A Novel Tactic for the Micro-mobility Management

YING-HONG WANG, HUI-MIN HUANG and CHENG-CHE LIN
Department of Computer Science and Information Engineering
Tamkang University
No.151, Ying-chuan Road, Tamsui, Taipei County 25137
TAIWIN

Abstract: This study refers to EVOLUTE (a project of Information Society Technologies (IST)) that combines Session Initiation Protocol (SIP) with Mobile IP (MIP) to support macro-mobility management and provides seamless multimedia services for roaming users. Moreover, this study utilizes Multicast-based Mobility (M&M) to assist Cellular IP (CIP) in micro-mobility management. The aim of this work is to generate a complete integration of heterogeneous network to support fine-fit mobility management for seamless handoff. Simulation results demonstrate that the proposed system achieves good performance. The proposed system also satisfies the demand for multimedia services. We conclude that the proposed system facilitates further development of wireless communication networks.

Key-words: micro-mobility; integrate heterogeneous network; M&M; EVOLUTE; 4G; hybrid system;

1 Introduction

The transfer from voice communication to video communication must be based on inherent technology and economic benefits. Thus, these following four points must be considered [1]:

1. Terminal mobility, session mobility, service mobility and personal mobility must be supported by mobile communication systems. Furthermore, mobility must be available among heterogeneous networks, such as Universal Mobile Telecommunication System (UMT S), Wireless LAN (WLAN), and even fixed networks.
2. Integration of authentication, authorization and accounting (AAA) mechanisms is necessary, because such integration will maintain required quality of service (QoS) and standardize user bills.
3. Flexible and powerful service architectures will be features of next-generation networks. Next-generation networks will require higher bandwidth rates and a winder range of services than current network.
4. Mobile users need good mobility management to achieve the objective that anyone could connect to Internet to do anything at anyplace by any way at anytime. In other words, mobility management architecture must provide mobile users with a seamless handoff that is efficient and convenient.

Information Society Technologies (IST) developed the EVOLUTE project. The project achieved the first three aspects mentioned above. However, the fourth aspect, providing mobile users with seamless handoff capability, is lacking in EVOLUTE. The project chose Cellular IP (CIP) [2] to support micro-mobility management in their mobile communication network.

This work presents a novel approach that Multicast-based mobility (M&M) facilitates CIP to support micro-mobility management. This architecture offers satisfactory multi- media service with seamless handoff to mobile users.

The remainder of this paper is organized as follows. Section 2 introduces some technologies related to this work. Section 3 presents a discussion of operation tactics of cooperative CIP/M&M. Section 4 presents simulation results. Section 5 gives conclusions.

2 Related Technologies

2.1 SIP/MIP combined for macro-mobility management in EVOLUTE

This section introduces the approach of macro-mobility management in EVOLUTE [2]. EVOLUTE proposed macro-mobility management which is mobility across administrative domains, is based on a combination of SIP and MIP. Routers in the domain edge separate traffic from/toward a MH; therefore, SIP signaling supports real-time traffic, and MIP supports non-real-time traffic, as shown in Figure 1 [2].

