SOFTWARE-DEFINED NETWORK TECHNOLOGY

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Abstract: *The current communication networks are vertically integrated which means that the control and data planes are bundled together. In an attempt to overcome this inconvenience, software defined networking (SDN) breaks vertical integration in the way to separate the network's control logic from underlying routers and switchers, promoting the centralization of network control. This paper starts with software-defined networking presentation. Next, general architecture of SDN is provided together with requirements and the corresponding management. Soft-Net architecture employing SDN is included, too. Finally, multimedia streaming on SDN is provided.*

Key words: *software-defined networking, soft-net, multimedia streaming, 5G wireless networks*

1. Introduction

Software defined network (SDN) represents one of the most important force in the area of computer networks. Today networks are vertically integrated. It means that the control and data planes are bundled together. In an attempt to overcome this inconvenience, in SDN the control logic is separated from the underlying routers and switches [1]. In that way the centralization of network control is promoted, while increasing flexibility. By means of physical, distributed control planes, a more scalable and reliable solution would be achievable. The separation of control from data plane would be realized through an application programming interface (API) between switches and the SDN controller [2, 3]. The importance of SDN is evidenced by the emergence of many start-up companies, as well as the interest of researchers.

For example, Soft-Net architecture [4] consisting of an SDN based core network and a unified radio access network (RAN) is proposed to deal with the recent trends and challenges.

This paper starts with software-defined networking presentation. Next general architecture of SDN is provided together with requirements and the corresponding management Soft-Net employing SDN is included, too. After all, multimedia streaming on SDN is provided.

2. Software defined networking

SDN has several slightly different definitions [5, 6]. All the definitions are the strong isolation between the control and data plane, central management and a high level of programmability. The technology will support the changing characteristics of future network, SDN, on his side, will support the changing of future networks, taking into account advantage of savings in equipment investment and operating costs. In that way, the operators will have opportunity to create high flexible and dynamic network capable of integration and monitoring terminal devices and even to control robots to support new services [7]. Some examples of machines that are part of "softwarization" are: self-driving vehicles, drones, medical sensors and actuators.

From the traditional network management point of view there are some benefits, because SDN simplifies or solves critical management tasks. For example, because SDN devices need to be registered or discovered by the network controllers, in order to establish a communication path between control and forwarding planes, network discovery, a traditional network management task is solved.

3. General architecture of SDN

SDN is defined as a new networking example with forwarding plane decoupled from the control plane [8]. General architecture of SDN composed of 4 planes and 3 interfaces is shown in Figure 1.

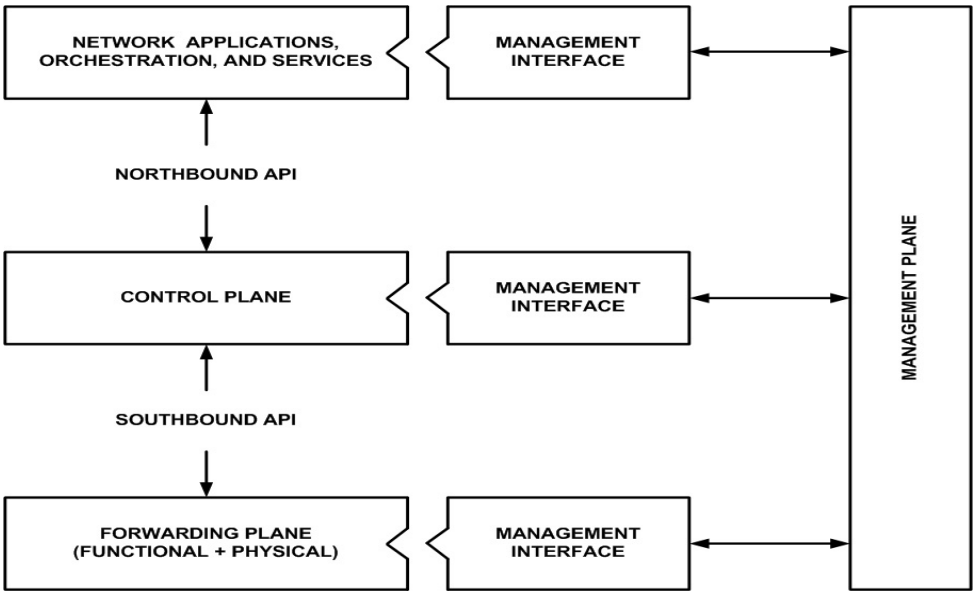

Figure 1. *General architecture of SDN*

The forwarding plane is split into "functional" and "physical" part. The functional part is a collection of software functions to be executed in forwarding devices. The functional part does not only hold data, but it must also allow the use of software to

perform forwarding tasks, employing tables, trees, queues and any other data structure. The other elements in this plane are physical, such as i/o ports, memory, processor and storage.

