Smart Device Communications Technology to Enhance the Convenience of Wi-Fi Usage

IIHOSHI Takahiro, SAIDA Yoshinori, WATANABE Yoshikazu, MORITA Gen, KARINO Shuichi

Abstract

With the widespread dissemination of Wi-Fi hotspots in the public area and Wi-Fi access points in individual homes, the number of Wi-Fi users of smart devices has increased. Acceleration in the practical use of a network access standard called ANDSF has also provided users with more convenience when using Wi-Fi communications. However, ANDSF-compliant smart devices have not been available with the conventional communications technology. NEC Knowledge Discovery Research Laboratories is challenging improvements in the efficiency and usability of Wi-Fi communications. In order to achieve this, the laboratory is focusing on the flexible communication control functions that are characteristics of the nature of OpenFlow and on how to use them optimally to control the communication functions of smart devices. This paper introduces technologies enabling smart devices that are compliant to ANDSF.

Keywords

OpenFlow, SDN, smart device, Wi-Fi, ANDSF

1. Introduction

The dissemination of smart devices such as smart phones, tablet PCs, etc. is accelerating the increase in the number of users that enjoy real-time communication services, including media content, chat, telephone calls via VoIP and other services. Under such trends, mobile phone network loads for 3G and LTE have been increasing, which have resulted in an increased burden on mobile carriers for investing more facilities and also in degradation of user experience due to network congestion. Such are the recent issues that mobile carriers are now facing.

In order to cope with these issues and to decrease the load on cellular networks, the employment of Wi-Fi communications in support of smart devices is being applied widely. This trend is accelerating the dissemination of a number of Wi-Fi access points in the public domain and also in individual homes, and brought an increase in the number of Wi-Fi users.

One solution that has been applied to these issues, the implementation of ANDSF (Access Network Discovery and Selection Function,)[1) 2)] that is a technology aimed at improving Wi-Fi usability, is being promoted actively. However, with the conventional communications technologies it has been difficult to deliver ANDSF-compliant smart devices.

This paper introduces technologies suitable for the delivery of ANDSF-compliant smart devices by employing features of OpenFlow such as flexible communications control functions, etc.

2. Recent Trends in Wi-Fi Accessibility of Smart Devices

Telecommunication carriers have been installing public Wi-Fi hotspots in downtown or places where people gather while also distributing Wi-Fi access points in individual homes. These efforts are providing more opportunities for users to access Wi-Fi communications.

In order to disseminate Wi-Fi access even more universally, it is required to achieve further improvements in usability such as by reducing power consumption, simplified setup of terminal devices and security countermeasures, etc.

2.1 ANDSF - Practical Technology to Improve Wi-Fi Usability

ANDSF is attracting market attention as a technology that can improve Wi-Fi usability. ANDSF is specified in the 3GPP standard and it provides the information to assist non-3GPP

access wireless networks such as Wi-Fi, etc. from mobile carriers to user equipment. Information to be distributed with devices: ANDI (Access Network Discovery Information) and ISRP (Inter-System Routing Policy) are listed in **Table**.

The information distributed via ANDSF allows users to facilitate Wi-Fi communications.

Moreover Wi-Fi access point information distributed by ANDI enables users to access Wi-Fi communications more conveniently. One of the advantages is a Wi-Fi ON/OFF control function linked with the location information. This function switches on Wi-Fi communications only in the area of a Wi-Fi access point, which results in reduced electricity consumption. Another advantage is the automatic Wi-Fi connection function using the distributed authentication information, which allows users to be free from Wi-Fi connection settings.

Applying the communication control policy specified in the ISRP to applications' communications may solve some issues that Wi-Fi communication possesses. The ISRP communications control policy allows users to select wireless access networks according to different applications or services (**Fig. 1**). For example, some applications such as a VoIP communication service, which may not work with Wi-Fi networks, can continue to communicate via cellular networks. Likewise, it is possible to avoid using Wi-Fi communications during connecting with a security vulnerable Wi-Fi access point when applications communicate with network domains such as credit card companies, shopping sites, etc.

