bed description in the following section. In section III, we provide our conclusions.

II. Demo and Test-bed Description

Figure 2: Traffic load specification using the H2N GUI

In this demo, we present a use case scenario where a Network Operator (NO) has deployed a multi-vendor and multi-technology infrastructure, consisting of Radio Access Networks (RANs) and backhaul or core segments. The whole infrastructure is virtualized and realized on our SDN platform. The NO is informed that a free-of-charge music concert will soon take place in the central square of the city and thus there will be additional traffic (number of active users for a specific service), since there will be attendees that will share the event with friends using a video conference service. In order to prepare the network for this, the NO is registering the general characteristics of the additional traffic load using the H2N GUI, as it is depicted in Figure 2. Moreover, the NO can specify, always in a high level manner, the way in which the traffic load shall be handled, i.e., he can set a goal to minimize energy consumption or to constrain the usage of specific technologies by specific user classes in case of specific conditions, etc. A high level request is created and sent to the system, which after three levels of translation and related processing by the UMF core, it results to a number of policies that are sent to the involved NEMs, in order them to be

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appropriately configured for the successful handling of the additional load [5]. This is realized through the optimal allocation of the required network resources and appropriate communication flow optimization based on the contraints of the environment and the requirements coming from the NO through the GOV and its H2N GUI.

Besides the three UMF core blocks, the following NEMs are involved in the demo: (i) the Load Level Estimation (LLE) NEM, which provides predictions of traffic load for multiple RAN elements, in specific time periods; (ii) the Core Traffic Engineering (CTE) NEM, which allocates virtual resources based on the NO requirements; (iii) the Virtual Infrastructure Management (VIM) NEM that manages the virtual infrastructure through providing management and control functions, such as virtual topologies and paths establishment, traffic monitoring and deployment of nodes providing network services (e.g. aggregation points); and (iv) the Placement Optimization (PO) NEM that optimizes the data flow through adapting the positioning of the communicating nodes in response to the dynamic network conditions (i.e., real-time topology and traffic status).

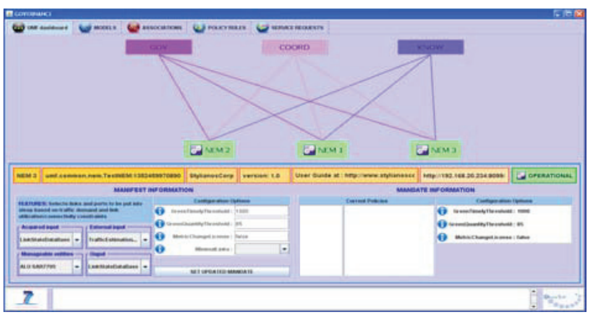

Figure 3: The UMF dashboard in the H2N GUI

The operator is constantly being informed about the NEMs that have been deployed by the GOV core service, their status and the status of the underlying infrastructure that they manage, through a powerful Human to Network (H2N) graphical user interface (GUI), a screenshot of which is depicted in Figure 3. During start-up, each NEM sends to the UMF core all the necessary information about its role and capabilities and provides details on the configuration options that can be set in order to control its operation. Then the Governance and the Coordination core blocks can send one or more control policies containing selected values that will ensure the desired behaviour, while all the procedures are supported by the Knowledge block.

As shown in Figure 4, the updates in the dynamic topology / communication node placement, the message-exchange diagrams for all interactions and the behaviour of the VIM and PO NEMs are visualized, including real-time monitoring information and topology status as well as the behaviour of the internal UMF core service functions.

The prototype system has been developed using Java. The interaction between the UMF core and the UMF NEMs is based on a RESTful API, namely several simple web services that have been implemented using the HTTP protocol and the principles of REST. Therefore, every UMF entity incorporates a light web server called SIMPLE and a suitable client based on RESTY. This choice for implementation was done in order to facilitate the communication of all kinds of devices and equipment with the UMF system, even if this was not taken into account during their design.

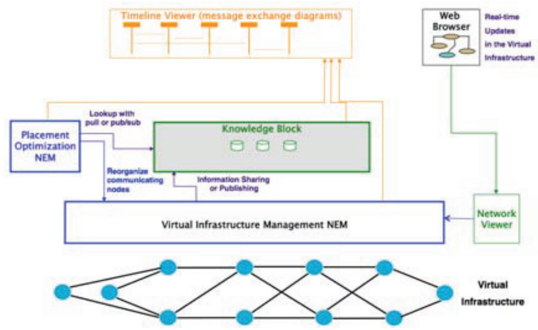

Figure 4: Virtual infrastructure and visualization tools

The SDN implementation is based on the Very Lightweight Software Driven Network and Services Platform (VLSP) developed by UCL. VLSP uses very lightweight virtual router elements that can be combined in order to build any network topology. It provides facilities to start and stop virtual routers on-the-fly, together with the ability to create and destroy network connections between virtual routers dynamically. Furthermore, these lightweight routers have an application layer interface that provides the capability to start and stop Java software applications.

III. CONCLUSIONS

This paper briefly proposes the demonstration of a prototype system that is able to successfully govern autonomic functions and to efficiently manage virtualized resources. The demonstration also showcases how SDNs can be managed using the UMF architecture, as well as how novel optimization algorithms and mechanisms can be associated with carefully designed management abstractions, in order to provide flexible management services on top of dynamic SDNs.

ACKNOWLEDGMENT

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