Initialization of Software Defined Wireless Bacteria-Inspired Network Platform

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Abstract. Fifth generation mobile network is a development trend for information and communication industry. In order to meet requirement which presented by some organizations which are working on 5 G standards and regulations, we had proposed a Software-Defined Wireless Bacteria-Inspired Network (SDWBIN) platform. In this paper, we will introduce how we initialize this prospective platform.

Keywords: 5 G mobile communication · Software-define networking · Bacteria-inspired method

1 Introduction

The information and communications industry are the development priorities for every countries, because every people think that almost all of the jobs can be completed through internet technology. The most importance is that these services can be used anytime and anywhere as long as the user's device has license for accessing of mobile communication. Such habits have made mobile communication becomes one of promising technology, hence mobile communication technology had been rapidly evoluted from 1 G to 4 G in just 30 years [1].

However, although 4 G provides 1 Gbps data rate for the static network and 100 Mbps data rate for high mobility network, it has already no potentiality to carry the explosively grown network traffic and user's expected quality of service (QoS). In order to meet demands of future information and communications industry, many organizations has begun to develop 5 G standard such as International Telecommunication Union (ITU), European Telecommunications Standards Institute (ETSI) and so on. No matter which organization agreed that next generation mobile communication must achieve 10 to 100 times of 4 G network capacity and so on. These requirements will be the major challenge for 5 G deployment. For the blueprint of future 5 G, Mobile

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and Wireless Communications Enablers for the Twenty-twenty Information Society (METIS) consider that 5 G not only retain the existing technologies but also extend several new technologies which include device-to-device (D2D) communication, massive machine communication (MMC), ultra-dense networks (UDN) and so on. Hence we can know that future 5 G must be a heterogeneous network (HetNet) [2] so that the whole network environment will be difficult to manage. It means that this problem cannot be improved just by hardware solution [3]. In the previous work, we had present an idea about the Software Defined Wireless Bacteria-Inspired Network (SDWBIN) platform [4]. It is a software solution for easy management of 5 G. It means that this method is able to configure easily and not spend extra cost. In this paper, we will explain how to use bacteria behavior to deliver network traffic as well as introduce how to implement this platform.

The rest of the paper is organized as follows. Section 2 introduces background of Software Defined Wireless Bacteria-Inspired Network. Section 3 will give a clear initialization process of this platform. Finally, we will summarize research contributions and discussing the future works.

2 Background and Related Works

2.1 Software Defined Wireless Bacteria-Inspired Network

In order to carry huge network traffic, we try to let the network process to imitate the behavior of bacteria [5]. The reason is that we found the ecology of bacteria is a stable, efficient as well as this ecology has very high ability to repair itself. In general, bacteria have three main steps which are perception, infection and diffusion respectively. The perception means that each bacteria is able to sense changes in the environment and status of neighbor bacteria, hence bacteria always can find a host which has a suitable living environment to support basic conditions for survival of bacteria. However, hosts may die so that bacteria must continue to expand their living space so that they have to "infect" other hosts. In the some cases, bacteria cannot success to expand, because the such bacteria suitable species may already be endangered as well as others species cannot support the same living environment with original specie, hence bacteria must be mutated so that they have ability to suit for new environment or to infect the other species such as zoonotic diseases (Bird Flu: H5N1). For better efficiency of infection, bacteria will produce a large number of copies to sound out their neighbors and further infect them. This behavior is so called "proliferation".

However, the mentioned phenomenons belong to biological behavior. They cannot directly apply to the engineering so that we can only mimic the strong point of biological characteristics. In other words, we still keep carries of original mobile communication such as radio frequency by 3 G–5 G, UMTS instead of the water, air or any biological elements. Therefore, we cannot call our method a bacteria network, but a bacteria-inspired network. In order to successfully complete this innovative approach, we must map the bacteria phenomenon to the engineering firstly that can be referred by [4].