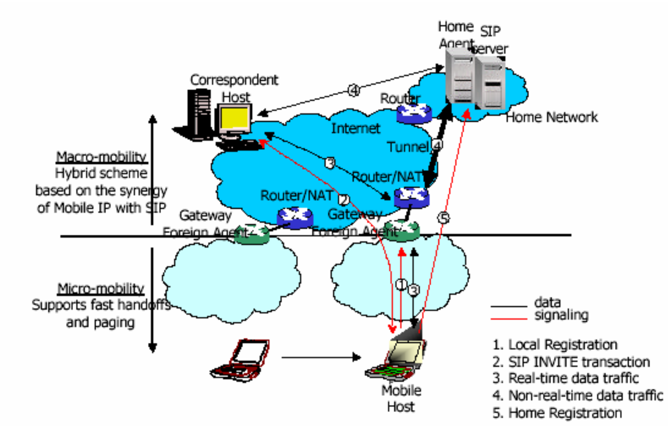

Fig. 1: Combine SIP and MIP for macro-mobility management in EVOLUTE

Both MIP and SIP can be complementary; however, they are unsuited to handling micro-mobility. High mobility within a single domain or Intranet is common; therefore, the MH must be allowed to move freely among wireless access points (APs) or base stations (BSs). The solution of the move freely can make the movement without informing the distant HA, redirecting services in every movement, and offering idle movement to maintain connections. Multiple standard options will likely be available in the future. Current research investigating micro-mobility management protocols, includes Hierarchical MIP (HMIP), HAWAII, and CIP [3−4]. This work refers a novel architecture, Multicast-based Mobility (M&M), that increases the efficiency of micro-mobility management. The CIP infrastructural is utilized to assist the M&M mechanism in providing IP paging, soft handoff, QoS, and context transfer capabilities.

2.2 Multicast-based Mobility (M&M)

Notably, M&M [5] proposes a multicast-based paradigm for micro-mobility management. While a visiting MH moves within a domain, it is assigned a unicast CoA that is unique within this domain. The unicast CoA is called Regional CoA (RCoA), and MH is also assigned a Multicast CoA (MCoA).

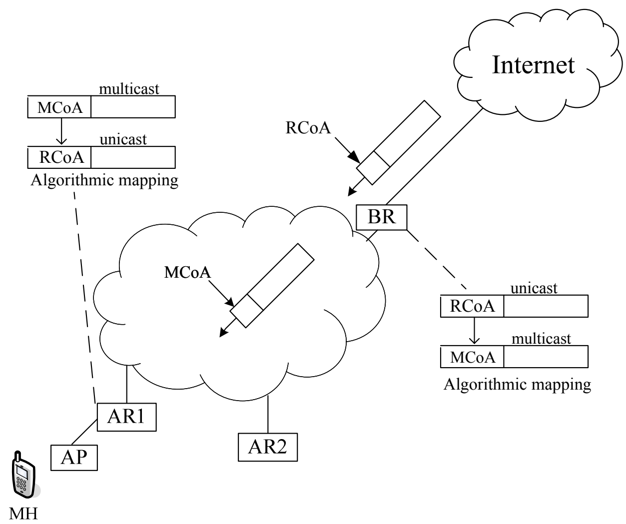

Fig. 2: Data packet flows in the M&M architecture

Figure 2 [5] shows the transition between RCoA and MCoA. When an MH moves to a new foreign domain, it achieves inter-domain handoff. Inter-domain handoff includes automatic registration of RCoA to the MH's HA, and the algorithmic derivation of the MCoA through the assigned RCoA. The AR triggers a Join message (J-message) to establish a multicast tree for each MCoA. Packets are sent to the MH's HA by home address, and are then tunneled to the foreign domain and received by BR in RCoA. The BR derives the MCoA from the RCoA and transmits these packets to the multicast tree of the MH. The Serving AR (SAR), which is the AR to which MH belongs, switches the MCoA to the RCoA and sends these packets to the AP to which

MH belongs. The SAR transforms the MCoA into the RCoA; consequently, these packets do not need a secure mechanism between multicast mechanism and the MH.

The adjacent radio coverage areas are based on areas adjacent to the SAR in the M&M mechanism. The SAR is called the head of the Candidate Access Router Set (CAR-set). Membership in the CAR-set is identified by a number of factors, such as the handoff type, movement direction, and predictable location. This procedure is called the CAR-set prediction algorithm. Other specific explanations are provided in [4].

One main contribution of the M&M is the handoff framework. Applying the CAR-set effectively completes proactive and reactive handoff. The M&M system obviously surpasses CIP and HAWAII, because of the capability of the CAR-set path setup.

Although the M&M system has outstanding performance for decreasing handoff interruptions, it increases overhead in packet replication between the BR and AR that belong to the CAR-set. From a network perspective, numerous packets are duplicated, even when the packet duplicated is useless to the MH. To meet customer requirement of communicatory quality, the multicast mechanism is not used in some cases. General telecommunications is a typical application that utilizes a simple micro-mobility management to obtain acceptable communication quality; moreover, the CIP does not costly deal with packets. Cooperative CIP/M&M generates a superior micro-mobility management method as the cooperation of SIP and MIP for macro-mobility management method.

