行政院國家科學委員會專題研究計畫　期中進度報告

子計畫四：快速行動擷取網路中之品質服務支援技術研究

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計畫編號：NSC92-2213-E-009-120-
執行期間：92 年 08 月 01 日至 93 年 07 月 31 日
執行單位：國立交通大學資訊工程學系

計畫主持人：陳耀宗

計畫參與人員：詹益禎、沈上翔、張君瑋、柳俊凱、何凱元

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支援下一代無線與 FTTx 擷取之光纖都會網路技術─子計畫四：快速行動擷取網路中之品質服務支援技術研究

QOS Enabling Technology for High Mobility Wireless Network

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「支援下一代無線與 **FTTx** 擷取之光纖都會網路技術」子計畫四

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一、中文摘要

本計畫在研究快速行動性(High mobility)下無線網際網路之品質服務(Quality of Services)技術，以能夠平順地支援無接縫式的即時多媒體串流(Real-time Multimedia Streaming)為目標。 由於傳統IETF所制定之行動IP協定，是針對大範圍且跨不同網域之行動性而設，在低遲滯(Low Latency)之延展性(Scalability) 與效能(Efficiency) 方面不足以應付經常性且小範圍之行動管理需求，因此有不少針對微行動性(Micro mobility) 之協定被提出。這些協定之主要目的在減少訊號處理之負荷(Signaling Overhead) 與降低由交遞(Handoff) 造成之封包延遲(Packet delay) 與封包遺失(Packet loss)。 本計畫所打算解決之問題，除了上述各點之外，將針對快速移動之無線行動環境下之服務品質技術做深入之探討，包括了第三層路由器上訊號封包與資料封包之處理、路由更新(Routing update)訊號協定(Signaling Protocol) 與封包改送 (Packet Forwarding) 機制之設計，以及第二層交換器端在Handoff 過程中針對品質服務提供(QOS Provision) 之處理機制之研究。 除此，本計畫也將與其它子計畫之實體層技術配合，以實際達到一個快速行動性下平順無接縫式之無線行動品質服務。我們將從三方面進行研究：支援快速交遞(Fast Handoff) 之IP路由(Routing)機制設計，包括研究更有效率之訊號協定與支援快速行動性下QOS機制之路由方式研究設計；行動端位置管理(Location Management)，包括如何透過各種訊號方式有效地去偵測、追蹤與更新行動端之正確網路位址，以利封包之傳送；以及快速交遞之支援，包括快速行動性下之交遞特性研究，與因應之訊號交換架構設計以達到最小化遲滯與封包遺失之快速交遞。在這三方面除了考慮品質服務之基本需求外我們也會將延展性(Scalability) 與系統效能Performance 列入研究重點。在計畫中，我們一開始將會研究現行各種Micro mobility協定之優缺點並透過模擬系統做比較，而後提出研究改進後之方法。 我們將利用不同性質之訊務做品質服務模擬測試。 針對UDP訊務，我們將著重交遞過程中，封包延遲與封包遺失之最小化；而針對TCP訊務，我們希望能做到交遞過程中，流通率(Throughput) 能夠不受影響。而後我們會將所提之方法實現在網路設備與行動端上，以建立一品質服務無線網際網路平台，並導入實際之多媒體串流訊務做Real World 之測試。 我們也將研究不同無線擷取技術之間之交遞方式，並與其他子計畫做垂直技術整合。

關鍵詞：快速行動性，無線網際網路，品質服務，即時多媒體串流，微行動性，快速交遞。

二、英文摘要

This proposal is for the investigation of QOS enabling technology under a high mobility wireless environment, it targets at smoothly supporting the seamless real-time multimedia streaming. Since the traditional Mobile IP protocol defined by IETF is focusing on a large scale and inter-domain mobility, its performance regarding the scalability of low latency and efficiency is insufficient to fulfill the requirement of managing the frequent and small scale mobility, called micro mobility, therefore many protocols focusing on micro mobility have been proposed. These protocols aim at reducing the signaling overhead as well as minimizing the packet delay as well as packet loss caused by the fast handoff. In addition to these problems mentioned above, other issues to be solved in this project include the investigation of QOS-provisioning under high mobility environment, this involves the layer 3 packet processing for both signaling messages and data