The control plane compiles higher-level decision and enforces the necessary configurations into forwarding devices. Elements in the control plane execute requests coming from the plane above. These elements included internal logic to handle network events and recover from failures. The design of this plane is dictated by environments specific demands. At the same time, the best strategies for locating and distributing elements are defined. On the top level of the general architecture SDN, network applications, orchestration functions for business, network logic and network services can be found. A fundamental part of architecture to organize the implementation of operations administration and management functions is the management plane. Management interfaces are used for allowing information to flow between the management plane and other plane. Also, interfaces allow settings to be enforced in network devices, while the information is retrieved back into management plane. Two other interfaces are a southbound application programming interface (API) and a northbound API. The first allows the forwarding plane to communicate with the control plane, while a second one abstracts control plane function to network applications at the top level. Since the behaviour of the network can now be defined by software, SDN management needs to be flexible enough to quickly adapt to new protocols written for all planes.

4. Soft-Net architecture

Software defined decentralized mobile network architecture toward 5G (Soft-Net) is designed on the system level [4]. Here, SDN and network function virtualization (NFV) technologies are employed. In that way, Soft-Net has scalability and flexibility from different kind of communication. Next, signalling overhead in the core network is reduced due to decentralized mobility management.

Also, it should be noted that system capacity as well as performance are improved by supporting decentralized mobility management, distributed data forwarding multi radio access technologies (RATs) coordination. The last but not the least is the fact that the network control protocol can be simplified by adopting RAT control protocol.

Figure 2 shows Soft-Net architecture for mobile networks [4].

It consists of a radio access network (RAN) and on SDN based core network. All radio access points in RAN are connected with access servers at the edge of an SDN based core network. Mobile terminals served by the radio access points can visit the operator's service network, or cloud computing platform via the core network, or access the Internet, or control delivery network (CDN) server via a distributed gateway function with the access servers.

The control plane network functions are supported separately in the SDN based core network and unified RAN. Network functions include communication control function (CCF), network policy control and network management function (NMF). CCF is responsible for mobility management policy control function supporting quality of service (QoS) and network policy control. NMF is monitoring network process and defines network architecture.

