



## SDN/NFV and Eduroam-based Global University Rambling Technology

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### ABSTRACT

With the raging wave of Internet Plus, global free wireless roaming technology-based Eduroam (Education roaming) used for academic exchanges has received extensive attention. In this paper, the SDN (Software Defined Networking) and NFV (Network Function Virtualization) technology architecture [1] and Eduroam wireless roaming authentication mechanism are analyzed, SDN/NFV-based virtualized and fine-grained authorization model proposed, and the SDN/NFV technical architecture-based Eduroam realized, thus providing references for colleges and universities deploying Eduroam in cloud platform and SDN network.

**Keywords:** SDN, NFV, Eduroam, Authorization model.

### 1. INTRODUCTION

In recent years, there are increasingly frequent academic exchanges between colleges at home and those at abroad and more and more teachers and students moving between colleges. Under the national strategy of Internet Plus, every college has started to deploy wireless network with full coverage having been realized in most colleges and universities in Project 985 and 211. The wireless network of colleges mainly serves their own teachers and students, yet the visitors for student exchange tend to be able to access wireless network directly without using password, thus bringing security risks to their intra-campus network. Recently, Eduroam, generated from Europe and used for student exchanges, has attracted the attention of colleges. And as a platform project to support global universities for free wireless roaming, Eduroam is designed to realize academic exchanges and talent mutual visiting between colleges free from geological limitation, hence making wireless network more open and free [2]. Due to the increasingly diversified demands of wireless roaming users and the strong rise of virtual cloud-based resources sharing mechanism, Eduroam needs to give flexible authorization to roaming users under virtual cloud structure, while the emergence of SDN/NFV technology provides possibility for the rapid deployment of the authorization strategy featured by flexible and fine control in SDN network with virtual platform [3][4]. This paper analyzes the technical architecture of SDN and NFV and Eduroam wireless roaming authentication mechanism, proposes virtual and finely controlled authorization Eduroam model based on SDN/NFV, and studies how to realize Eduroam with the technical structure of SDN/NFV.

### 2. ANALYSIS OF EDUROAM AND SDN/NFV TECHNOLOGY STRUCTURE

#### 2.1 Eduroam technical structure of Eduroam-based wireless roaming

Eduroam is a brand-new academic wireless roaming service established jointly by universities and academic research institutions of many countries, and currently it has covered universities and research institutions of more than 70 countries and regions across the world [5]. Users can realize wireless network roaming access within global Eduroam alliance with no need of changing any configuration only after applying for an Eduroam account number from their unit. The technical foundation of Eduroam lies in the 802.1X authentication protocol and hierarchical RADIUS proxy server. For the specific structure, see Figure 1. Clinet serves as user terminal, and NAS devices include wireless controller, Institution RADIUS (institutional level RADIUS Server), TLR (Top Level RADIUS, top-level RADIUS Server), FLRS (Federation level radius, Alliance level RADIUS Server), IDP (Identity Provider), and SP (Service Provider). The working flow of Eduroam is introduced with the teachers from Northwest Agriculture and Forestry University going to a European university for student exchange as an example. First of all, the teachers hope to access Internet via local Eduroam wireless network, so they make request for wireless access to local Eduroam wireless network to start 802.1X process. After detecting network access request, local RADIUS server of Eduroam wireless network will transfer it to the SP of local university and the SP will transfer it to FLRS via RADIUS proxy after judging the certification information user@nwsuaf.edu.cn. Based on the existing IDP and SP

routing information, FLRS can judge whether the user belongs to the alliance. If it is forwarded directly, it will be forwarded to the corresponding local IDP; while if not transferred to TLR, it will be finally transferred to RADIUS server of Northwest Agriculture and Forestry University which will forward the verification result via RADIUS server to SP of European universities after identity confirmation and the SP will authorize the teachers from Northwest Agriculture and Forestry University access to local wireless network.