By previous mentions, we know that "perception" is an initial step in the bacteria ecology. In order to achieve it, we will implement the basic network platform then

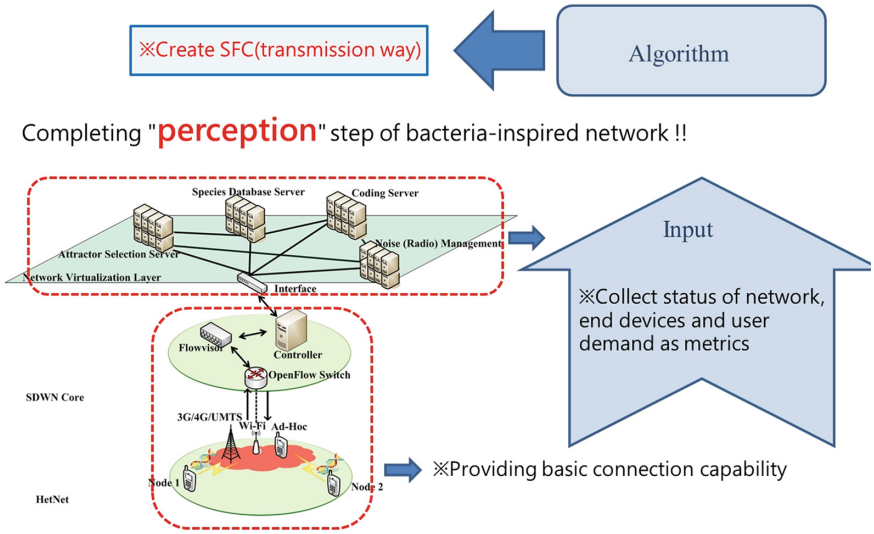

Fig. 1. Correspondence table

collects status of network, end devices and user demand as metrics. Finally, these collections will input to a policy algorithm then create a robust path to carry the network traffic so that this method will be like bacteria to perceive and find a favorable host that is shown in Fig. 1. In this paper, we will clearly introduce how to initialize our SDWBIN platform.

3 Implementation

The main concept of perception is that bacteria can sense the surrounding environment so that any bacteria are able to find a favorable host to parasitize. It means that to implement a bacteria-inspired network platform, a whole view is necessary. Therefore, we think that software-defined networking (SDN) is a great solution for monitor, manage and control the network status. Opendaylight is one of the popular organizations which committed to promote SDN development. It developed a controller with the same name which named OpenDayLight (ODL). When SDN has been a core network, we are able to know anything happened in any network equipments as long as they do support Openflow protocol that is shown in Fig. 2. We can see that there is a topology in ODL GUI which includes connection, MAC and so on of linked switches and linked end devices.

The switch must be a openvswitch (OVS). Because general switch does not support Openflow protocol so that it cannot recognize the flow entry of Openflow protocol. OVS is able to easy control the switch by software way that including setting of VLAN, bridge and network interface. Figure 3 shows an example of our configuration. We set eth0 which uses out-band mode to connect controller, and then creating a bridge between eth1 and eth2. Due to SDN has not official wireless supported solution so that

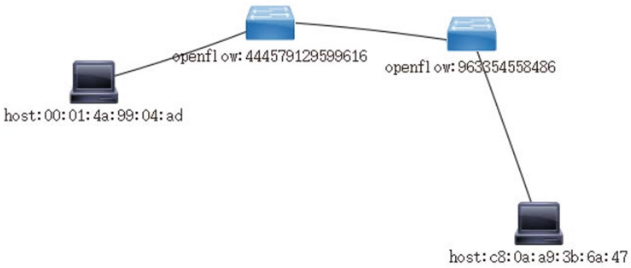

Fig. 2. Topology from ODL GUI

```
switch@switch-Lenovo:~$ sudo ovs-vsctl show
[sudo] password for switch:
4325bb34-420f-4c9e-9440-eca141e9e439
    Bridge "br0"
        Controller "tcp:192.168.5.1:6633"
            is_connected: true
        fail_mode: standalone
        Port "eth2"
            Interface "eth2"
        Port "br0"
            Interface "br0"
                type: internal
        Port "eth1"
            Interface "eth1"
```

Fig. 3. Configuration of OVS

there are not any access points (AP) can recognize packet of Openflow. In order to solve this problem, we have to implant Openwrt to AP and then mount the image file of OVS. Regrettably, current controller still cannot identify the connection which adopts to wire or wireless link. But this point is in an acceptable range.

In order to verify this platform can be interfaced with others commercial platform as well as supporting large scale environment, we purchased a HP 2920 switch as an edge switch and a pure OVS. The entire network topology is shown in Fig. 4.

After testing by wireshark, we can confirm that connectivity of this platform is no problem for data transmission than is shown in Fig. 5. Because the traffic flow in SDN must to follow the flow entry, this figure shows that a catched packet by wireshark. We can see that this packet did use Openflow protocol and successfully deliver to destination.