packets, signaling protocols for routing update, design of packet forwarding mechanism for fast handoff, and study of layer 2 mechanisms on switches regarding QOS related schemes under handoff. Further, we will cooperate with other subproject to work on the physical layer issues such as to achieve smooth and seamless QOS-enabled wireless mobile services. The project will be performed with three objectives: First, the design of IP routing mechanism to support fast handoff, this includes the investigation of a more efficient signaling protocol and QOS-capable mechanism inside routing equipments; second, location management of mobile hosts, this includes how to use various signaling messages to effectively detect, track and update the IP address of a mobile host precisely, so that packets can be forwarded efficiently and correctly during fast handoff period; and third, handling of the fast handoff, this includes the investigation of handoff characteristics under high mobility, and the corresponding signaling exchange infrastructure so that latency and packet loss can be minimized during the handoff. We will also consider both scalability and performance issues in addition to the three objectives described above. We will start from the study of existed micro mobility protocols, then we will compare their pros and cons through system simulation and propose either a new or an improved approach. We will perform the simulation regarding the QOS evaluation using data traffic with different characteristics. For UDP traffic, we will focus on the minimization of packet delay and packet loss during fast handoff; while for TCP traffic, we will emphasize on the stable throughput during the handoff under high mobility. We will then realize our proposed approach on the network equipment and mobile devices, so that we could build a QOS-enabled wireless Internet platform, on which the real-time multimedia streaming traffic could be added on for the experiment and system evaluation. We will also investigate the fast handoff protocols between various wireless access technologies, and make vertical technology integration with other subjects.

Keywords: High mobility, wireless Internet, Quality of Services, Real-time multimedia streaming, micro mobility, fast handoff.

三、計畫緣由與目的

The ever-growing demand for Internet bandwidth and recent advances in optical Wavelength Division Multiplexing (WDM) and wireless technologies brings about fundamental changes in the design and implementation of the next generation networks. To support end-to-end data transport, there are three types of networks: wide-area long-haul backbone network, metropolitan core network, and local and access networks. First, due to steady traffic resulting from high degree of multiplexing, next-generation long-haul networks are based on the Optical Circuit Switching (OCS) technology by simply making relatively static WDM channel utilization. Second, a metropolitan core network behaves as transitional bandwidth distributors between the optical Internet and access networks. Unlike long-haul backbone networks, metro networks exhibit highly dynamic traffic demand, rendering static WDM channel utilization completely infeasible. Finally, access networks are responsible for providing bandwidth directly to end-users. Two most promising technologies have been optical access and wireless access networks, respectively. Due to superior performance of fiber optics and tremendous bandwidth demand, providing broadband access and services through optical access technology becomes indispensable. Finally, regarding wireless access networks, the new demand of wireless communications in recent years inspires a quick advance in wireless transmission technology. Technology blossoms in both high-mobility low-bit-rate and low-mobility high-bit-rate transmissions. Apparently, the next challenge in wireless communications would be to reach high transmission rate under high mobility.

The main objective of this subproject is the provision of QoS guarantees over wireless access networks. By investigating the QOS enabling technology under a high mobility wireless environment, we attempt to smoothly support the seamless real-time multimedia streaming.

四、研究方法與成果

The subproject is performed with three directions: first, the design of IP routing mechanism to support fast handoff; second, location management of mobile hosts; and third, handling of the fast handover. In this year, we develop a new handover scheme named "speedy handover" to enhance the performance of wireless handover. The proposed scheme makes use of IEEE 802.11 [2] RTS/CTS exchanging messages to quickly detect the movement of mobile nodes. It can improve the performance of traffic transmission during the handover period.

During handover period, packets for the mobile node maybe lost in its old foreign agent (FA), because it will attach to another new FA and has detached from the old one. We want to keep these packets and forward them to the mobile node. However, when to buffer and to forward packets are critical issues.

In our scheme, we use RTS/CTS messages exchange between FA and the mobile node to detect if the mobile node still attaches to the FA or not. The RTS/CTS messages exchange is an important method for solving hidden terminal problem in IEEE 802.11. When a FA wants to send a data packet to a mobile node, it sends a RTS message. Upon receiving a CTS message from the mobile node, the FA starts to send data packets. Since RTS/CTS messages are short, high frequent transmitted, and less affected by random loss, thus we can use them to detect the mobile node movement.