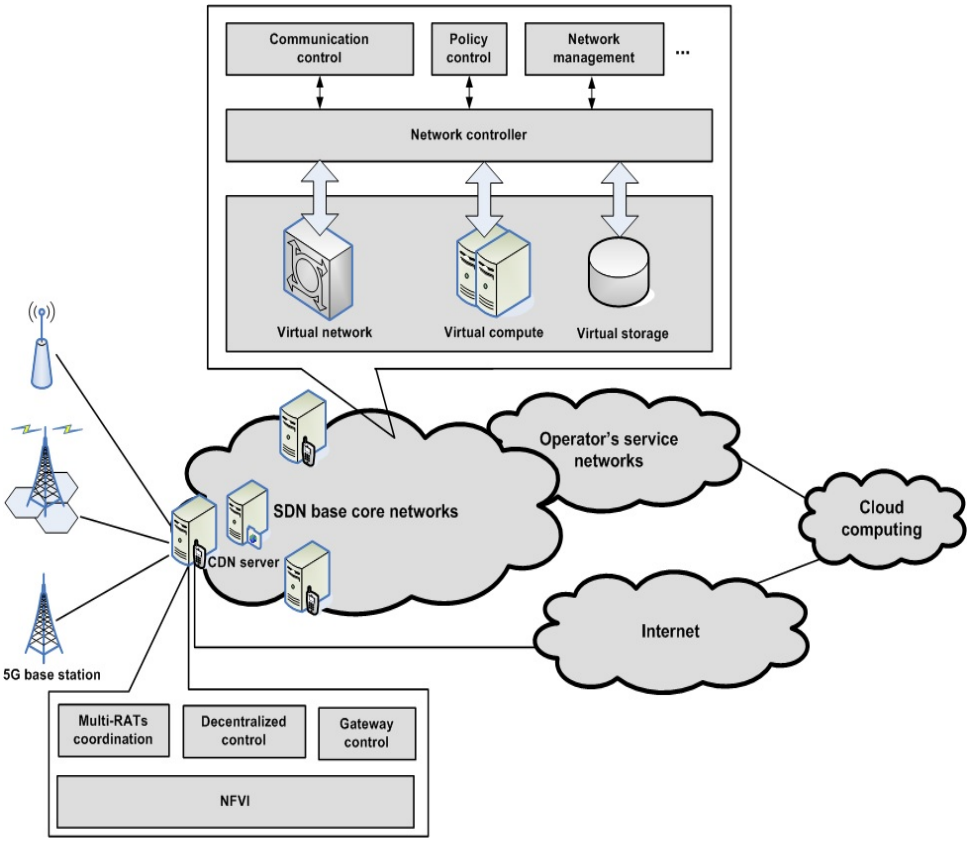

Figure 2. *Soft-Net architecture for mobile networks*

Generally speaking, network functions in the unified RAN are deployed on the access servers, which include a multi-RATs coordination function, decentralized control function (DFC), and finally gate-way control function. The RATs coordination function serves to monitor wireless network conditions and is responsible for user traffic. The DCF allows mobility to be handled by decentralized control plane network elements. The gateway function allows mobile terminal to access the Internet or content delivery network without passing through the core network.

The network functions in the SDN based core network are responsible for centralized network control (admission control, QoS control, network management and so on). As for network controller, it consists of an SDN controller and virtual network function (VNF). The network infrastructure in the core network consists of network function virtualization (NFV), infrastructure and physical equipment. Radio access points including existing and 5G base stations, evolved Node B (eNB), NodeB, BTS, WLAN AP, are served by access servers.

5. Multimedia streaming on SDN

With the rapid growth of wireless traffic, the current wireless technology will reach its limits in the next 10 years. The International Mobile Telecommunication (IMT) systems are expecting that fifth generation (5G) communication technology will be able to achieve 10 times higher spectral efficiency, 5 times reduced end-to-end delay, a 50 Gb/s data rate for low mobility user equipment (UE), and 5 Gb/s for high mobility UE, etc. SDN is regarded as a new technology [9] to virtualize networks for designing 5G wireless communication networks. The deployment of network services enables many functions to achieve speed and flexibility as networking advantages. Also, SDN provides satisfying different service requirements [10]. A very significant challenge is multimedia streaming which represents one of the most bandwidth-consuming services. New architectures are designed for providing a multimedia on SDN-enabled 5G networks.

Currently, due to emerging on-line streaming video, people tend to watch movies, videos and TV programs via streaming servers, resulting in the discussion of various subjects, such as how to use appropriate network protocol for transmitting video content, how to efficiently reduce the delay time, how to select appropriate video formats, how to achieve seamless streaming and how to balance the operating load between the streaming servers.

Finally, the fifth generation (5G) architecture has to support the delivery of service flows with diverging requirements, while the architecture will be based on SDN principle.

6. Conclusion

SDNs are regarded as a technology to renew the traditional networking industry. With SDNs, traffic flow can be controlled in more flexible way. Centralized control enables more coordinated management of traffic and network resources. The importance of SDN is evident by the emergence of many start-up companies, the interest of researchers, and the support of Internet. In order to improve the system capacity and performance, Soft-Net is invoked. This is a flexible and scalable system that can enable related virtual network function and employ new working mechanisms to improve the efficiency of network utilization. One of the most bandwidth - consuming services is multimedia streaming. Today, researchers are dealing with designing new architecture for providing multimedia streaming mechanism on SDN - enabling 5G wireless networks.

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Sadržaj: *Komunikacione mreže su vertikalno integrisane što znači da se kontrolna ravan i ravan podataka međusobno preklapaju. Da bi se prevazišao taj slučaj, uvedene su tzv. Softverski definisane mreže (SDN) u kojima je ukinuta vertikalna integrcija na taj način što je kontrolna logika u mreži odvojena od rutera uz istovremeno centralizovano mrežno upravljanje. Rad počinje prikazom tzv. Softverskog umrežavanja. Zatim sledi ahitektura SDN, uz zahteve i mogućnosti upravljanja. Takođe je predstavljena mreže tipa Soft-Net. Rad se završava analizom multimedijalnog striminga u SDN mreži.*

Ključne reči: *softverska mreža, softverski definisano umrežavanje, multimedijalni striming, bežična mreže pete generacije*

SOFTVERSKI DEFINISANA MREŽNA TEHNOLOGIJA

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