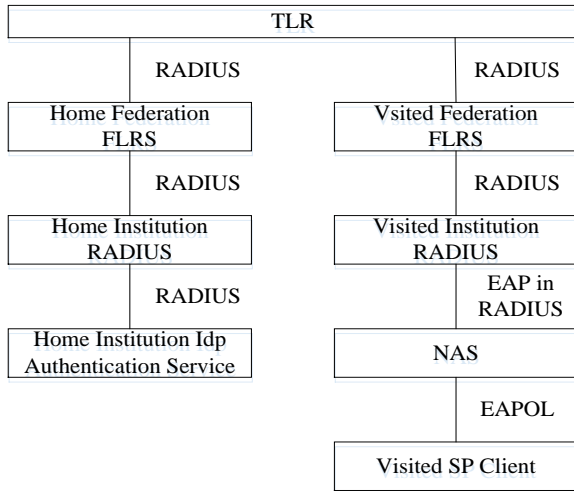


Figure 1. Hierarchical RADIUS Structure

## 2.2 SDN technical structure

SDN stems from the Clean Slate task of Stanford University funded by American GENI project in 2006. In 2009, the research team led by Professor Nick McKeown proposed OpenFlow-based SDN concept for the test innovation of campus network [6]. Its core lies in the idea of separating data forwarding and controlling with hierarchical ideology so as to change the existing network infrastructure framework featured by increasingly complex structure and function, continuously weakened control capability and difficulty in evolution and development [7]. In the control plane, through the programmable controller of logic centralization, operators and researchers can control all network information to deploy new protocol and manage configuration network. In the data plane, standardized general equipment is used as much as possible to improve the unity, universality and suitability of the access network equipment, reducing the heterogeneity of networks. Open unified interface is adopted between layers for interaction (such as OpenFlow, etc.) SDN controller will send out standard rules to network equipment via standard interface [6] and network equipment only needs to conduct corresponding action as per the rules. Through centralized scheduling, the fine-grained management and control over resources in existing network equipment and access network can be realized. Therefore, MIT honors SDN as “One of the Top Ten Innovative Technologies to Change the World”. TCP/IP structure and open application-layer software design have brought rapid development for Internet, but in actual management, due to the difference of special hardware network equipment and operating system, network administrators need to pay much attention to get familiar with network equipment. And once a new business starts online, they need to re-configure all network equipment related to it. SDN technology provides

them with the possibility of quickly implementing and deploying new strategies as per users’ demands. The specific architecture of SDN is shown in Figure 2, includes data layer, control layer and application layer. Data layer (it can be understood as data plane) abstractly consists of network elements like switch and specific forwarding surfaces with each network element connected by SDN network data routes which are formed by small and same rules; control plane consists of the controllers featured by logic centralization, responsible for intensively maintaining network status, obtaining data layer information via OpenFlow and meanwhile providing extensible northern interface for application layer [8]. The application layer will transfer the northern interface of the control layer according to small and same rules so as to realize the functions of application program. In this controlling way, network administrators are able to dynamically configure, manage and optimize the low layer network resources.

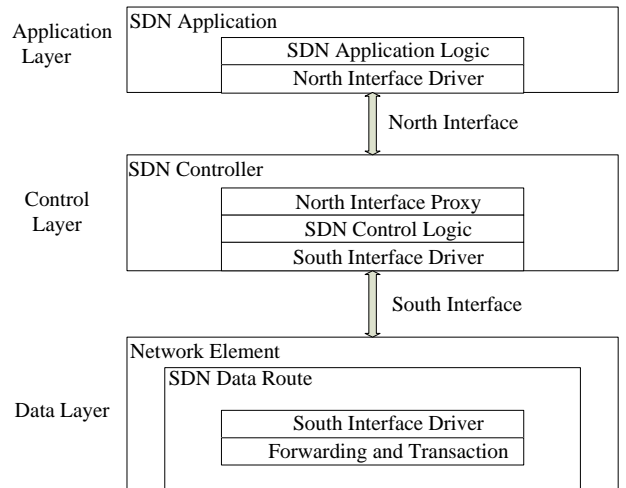


Figure 2. SDN Technical Structure

## 2.3 NFV technical structure

The European Telecommunications Standards Institute (ETSI) firstly proposed the concept of NFV (Network Function Virtualization) [9] which can realize the functions of original network cell equipment with virtualization technology and general industry standard-based hardware such as server, storage and switch equipment and virtualization technology and through software processing method, thus reducing the cost of colleges spent on network equipment. Through hardware decouple and function abstraction, the function of network equipment will not rely on specialized hardware and software any more. And with the help of resource sharing and sufficient and flexible scheduling approaches, the rapid deployment and technological development of new businesses can be realized and network breakdown be separated and self-cured as per the demands of actual business.