Table Representative information distributed by ANDSF.

Name	Distributed information
ANDI	Wi-Fi access point location and authentication information required for a connection
ISRP	By defining an IP address, an application name and a domain name, this policy may allow users to specify the wireless access network to be used to demand communications. Available policy may be different depending on time, place, or if the access network is to be connected.

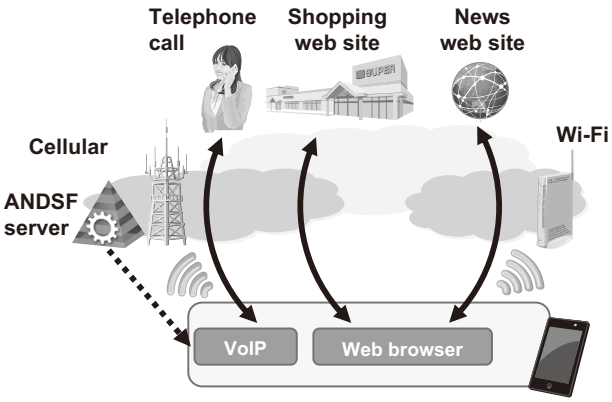


Fig. 1 Different usage scenarios of wireless access networks using ISRP information.

2.2 Issues to Implement ANDSF-compliant Devices

Devices conforming to ISRP allow users to select a suitable wireless access network according to favorable applications or services. However, it is difficult to implement such devices using the conventionally available communications control technologies.

With ISRP, users are allowed to use information such as an application name or a domain name as a communications control policy description. However, with conventional communications control technologies, only the IP address and the port numbers included in the header information are available to process packets (**Fig. 2**). Therefore, in order to employ ISRP as communications control protocol, it is necessary to match information between application names and port names, domain names and IP addresses, and the like.

However, a function capable of centrally matching information is not provided as part of the OS installed in conventional devices. Function blocks with the conventional device are located over various sections. Therefore, in order to employ ISRP communications control standards effectively, it is essential to provide large-scale modifications of the OS function blocks. Even if such drastic modifications are successfully completed, the system will tend to be rather complicated. Therefore, the conventional OS function blocks and the ANDSF policy-compliant engines could be a complicated system in the background linkage (**Fig. 3**).

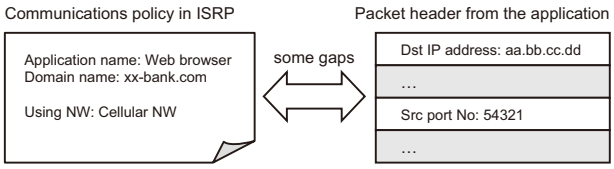


Fig. 2 Differences between the ISRP description type and the packet header.

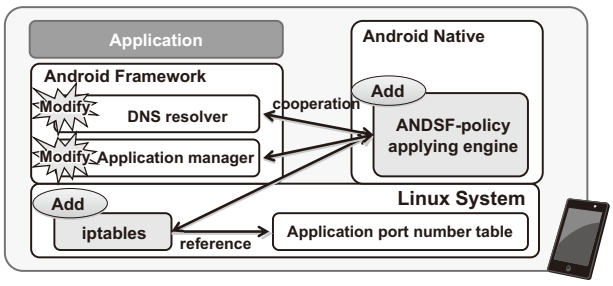


Fig. 3 Example of the conventional communications control technology.

3. Implementation of an ANDSF-Compliant Smart Device Using OpenFlow Technology

By introducing OpenFlow to smart devices, NEC Knowledge Discovery Research Laboratories has developed a technology that enables the ANDSF-compliant ISRP communications protocol to be applied as an application communication function. Being compliant with OpenFlow enables avoidance of modifications to the OS function block as well as separating the ANDSF policy-compliant engine block operation from the other function blocks. This will allow manufacturers to simplify the system configuration (**Fig. 4**).

With OpenFlow, the system is composed of OFC (OpenFlow Controller) and OFS (OpenFlow Switch); OFC centrally controls the communications processing rules, and OFS processes communications procedures according to the commands received from OFC.