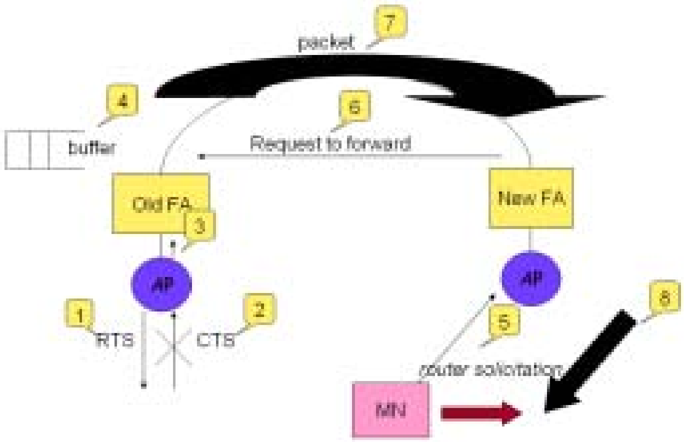

Fig. 1: Messages flow of speedy handover scheme.

The proposed speedy handover mechanism can be briefly described by Fig. 1. When a FA have send RTS for three times but not being responded by the mobile node, we can infer that the mobile node has left. It is a good time point to start buffering the packets for the mobile node. Steps 1 and 2 show the AP (access point) of the old FA sends RTS three times and no CTS responded by the mobile node. Then the AP sends a specific message to the old FA to request the FA to buffer packets for the mobile node as depicted in steps 3 and 4.

When the mobile node gets the beacon from the new AP, it delivers "router solicitation" messages. The message informs the new FA that a new mobile node has arrived as shown in step 5. Then the new FA sends "request to forward" message to old FA as soon as the routing table to mobile node is updated as shown in step 6. Finally, in steps 7 and 8, the old FA forwards packets to the mobile node through the new FA.

Speedy handover needs a simple modification on a mobile node. Because the mobile node wants the new FA to send the "request to forward" message to the old FA, thus the new FA must know where the mobile node comes from. Therefore the old care of address of the mobile node will be added in router solicitation messages.

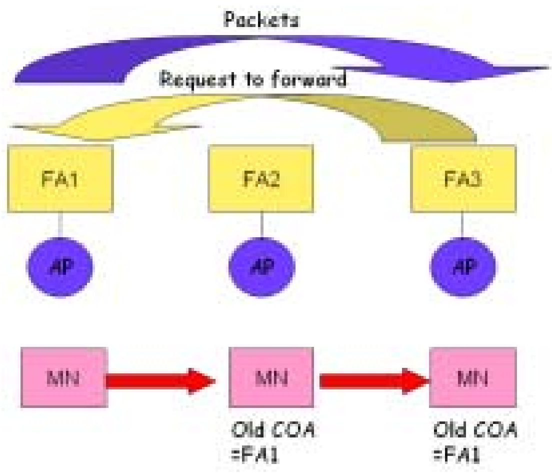

Fig. 2: Fast movement of a mobile node (scenario 1).

Speedy handover can still work when the mobile node moves fast. As shown in Fig. 2, the mobile node leaves the FA2 very quickly before router solicitation is send. After the mobile node reaches the FA3, the old COA (care of address) record in it is the IP of the

FA1. Therefore, the FA3 will send "request to forward" message to the FA1. Since the mobile node does not complete the handover to the FA2, so packets for the mobile node are still sent to the FA1 before handover to the FA3 finish. FA1 keeps packets for the mobile node and then forwards them to the FA3.

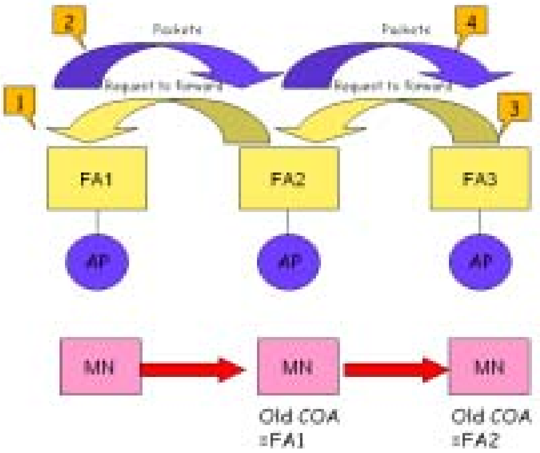

Fig. 3: Fast movement of a mobile node (scenario 2)

Another fast movement scenario is depicted in Fig. 3, the mobile node leaves the FA2 after router solicitation is send but before the handover finishes. Because of the router solicitation, packets for the mobile node are forwarded to the FA2 from the FA1. After the mobile node reaches the FA3, the FA3 send "request to forward" message to the FA2. Therefore packets for the mobile node are forwarded from the FA1 to the FA2 and then from the FA2 to the FA3. The mobile node can receive the packets successfully.