Many online services in colleges are deployed by large-scale increasingly growing special hardware equipment. The launching of a new network service usually needs another variation, but currently it becomes more and more difficult to find space and driving force to propel these boxes containing variations; and colleges tend to have limit network fund investment and are lack of technical design technique to integrate and operate increasingly complex equipment. NFV technology solves the above problems: on the one hand, low cost of x86 standard-based IT equipment can save a lot for

network operation and maintenance; and on the other hand, open API interface can also help network in colleges to obtain more application [10]. According to the normative document released by ETSI which serves as the promoter of NFV standards formulation, NFV's Technical Structure is as shown in Figure 3, and it is divided into Virtualized Network Function (VNF), NFV Infrastructure (NFVI), NFV Management and Orchestration (NFV MANO), Operation Support System (OSS) and Business Support Systems (BSS), Service as well as VNF and Infrastructure Description.

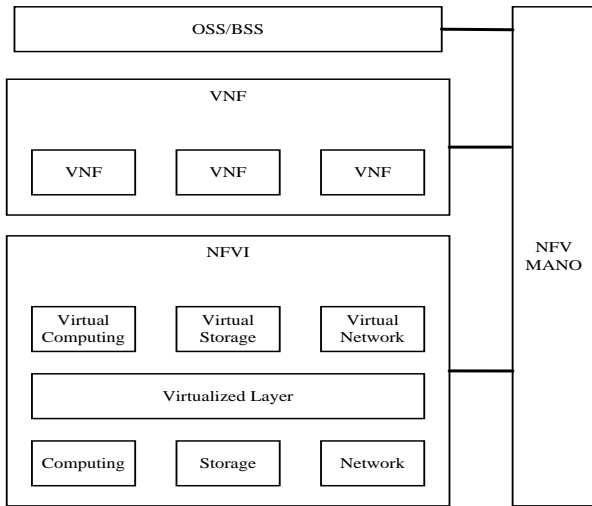


Figure 3. NFV technical structure

### 3. EDUROAM AUTHORIZATION MODEL BASED ON SDN/NFV TECHNICAL STRUCTURE

After the authentication of wireless roaming, the teachers from Northwest Agriculture and Forestry University are allocated by European Universities' SP to a specific visitor subnet which has the corresponding access rights. With the diversification of users' demands and resource sharing, more

flexible authorization strategy needs to be designed in order to make visitors access the resources of colleges conveniently and safely.

Current network structure fails to hand out quickly fine-grained roaming strategy, but SDN/NFV technology can not only realize centralized management on control rights of network equipment but also hand out targeted strategy according to the needs of users. Thus, SDN/NFV technology is introduced in this paper which intelligently operates the path of data flow via various upper applications to conduct more elaborate ruling matching and function optimization. And the combination of these two technologies can realize fine-controlled roaming strategy. Therefore, it is very necessary to build an Eduroam wireless roaming authorization model based on SDN/NFV technology. See Figure 4 for detailed design.

After roaming users of a university in Europe have submitted wireless roaming authentication information to the Network Education Center of Northwest Agriculture and Forestry University of Science and Technology, certification server of the Network Education Center records their authentication information and sends out authentication request to IDP of the university from Europe which will return visitors' authorization information. Based on SDN and NFV technology, an Eduroam RADIUS server is established in the Network Education Center of our university, responsible for collecting user authorization information corresponding to user authentication information returned by a European University' s SP. Authorization strategy database formulates suitable authorization strategy for different visitors and then integrates it with the authorization strategy returned by the European university as the default authorization strategy of users; then the default authorization strategy and user information will be sent to SDN controller managed by Cloud Platform and next SDN controller hands out user access right and data flow. Network Education Center administrators can customize authorization strategies for visitors, with no need of configuring authorization strategies on different network devices.

