ネットワーク情報を用いた異種ネットワーク間における ハンドオーバーサポートアーキテクチャ

アブクデース　アマニ[†]　　　相田仁[‡]

東京大学大学院　工学系研究科　電気系工学専攻　　　東京大学大学院　工学系研究科　電気系工学専攻

Abstract

Handover across heterogeneous wireless environments is one of the most challenging issues in the next generation communication systems.
In such systems, the device's knowledge of available network information ahead of time helps in achieving smarter handovers that match the user preferences.
One of the ways to provide network information is through Information Servers as a location-based service. However, in this method the issues of Information Server deployment and management on a global scale have not been tackled in the literature yet.
In this paper we propose a global-scale architecture for Network Information Servers and define mechanisms in which network information should be managed on these servers.

1. Introduction

Future fourth generation (4G) systems are considered to be heterogeneous networks with multiple Radio Access Technologies (RATs) as well as more capable user terminals allowing mobile users to enjoy seamless wireless services [1]. Devices having multiple Network Interface Cards (NIC) with different radio technologies are becoming the norm in today's market. For example a device might have both WiFi and WiMAX NICs.

In such devices, the so called "Vertical Handover" is possible; which means that the device can perform handovers between networks of different RATs. In our example device mentioned above, a handover from a WiFi network to a WiMAX network is possible.

Compared to traditional handovers that are mainly based on the signal levels, vertical handovers are more complex and require taking more parameters and criteria into consideration when deciding the need for handover and selecting the target network.

Moreover, if devices could obtain more detailed information about the networks available in its current location, such as bandwidth, used radio channels and cost, it will be able to perform handovers in shorter time, with less power consumption and obtaining the most suitable network for the user's current situation. It can also detect the need for handovers ahead of time.

The IEEE recent effort in this field, namely the IEEE802.21 standard, suggests the use of servers to provide network information [2]. This method was also employed in [3] and [4]. However, the server discovery and scalability in a global context have not been well addressed yet.

In this paper we argue that network entities providing network information will become an important part of the future network infrastructure and thus a flexible supporting architecture is a stressing need. Accordingly, we propose a framework for Information Server discovery and management on a global scale.

2. The Proposed Architecture

In the proposed network information architecture we define two main entities as shown in figure 1.
1) Top-level Directory (TLD)
2) Regional Information Servers (RISs)

One Regional Information Server contains detailed information about networks in a predefined area. User devices contact these servers to get location-based Network Information. Figure 2 shows example entries in an RIS.

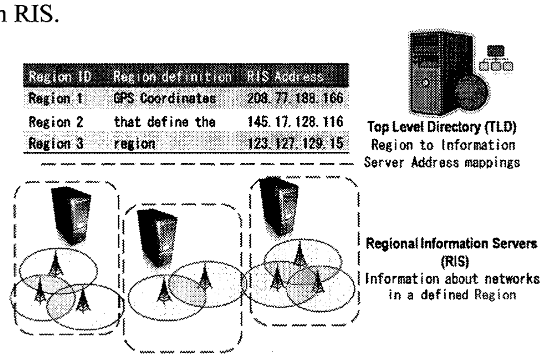

Fig. 1. The proposed Network Information Architecture. RISs contain Network Information. TLDs contain RIS addresses.

A Global Network Information Architecture for Handover Support in Heterogeneous Networks
†ABUQDAIS Amani　‡AIDA Hitoshi
Dept. of Electrical Engineering and Information Systems, Graduate School of Engineering, The University of Tokyo

Network ID	Type	Location coordinates	Coverage radius	Data rate	Channels
1	3G UMTS	35.70043, 139.718628	30 Km	1Mbps	2100MHz
2	WiMAX	34.839356, 138.949585	5Km	2Mbps	30GHz
3	WiMAX	35.771772, 140.180054	2Km	5Mbps	10GHz
4	WiFi	36.21621, 139.32312	100m	11Mbps	6, 11


RIS

Fig. 2. RIS Network Information entries example

Top-level directories are used by user devices to retrieve the address of the RIS responsible for the area where the device currently is. This is important for devices that are highly mobile and move out of the area that is managed by the current RIS. In this case, devices will contact the TLD to obtain the address of the RIS responsible for the new area. Thus, TLDs contain data entries of RISs, their IP addresses and the region they are responsible for.

In addition to Network Information, RISs also include the address of the TLD they belong to. This way, devices will know how to contact the TLD in case they move out of the area of the current RIS.

The merits of such system can be summarized as follows:

1) Devices can retrieve information about different RAT networks by using only one NIC. This greatly saves power because devices do not need to turn all its NICs.
2) After obtaining network information, a decision function can be used to choose the best network for the current situation.
3) Devices that obtained network information can directly perform handover to the new network without the need for performing a scan on all channels, since the obtained information include the operating channels of the different networks. This reduces the time for network discovery.

3. Design using the OMNeT++ simulator

The INET framework of the OMNeT++ simulator was used to build the elements of the proposed architecture, which are:

1) The server applications (for both RIS, TLD)
2) A Handover Support module that controls the NICs and implements a network decision function.

Modifications were also performed on the NICs design to enable them to notify the Handover Support module with current channel information.

A comparison will be performed between two devices. One device is making use of the Information Servers to obtain Network Information. The other device is using the traditional channel scanning method to discover available networks. The parameter settings are shown in Table 1.

Parameter	Value
WLAN max channel time	0.3s
AP Tx Power	30mW
Beacon Interval	100ms
Total number of Available Channels	11
RTT to Information Servers	150ms

Table 1. Simulation Parameter Settings

The time required to connect to the AP and finally associate with it was calculated.

Information Service case	Traditional discovery case
0.453s	2.97s

Table 2. Time required to associate with an AP in the two studied cases

This large difference can be referred to the fact that with information servers, the device already knows the available channels and thus only scans these channels, as opposed to the full scan (of 11 channels) in the other case.

4. Conclusion

Handover across heterogeneous networks can be much more efficient if more network information is provided.

The proposed architecture provided a well-defined framework for any Information Server-based network discovery system that can be applied on a global scale. It was also shown that the ahead of time knowledge of network information can make a large difference in association latency.

References

[1] T. Van Leeuwen et al., "Location assisted fast vertical handover for UMTS/WLAN overlay networks", Computer Communications 29 (2006).

[2] V. Gupta et al., "The IEEE 802.21 Standard : Media Independent Handover Services," IEEE Computer Society (2009).

[3] W.-S. Lim et al. ,"Efficient WLAN Discovery Schemes Based on IEEE802.21 MIH Services in Heterogeneous Wireless Networks", proceedings of GLOBECOM 2008.

[4] W.-T. Chen and Y.-Y. Shu, "Active Application Oriented Vertical Handoff in Next-Generation Wireless Networks," proceedings of IEEE WCNC 2005.