3 The Cooperative CIP/M&M for micro-mobility management

3.1 Methods of the Cooperative CIP/M&M

There are two methods of combining CIP with M&M for micro-mobility management—CIP and M&M replacement and cooperation. One method is that CIP function first, all packets transform to M&M standardization when the MH requires real-time packets; this method is named the replaceable CIP/M&M. The postponed transmitting and wasted bandwidth are predictable. Additionally, system transmission will change and complicate the way of bill calculating; consequently this method was abandoned.

The second method is to take CIP as a basic protocol for micro-mobility management. When real-time traffic trigger the M&M mechanism, the CIP deals with the routes of non-real-time traffic, and the M&M is employed to route real-time traffic. Figure 3 shows the two data flows—real-time and non-real-time. There are two Correspond Node (CN1 and CN2) communicate with the MH simultaneously. Node CN1 requires non-real-time service, and CN2 requires real-time service; consequently, communication is divided into two parts. One part is macro-mobility management, and the real-time packet is routed by SIP, and the non-real-time packet is routed by MIP. Another part is micro-mobility management, and the real-time packet is routed by the M&M, and the non-real-time packet is routed by CIP.

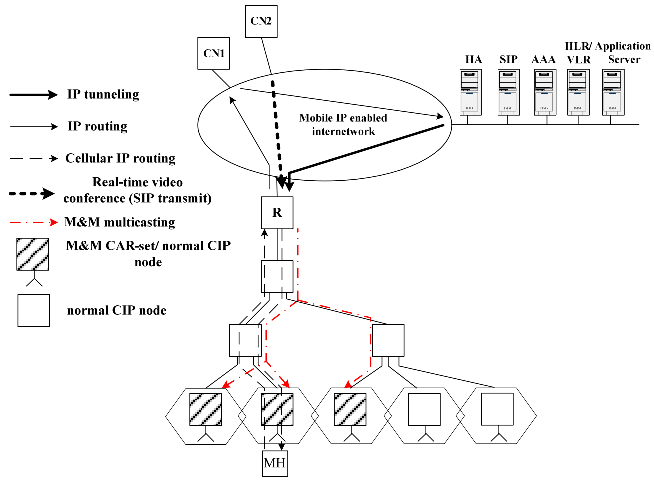

Fig. 3: Overview of the CIP/M&M cooperation policy

Let the packet use the proper route protocol, according to demanded type by the MH, the proposed system then establishes a Routing Information Table (RIT) (such as Table 1). The RIT-BR (similar to Table

1(a)) is maintained by BR and RIT-SAR (similar to Table 1(b)) is maintained by SAR. The tables take the minutes when the M&M protocol is completed. The most important part of Table 1(a) is the client specific information. The client specific information function is used between a user and service provider to distinguish incoming packets that need the M&M or CIP. In Table 1(b), the packets transmitted by M&M to MH are transformed from a MCoA to a RCoA.

Table 1: The RIT in cooperative CIP/M&M

(a) The table in BR or FA

The address information of MH	How many applications should be transmitted by M&M now	The total time of performing M&M application	The client specific application need transmitting by M&M
MH's RCoA	2	00:20:45	e.g.1.UDP connection 2.viedo conference
MH's MCoA			

(b) The table in SAR and other ARs in the same CAR-set

The address information of MH	How many applications should be transmitted by M&M now	The total time of performing M&M application
MH's RCoA	2	00:20:45
MH's MCoA		

Additionally, M&M does not work all the time in the proposed architecture. For each user, the system always adopts the CIP to offer the packet a route, except the MH requests real-time services. It is means that the overhead caused by M&M is temporary.

Comparing replacement with cooperation of CIP/M&M, there are two advantages of cooperation. One advantage is that the charging system is simple, because adopting M&M does not change the transmitted form of the original request. Another advantage is the decrease of wasted resources, as the request only obtains adequate QoS. Therefore, we recommend using cooperative CIP/M&M.