According to current results, we know that we already have ability to transmit packet and monitor network status through Openflow. It means that we have completed basic “perception” function. Generally, bacteria will start to move to suitable host after perception is completed. Therefore, we must to use these collected information to create the stable path for data transmission. Service Function Chain (SFC) is a project of Opendaylight. They consider that a transmission process is a collection which includes changes of service functions (SF). These service functions can be a firewall, NAT or balancer and so on possible network function. Due to each bacteria will perceive the environment when it just parasitized a host and then it will find the most advantageous way such as how to make interaction with other bacterias that including

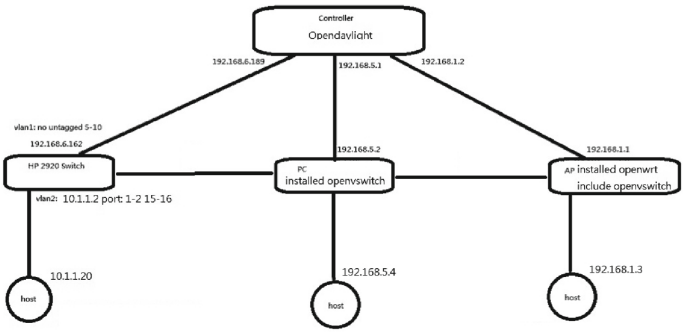

Fig. 4. Whole topology

```
Ethernet II, Src: QuantaCo_3b:6a:47 (c8:0a:a9:3b:6a:47), Dst: SonyCorp_99:04:ad (00:01:4a:99:04:ad)
  Destination: SonyCorp_99:04:ad (00:01:4a:99:04:ad)
  Source: QuantaCo_3b:6a:47 (c8:0a:a9:3b:6a:47)
  Type: IPv4 (0x0800)
Internet Protocol Version 4, Src: 192.168.5.4, Dst: 10.1.1.20
Transmission Control Protocol, Src Port: 45824 (45824), Dst Port: 6633 (6633), Seq: 1, Ack: 1, Len: 140
OpenFlow 1.3
  Version: 1.3 (0x04)
  Type: OFPT_PACKET_IN (10)
  Length: 140
  Transaction ID: 0
  Buffer ID: OFP_NO_BUFFER (0xffffffff)
  Total length: 98
  Reason: OFPR_ACTION (1)
  Table ID: 0
  Cookie: 0x2b00000000000000
  Match
  Pad: 0000
  Data
```

Fig. 5. Connectivity by wireshark

```
INFO:sfc/sfc_agent.py:Received request for SF creation: SF1
INFO:sfc/sfc_agent.py:Received request from ODL to create SF ...
INFO:sfc.common.launcher:Starting Service Function: SF1
INFO:sfc.common.launcher:Starting FIREWALL serving as SF1 at 192.168.5.2:40001,
service type:firewall
INFO:sfc.common.launcher:Starting control UDP server for SF1 at 192.168.5.2:6000
INFO:sfc/sfc_agent.py:Received request for SF creation: SF2
INFO:sfc/sfc_agent.py:Received request from ODL to create SF ...
INFO:sfc.common.launcher:Starting Service Function: SF2
INFO:sfc.common.launcher:Starting DPI serving as SF2 at 192.168.5.2:40002, servi
ce type:dpi
INFO:sfc.common.launcher:Starting control UDP server for SF2 at 192.168.5.2:6002
INFO:sfc.common.launcher:Starting Service Function Forwarder: SFF1
INFO:sfc.common.launcher:Starting SFF serving as SFF1 at 192.168.5.2:4789, servi
ce type:sff
INFO:sfc.common.launcher:Starting control UDP server for SFF1 at 192.168.5.2:600
1
INFO:__main__:Sending VXLAN-GPE/NSH/IPv4 packet to SFF: ('192.168.5.2', 4790)
INFO:__main__:Received packet from SFF: ('192.168.5.2', 4790)
```

Fig. 6. A process of SFC

competition and mutualism. It means that only creating a route is not enough. We think that the needed network functions are necessary to consider. Therefore, in the next step, we will use SFC to define the stable routing according to the needed network function or the services of any packets. These function or services are regarded as SF of SFC that are shown in Fig. 6.

4 Conclusion

In the future, network traffic will become very huge since the numbers of mobile devices are increased. Hardware solution has been unable to meet this situation completely. In this paper, we used cloud computing architecture to provide flexible adjustment and higher computing power, as well as use SDN to provide global monitoring and management. Basing on this structure which supplies a basic network function then we can implant the bacteria-inspired concept to initialize SDWBIN platform successfully. Any network traffic will able to perceive whole network status to find a most stable transmission way for packet delivery. In the future, we will try to implement "infection" and "diffusion" functions according to the definition of SDWBIN.

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