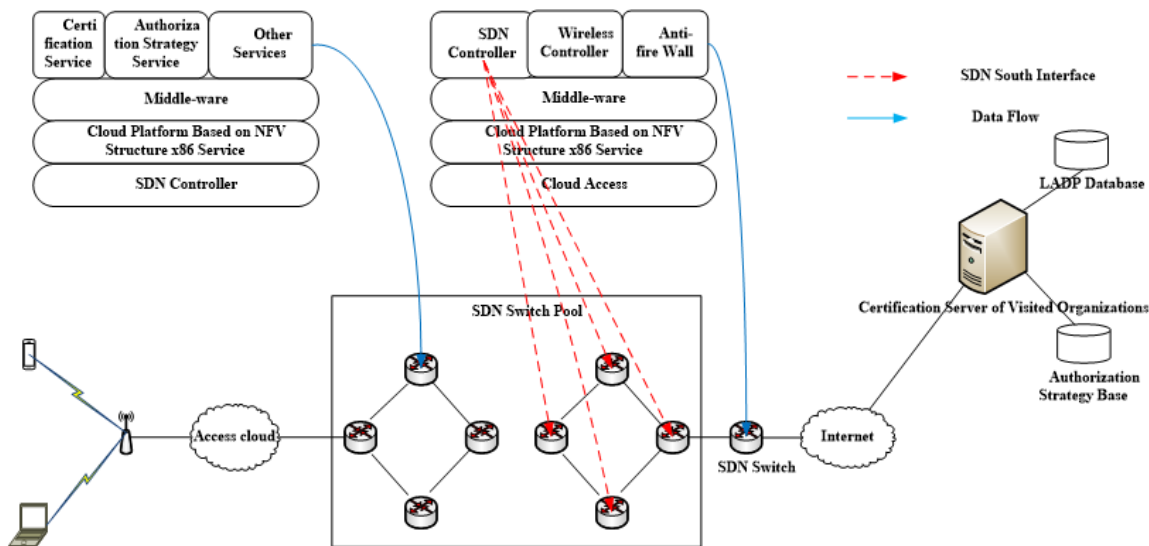


Figure 4. Eduroam wireless roaming authorization model based on SDN and NFV structure

## 4. IMPLEMENTATION SCHEME OF EDUROAM BASED ON SDN AND NFV TECHNICAL STRUCTURE

### 4.1 Basic preparation

To plan new Vlan and SSID in tested SDN network and to configure IPv4/IPv6 information in DHCP server; to allocate one virtual machine on Cloud platform with Cent-OS (Enterprise Operating System Community, community enterprise operating system) 7.1 as the operating system, acting as Eduroam RADIUS server.

### 4.2 To propose access application to Chinese Eduroam organization

To make an access application via email to Chinese Eduroam organizations, and the receiver will returned the KEY and testing account number via mail after identity confirmation.

### 4.3 To install and configure Eduroam RADIUS Server

According to the actual need, FreeRADIUS and Sever SQL software package are directly installed when Cloud platform is serving as the virtual machine. We only need to install the GIT software to track the changes of FreeRADIUS and to configure the /etc/raddb/proxy.conf files to achieve strategy forwarding. According to the above obtained KEY, RADIUS server information is connected so as to add records of testing users to the data base, thus establishing testing users.

### 4.4 To configure wireless controller AC

Configure the name of this SSID named as Eduroam on wireless network controller, set to launch 802.1X authentication, and make RADIUS server point at Eduroam RADIUS server.

### 4.5 Connection for testing

Firstly open the authentication service process on the server, select the SSID named as Eduroam in the testing phone and enter users' name and password to test whether it can be properly connected. If normal connection is available, it indicates that local user can use it normally. Then test the testing accounts given by Eduroam organizations to test whether users in other domains can pass the authentication and log in.

## 5. CONCLUSIONS

Currently, international exchange and cooperation in higher education has been an internationalized educational

cooperation platform. Eduroam can provide convenience for teachers and students to access wireless network and to obtain various resources of foreign universities. Therefore, in this paper, a virtual and finely-controlled Eduroam model featured by flexible authorization based on SDN / NFV technical structure is proposed and the implementation scheme of this model is provided so as to facilitate the implementation or study of Eduroam technology in other colleges.

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