3.2 Handoff in cooperative CIP/M&M

Another important issue in micro-mobility management is how CIP/M&M handoff when working simultaneously. When the MH detects signal weakness from the old BS, and the signal strength from a new BS, the MH will request a handoff. The handoff mechanism of the CIP will always work properly because the MH will connect with an AP through the CIP regardless of whether the MH is idle or active. Additionally, the real-time request of the MH will trigger the M&M handoff. Through the specific triggering [5], the M&M will initiate the CAR-set predication algorithm to predict members of the CAR-set.

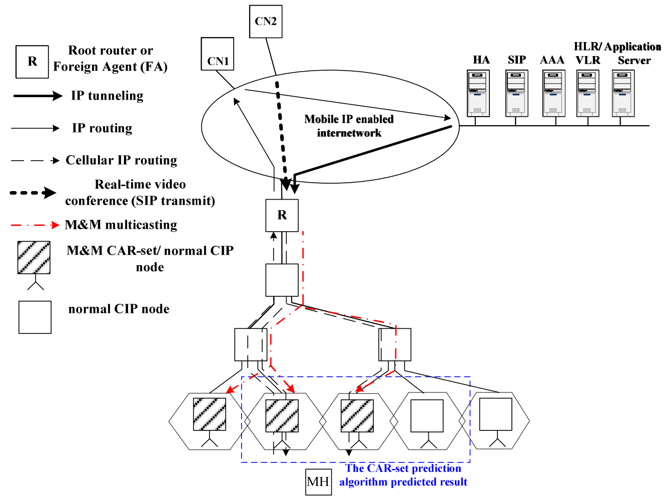

Fig. 4(a): Data flows during a handoff

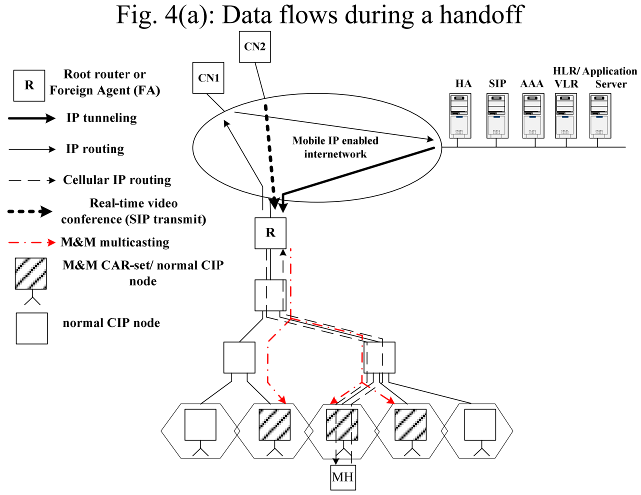

Fig. 4(b): Data flows after a handoff

To simplify description, this work only describes the proactive handoff. Figure 3 shows the packet routes before a handoff. Figure 4(a) shows the packet routes in the period of handoff. Real-time packets have been sent to the MH's CAR-set according to M&M protocol. Non-real-time packets have been sent to the old and new BS, according to CIP protocol. Figure 4(b) shows the packet routes after a successful handoff.

This work adopts a new idea of cooperative CIP/M&M to support micro-mobility management for mobile users in the 4G network. The proposed system will offer many types of services and meet the needs of MH when dealing with special handoff. Furthermore, the proposed system will become a popular micro-mobility management scheme, because it is much better than other single work protocols.

4 Simulation

4.1 Simulation parameters

With cooperative CIP/M&M tactic, the simulation is conducted in C++. The simulation parameters are as follows (Refer to the simulations in [6-9]). There are 5−20 MHs that randomly propose 1−3 real-time or non-real-time requests. The real-time requests get bandwidth first and are serviced by M&M, whereas non-real-time requests are serviced by CIP. The real-time requests randomly ask for sufficient bandwidth between 144−384 K/b, whereas sufficient bandwidth of non-real-time requests is between 4.75−12.2 K/b.

4.2 Simulation results

Requests are refused when there is insufficient bandwidth. The proposed system and some single micro-mobility management systems are compared by observing the rate of achieved requests and the rate of used bandwidth.

Figure 5 shows the rate of achieved request in one BS (or AP). The effectiveness of cooperative CIP/M&M decreases when the number of MH is >16, because the intention of micro-cell is office or coffee bar [10].