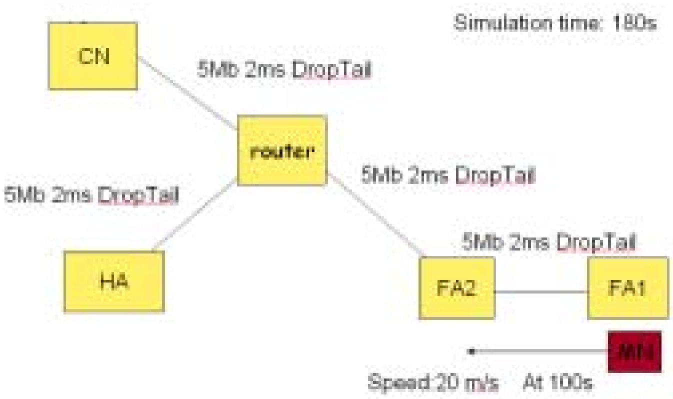

Fig. 4: Network topology for simulations.

We evaluate the proposed scheme with network simulator ns2 [5] and the simulation network topology is shown in Fig. 4. The performance of mobile node during handover period is what we want to know. There are one mobile node (MN), one corresponding node (CN), two foreign agents (FA), and one home agent (HA) in the simulation network. The communication range of all nodes with wireless interface is 550 m. The distance between FA1 and FA2 is 856 m and the overlap of communication range is about 244 m. The simulation starts at 0 second and ends at 180 second. An UDP sender (CN) starts to send packets at 100 second until the end of simulation and the mobile node begins to move from the FA1 to the FA2 at the same time with speed 20 m/s. The packet size is 1000 bytes and sending rate is 1 Mb/s. We give each packet a sequence number. By checking the packet sequence numbers we can observe that which packet is received by the mobile node and which packet is lost. We compare the performance between the original structure and speedy handover.

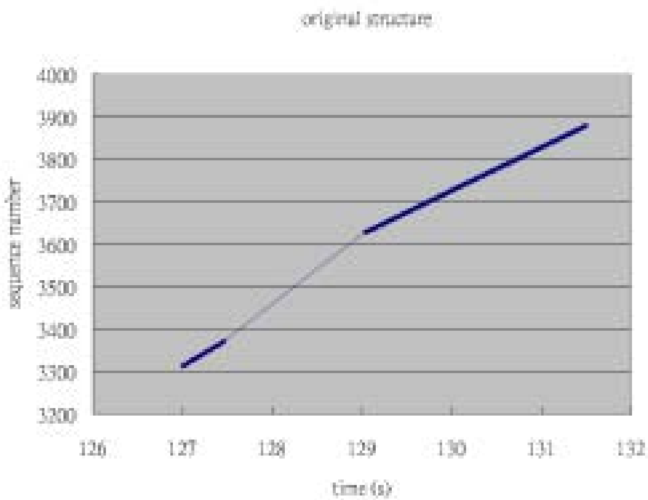

Fig. 5: Sequence number of packets that the mobile node receives with original structure.

The handover begins at about 127.46 second, so we show the result from 127 second to 131.5 second. As shown in Fig. 5, the mobile node can not receive any packets from the UDP sender (CN) during the handover period. Packets are lost because no body buffers and forwards them for the mobile node. Obviously the packet loss rate is very high.

