POF-ICN based multihoming transmission framework
draft-wang-multihoming-icn-00

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Abstract

This document presents a POF-ICN based multihoming transmission framework. POF is an SDN forwarding plane technology proposed by Huawei, we use it to enable information-centric networking (ICN). The purpose of the framework is to provide an overall picture of the multihoming transmission system. We first describe the relationships among the various components of mobile networks and the newly added entities, such as Mobility management and Session management. Then we describe the Multihoming transmission operation flow to outline what each component needs to accomplish and to how these components and mechanisms fit together.

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1. Introduction

Software-Defined Networking (SDN) [RFC7149] gives operators programmatic control over their networks. In SDN, the control plane is physically separate from the forwarding plane, and one control plane controls multiple forwarding devices. In SDN, a common, open, vendor-agnostic interface between the control plane and the forwarding plane, which may contain forwarding devices from different hardware and software vendors, is required. OpenFlow is such an interface.

Huawei presents the Protocol Oblivious Forwarding (POF) technology based on openFlow. The basic idea is to denote any protocol field, as well as the metadata, which is considered as one special protocol header that can be configured by the controller, with a triad of <type, offset, length>. POF also defines a set of protocol oblivious forwarding actions/instructions. The actions/instructions can realize the functions of all forwarding instructions/actions defined in OpenFlow, not only for the existing protocols but also for any new protocols. With the protocol oblivious data plane that are composed of POF forwarding devices, we will use POF to enable information-centric networking (ICN). In the following content we will use POF-ICN to refer to it.

On the other hand, multihoming support on IP hosts can greatly improve the user experience. With the simultaneous use of multiple access networks, multihoming brings better network connectivity, reliability, and improved quality of communication. Compared to tcp/ip network, we will discuss how to realize multihoming in POF-ICN.
1.1 Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

Software-Defined Networking (SDN) - A programmable networks approach that supports the separation of control and forwarding planes via standardized interfaces.

Forwarding Plane (FP) - The collection of resources across all network devices responsible for forwarding traffic.

Control Plane (CP) - The collection of functions responsible for controlling one or more network devices. CP instructs network devices with respect to how to process and forward packets. The control plane interacts primarily with the forwarding plane and, to a lesser extent, with the operational plane.

Protocol Oblivious Forwarding (POF) - The protocol that is proposed by Huawei to provide a new way to develop SDN.

2. Framework Benefit

To provide better multi-homed transmission services, POF-ICN support for multi-hosting is reflected in the following aspects:

2.1 Forwarding speed

Forwarding speed of the forwarding plane is fast and the forwarding path is controllable. Under the POF-ICN architecture, the control plane is separate from the forwarding plane. The forwarding plane is only responsible for simple flow table matching and data packet forwarding, which greatly eases the switch processing burden. Compared to the traditional TCP/IP architecture. Therefore, packet forwarding is faster than traditional networks. On the other hand, the flow entry on the switch is delivered by the POF controller, so that the forwarding path can be controlled. Multiple paths can be used conveniently under multi-homing scenario. In the traditional network architecture, multi-homing needs to be implemented by using multiple IP address pairs which is completely uncontrollable.

2.2 Control plane
The control plane can select the optimal content source and get the optimal transmission path. The POF controller in the POF-ICN architecture manages the underlying forwarding devices. Each POF controller can obtain the interconnection information of the switches in its control domain through the virtual layer. It can control the forwarding rules between switches by issuing the flow table. This feature brings great convenience to multihoming transmission. In scenarios where the user needs multihoming transmission, the POF controller can calculate the position of the content source closest to the user in the network according to the topology information. The TCP/IP network cannot achieve that. In the TCP/IP network architecture, content can usually only be acquired via a fixed IP address. In POF-ICN, it is possible to obtain the required content through the network cache.

2.3 Session management

The session management module is introduced. In the POF-ICN, a session management module is introduced to maintain the request connection through the user network address and the request content name so that it can provide a basis for further optimization of the algorithm. In the POF-ICN multihoming transmission scenario, the session management obtains connection information through the POF controller. It will use optimization algorithm to obtain the optimal forwarding strategy. Finally, the best solution to the solution is fed back to the controller. The controller controls the underlying switch forwarding rules to maximize link utilization in multihoming transmissions.

3. Framework overview

This document provides a POF-ICN multihoming transport framework, as shown in Figure 1. In addition to the existing network entities (such as base stations and mobile gateways, POF switches, etc.), some logical entities are defined, namely Mobility Management Entity (MME), POF controller, and session management.

Mobility management is responsible for the management of terminals and hosts. Each time the terminal starts a service, it interacts with the MME to obtain multiple available hosts and MME will allocate access bandwidth. When it leaves, it will log out at the MME and release the bandwidth. The MME will update the network.
conditions in real time, such as available bandwidth, available hosts, access terminals, and so on.

Session management is responsible for the management and transmission control of all multihoming services. The session management firstly completes the access bandwidth allocation (host resource management) through the interaction between the MME and the terminal on the access side, then the controller completes path planning and path bandwidth resource allocation on the ICN network side. Session management implements a dynamic decision model by randomly estimating the transmission rate and the transmission link delay at both ends of the access switch and the content source switch.

The POF controller is responsible for the transmission path planning. According to the session management, a plurality of parallel paths from the request side to the content source are planned for the current network resources allocated by the multi-homed service, and the path planning is implemented by issuing a flow table to the POF switch of the forwarding plane.

4. Operation flow

The terminal in this example is equipped with WLAN and LTE interfaces and is also equipped with multihoming features. It can connect base stations and wireless POF switches. The transmission steps are as follows:

Step (1): The terminal is connected to multiple hosts such as a WLAN and an LTE network.

Step (2): The host will register the access to the MME with the MME and update it regularly.

Step (3): When the terminal has service requirements, it needs to report the service request first. Through the different access networks, the current quality of service, network status, reported to the MME; At the same time, the MME will periodically receive the load of the cellular base station, Wi-Fi access point;

Step (4): After receiving the request, the MME considers the different transmission characteristics of multiple wireless networks and the respective network load conditions, and reasonably allocates the services and resources among multiple networks, and sends the resource allocation plan to the base station and the access point, which simultaneously sends the distribution plan to the session management module of the control plane.
Step (5): The controller obtains the host and bandwidth allocated for the terminal from the session management office, and parses the location of the content source (possibly multiple), and combines the above information to plan multiple paths between the terminal and content source in the network topology. It will send the result to the session management module.

Step (6): According to the result of the bandwidth allocation, the session management module establishes a dynamic decision process according to the service requirements. It calculates an end-to-end multi-path transmission strategy, and invokes the controller to create a flow table.

Step (7): The controller delivers a flow table to the forwarding plane.

Step (8): When the terminal moves or the network is abnormal, the session management cooperates with the MME and the controller to update the access host and the transmission path.

Step (9): Update and deliver new flow tables.

5. Security Considerations

The mechanism described in this document does not raise any new security issues for the PCEP protocols.
6. IANA Considerations

This document includes no request to IANA.

7. Conclusion

We describe the framework of our system. At the same time, we describe the function of each module.

8. References

8.1 Normative References


8.2 Informative References


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