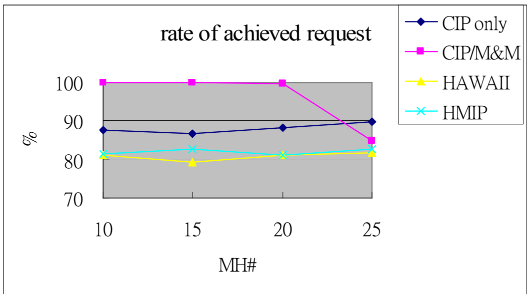

Fig. 5(a): Rate of achieved requests when real-time: non-real-time ration is 1:9

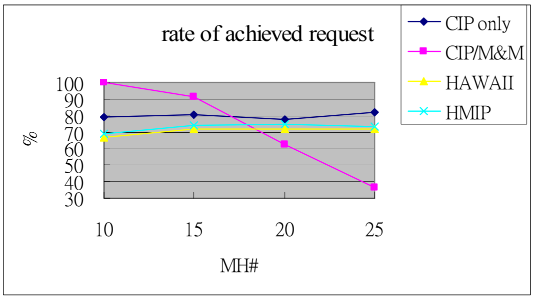

Fig. 5 (b): Rate of achieved requests when real-time: non-real-time ration is 2:8

Figure 6 compares the rates of used bandwidth. The simulation results reveal that the proposed system meets current demands, and that the cooperative CIP/M&M uses the bandwidth effectively even when the number of MHs is low.

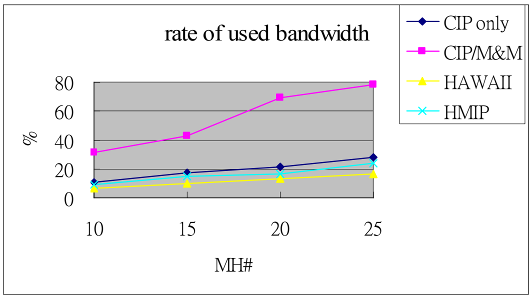

Fig. 6(a): Rate of used bandwidth when real-time: non-real-time ratio is 1:9

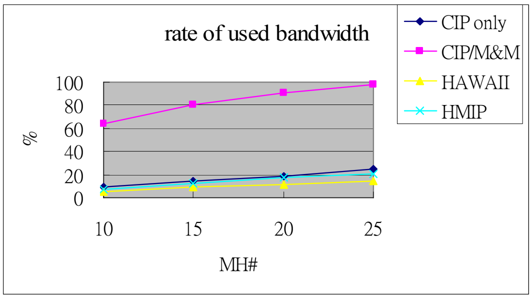

Fig. 6(b): Rate of used bandwidth when real-time: non-real-time ratio is 2:8

4.3 CIP/M&M system's great future

The proportion of high QoS services to total services will increase from 10%−20% to >90%, and the proportion of voice services decreases gradually [11]. According to the increase in proportion of high QoS services, this work simulated a system for future needs. In Section 4.2, the system work best when the number of MHs is 15 (fig. 5(b) and fig. 6(b)). Consequently, 15 is adopted as the number of MHs for predicting sufficient bandwidth when high QoS service is increased further. The other parameters are as the same as those in Section 4.1.

The system has the highest rate of achieved requests and rate of used bandwidth, when bandwidth is 4M and the proportion of high QoS services is 40% (fig. 7). The bandwidth must be 10M, when the proportion of high QoS services is 90%.