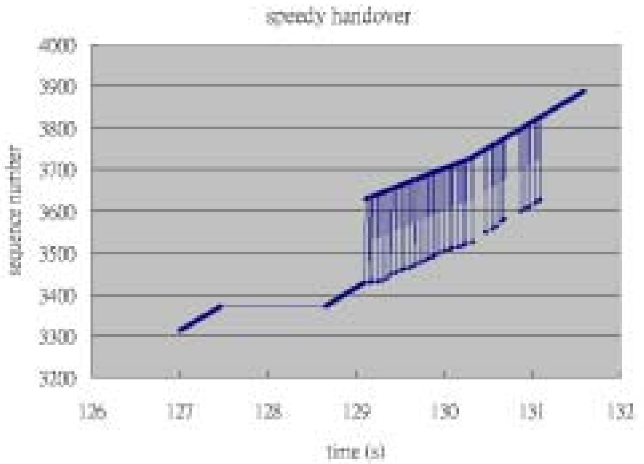

Fig. 6: Sequence numbers of packets that the mobile node receives with speedy handover.

Figure 6 depicts the performance when the speedy handover mechanism is used. The old FA buffers the packets during handover period and forwards them as soon as the new FA knows how to deliver the packets to the mobile node. The mobile node can receive the packets before handover procedure finishes. The handover procedure is complete at about 129.15 second and the mobile receives forwarded packets at about 128.66 second, so we shorten the time that the mobile node can not receive any packets. After handover procedure finish the new packets stream toward the mobile node make the packets out of order. It is the cause of the wavy line in Fig. 6.

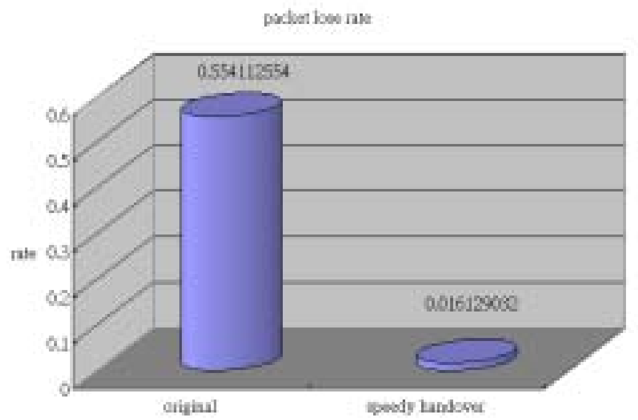

Fig. 7: Packet lose rate between handover start to forward finish.

By observing the Fig. 7, we can find that the packet loss rate for speedy handover is much lower than that of original structure. The packet loss rates are 55.41% and 1.61% for the original structure and speedy handover respectively. For a multimedia service, low packet loss rate is an important condition for smooth quality.

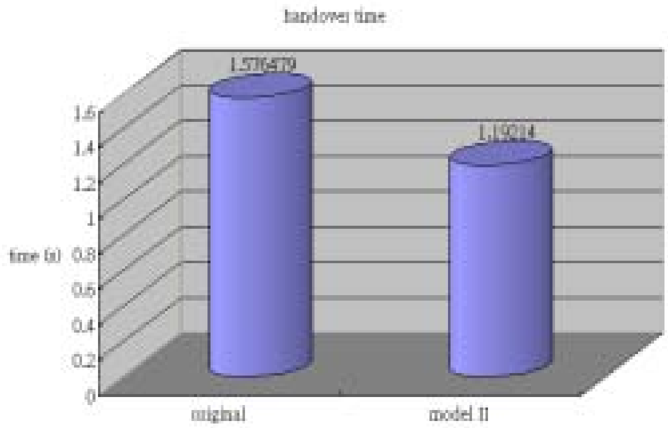

Fig. 8: Handover time.

Figure 8 shows the time from the start of handover to end of period that the mobile node can not receive any packets. It is clear that speedy handover can shorten the time.

In short, comparing with the original mobile IP mechanism, speedy handover features a fewer number of packet losses and a shorter handover period. The simulation results demonstrate the effectiveness of the proposed scheme.

五、結論與討論

The speedy handover mechanism is proposed to meet one of the objectives of this subproject. It can enhance the performance of wireless handover. Different from the famous fast handover scheme that a mobile node must discover the movement by itself, an access point take charge of detecting the movements of mobile nodes in speedy handover mechanism. As a result, the proposed scheme can work no matter the radio covering area of the two neighbored FAs are overlapped or not. We are planning to refine the speedy handover further and submit it to an international conference.

In the second year of this subproject, we will develop a scheme for location management of mobile hosts. Load balance and QoS provision in wireless access networks will be the targets of our new scheme.

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