When manufacturing an ANDSF-compliant smart device, both of the OFC and the OFS software applications are installed in the device (**Fig. 5**). The communications processing rule based on the ISRP is generated in the OFC in order to conduct communications processing in the OFS. This is the means by which the ISRP-compliant communications control protocol is adapted to perform communications processing between applications.

3.1 Application Layer Communications Identification with OpenFlow

Application layer communication control can be enabled by identifying ISRP policy to match each application session, which is done by communications identification engines implemented in the OFC, who can accommodate complex communications control functionalities (**Fig. 6**). The communications identification engine achieves functions such as corresponding information between domain names and IP addresses, and also those between application names and sender's port numbers.

The functions to be implemented in the communications identification engine can be easily achieved almost without the need to modify functions of the existing OS. This is done by using the advantages of the "packet-in" which is a distinguishing mechanism of OpenFlow and also by using some of the functions that the existing OS already possesses.

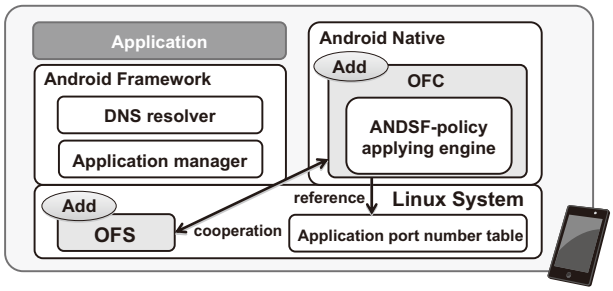


Fig. 4 OpenFlow achievement diagram.

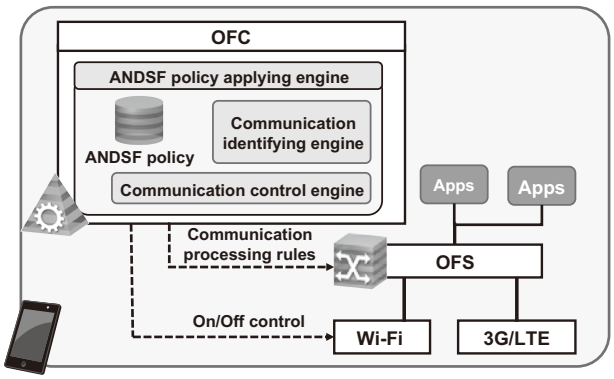


Fig. 5 Prototype architecture configuration using an Android smart phone.

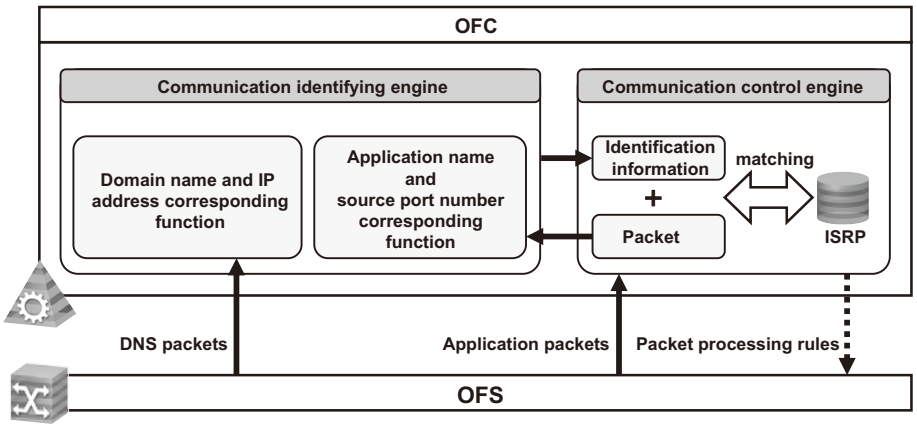


Fig. 6 Advanced layer communications identification compliant with the ISRP communications control policy.

4. Further Applications Using OpenFlow

4.1 Communications Control Using Device Information

By using both the information given by the ANDSF and the device information to control communications processing, it is possible to increase quality of experience more than the case when using only the information given by ANDSF. For example, observing Wi-Fi quality information enables to avoid unexpected communications via Wi-Fi when it is not in a favorable communications mode. However, if such a function has to be achieved using conventional communications technology, a significant OS modification is required in order to expand the functions and this will also require complicated system configurations.