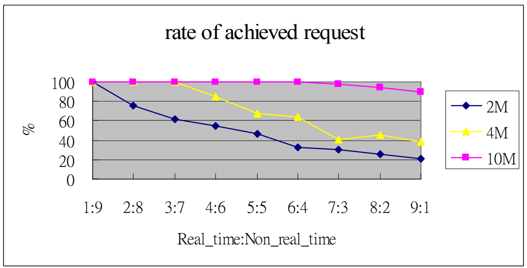

Fig. 7(a): Rate of achieved requests when MH# is 15

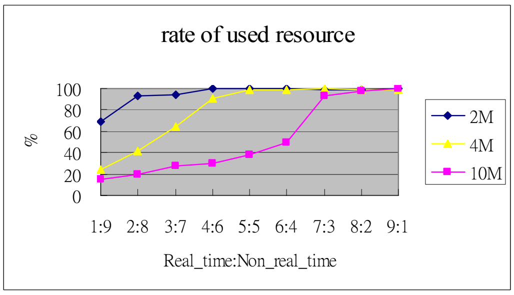

Fig. 7(b): Rate of used bandwidth when MH# is 15

5 Conclusion

This study adopted M&M to facilitate CIP in micro-mobility management. Macro-mobility management is operated by the cooperation of SIP and MIP in EVOLUTE. The proposed network architecture has several benefits. The primary contribution of this network architecture is that it supports mobility management in the integration of heterogeneous network in future. The M&M can easily cooperate with other micro-mobility management schemes thereby providing network providers with flexible space to set up their own services. According to simulation results, the proposed system meets future demands and effectively uses available bandwidth.

Reference:

[1] Tasos Dagiuklas, Dionisios Gatzounas, Dimitris Theofilatos, Dorgham Sisalem, Stefan Rupp, Ross Velentzas, Rahim Tafazolli, Christos Politis, Sara Grilli and Antonis Marinidis, "Seamless Multimedia Services Over All-IP Based Infrastructures: The EVOLUTE Approach", IST Mobile and Wireless Telecommunications Summit, Thessaloniki, Greece, June 16-19th 2002

[2] Tasos Dagiuklas, Dionisios Gatzounas, Dimitris Theofilatos, Dorgham Sisalem, Yacine Rebahi, Sara Grilli, Glauco Bigini, Ross Velentzas, Antonis Marinidis, George Thanos, Stefan Rupp, Matthias Duspiva, and etc., "EVOLUTE, IST-2001-32449 D2.1 EVOLUTE Architecture Specification"

[3] Pierre Reinbold and Olivier Bonaventure (2003), "IP micro-mobility protocols", http://citeseer.ist.psu.edu/reinbold03ip.html

[4] Fabio M. Chiussi, Denis A. Khotimsky and Santosh Krishnan, "A Network Architecture for MPLS-Based Micro-Mobility", Wireless Communications and Networking Conference, 2002. WCNC2002. 2002 IEEE, March 17-21 2002, Vol. 2, pp.549 - 555

[5] Ahmed Helmy, Muhammad Jaseemuddin and Ganesha Bhaskara, "Multicast-based Mobility: A Novel Architecture for Efficient Micro-Mobility", http://citeseer.ist.psu.edu/597177.html

[6] Gang Wu, Mitsuhiko Mizuno and Paul J. M., "MIRAI Architecture for Heterogeneous Network", IEEE Communication Management, February 2002, Vol. 40, No. 2, pp.126-134

[7] Harri Holma, Juan Melero, Janne Vainio, Timo Halonen and Jari Mäkinen, "Performance of Adaptive Multirate (AMR) Voice in GSM and WCDMA", Vehicular Technology Conference, 2003. VTC 2003-Spring. The 57th IEEE Semiannual , April 22-25 2003, Vol. 4, pp.2177 -2181

[8] Phil Jones and Ray Owen, "Sensitivity of UMTS FDD System Capacity and Coverage to Model Parameters**",** 3G Mobile Communication Technologies, 2000. First International Conference on (IEE Conf. Publ. No. 471)**,** March 27-29 2000, pp.224-229

[9] Shin Horng Wang, "7.68Mcps TDD option: RF transmission/reception, System performance reguirements and conformance testing", TR 25.829 release 7, http://www.3gpp.org/ftp/specs/html-info/25829.htm

[10] Harri Holma and Antti Toskala, "WCDMA for UMTS Radio Access For Third Generation Mobile Communications" Second Edition, JOHN WILEY & SONS, LTD, 2002

[11] Xiao-Hu Yu, Guoan Chen, Ming Chen and Xiqi Gao, "Toward Beyond 3G: The FuTURE Project in China", IEEE Communication Management, January 2005, Vol. 43, No. 1, pp.70-75