On the other hand, a device employing OpenFlow architecture can achieve the requisite expanded functionality only by modifying the OFC (**Fig. 7**).

4.2 Improvement of ANDSF Policy by Adopting OpenFlow

OpenFlow can be used also for tuning the communications control policy to be described in the ISRP. OpenFlow enables to visualize applications' communication volumes and frequencies. By employing such information, the communications control policy that matches individual application communication characteristics can be described in the ISRP (**Fig. 8**).

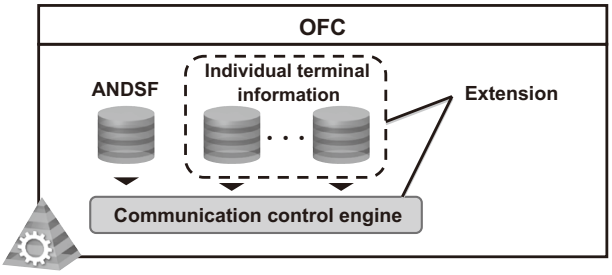


Fig. 7 OFC that achieves advanced communications control.

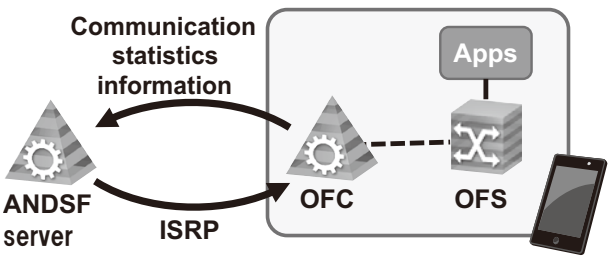


Fig. 8 Improvement of ISRP using OpenFlow.

5. Conclusion

As explained above, OpenFlow provides flexible communication control architecture. This paper has discussed suitable technologies for achieving ANDSF-compliant devices that can enhance the usability of Wi-Fi communications.

NEC Knowledge Discovery Research Laboratories intend to continue R&D into solutions aimed at improving the usability of mobile communications via SDN.

6. Acknowledgement

This work was partly supported by National Institute of Information and Communications Technology (NICT), Japan.

Reference

1) 3GPP TS23.402 - Architecture enhancements for non-3GPP accesses
http://www.3gpp.org/ftp/Specs/html-info/23402.htm
2) 3G PP TS24. 312 - Access Network Discovery and Selection Function (ANDSF) Management Object (MO)
http://www.3gpp.org/ftp/Specs/html-info/24312.htm

Authors' Profiles

IIHOSHI Takahiro
Knowledge Discovery Research Laboratories

SAIDA Yoshinori
Principal Researcher
Knowledge Discovery Research Laboratories

WATANABE Yoshikazu
Assistant Manager
Knowledge Discovery Research Laboratories

MORITA Gen
Knowledge Discovery Research Laboratories

KARINO Shuichi
Principal Researcher
Knowledge Discovery Research Laboratories

Information about the NEC Technical Journal

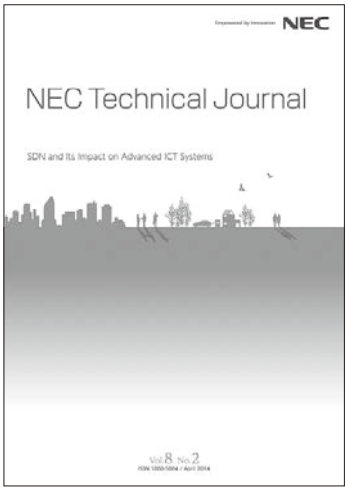
Thank you for reading the paper.
If you are interested in the NEC Technical Journal, you can also read other papers on our website.

Link to NEC Technical Journal website

Japanese

English

Vol.8 No.2 SDN and Its Impact on Advanced ICT Systems



Vol.8 No.2
April, 2014

Special Issue TOP