Location Management and Multimedia Communication Service Based on Mobile IP and Cellular IP Network

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Abstract

Wireless communication that provides voice only is not sufficient to support the necessity of user. It is an important feature of future wireless communication to offer this capability through mobile Internet. Mobile IP allows mobile hosts to change their location and reduce the losing probability of data packets in wireless communication networks. However, Mobile IP still have some defects in handoff and route aspects. Therefore, Cellular IP protocol is proposed for routing of IP diagrams to mobile stations and fast handoff control in a limited geographical area. In this paper, a handoff method is proposed to improve Quality of Service and resource switching management to reduce data packet loss for mobile multimedia communication in hierarchical network. In the future, all-IP network and mobile multimedia communication are two important characteristics, so that IP macromobility and micromobility network architecture are combined for data packets transfer. A Soft-handoff method is also presented to improve Quality of Service (QoS) and resource switching management to reduce data packet loss.

1. Introduction

The major objective of this paper is to propose multi-tier wireless communication architecture based on Mobile IP and Cellular IP to support the service requirements of mobile Internet and mobile multimedia communication. Based on this architecture, there are some issues of research will be executed. How to satisfy the users' requirement for mobile Internet through wireless communication? In the proposed architecture, the overhead of system management is decreased and the total effectiveness is improved. Furthermore, the handoff and location management methods are presented to improve Quality of Service. By the way, resource-switching management is introduced to reduce data packet loss.

This paper is organized as follows: next section introduces the background of related technologies and the overviews of Mobile IP and Cellular IP network architectures, two of the most important techniques for providing the multimedia services over mobile communication. In section 3, the handoff and location management progresses are presented in the proposed network architecture. Section 4 describes the proposed multi-tier architecture based on Cellular IP and Mobile IP network. At last, conclusions and future works are drawn.

2. Related Technologies

Mobile Internet architecture is considered including an overlap hierarchical framework [1][2]. Each framework has its individual feature, i.e. satellite, macro-cell, micro-cell and pico-cell area. Such that, by applying this framework, we can support different transfer rates between mobile nodes and distinct geographical areas.

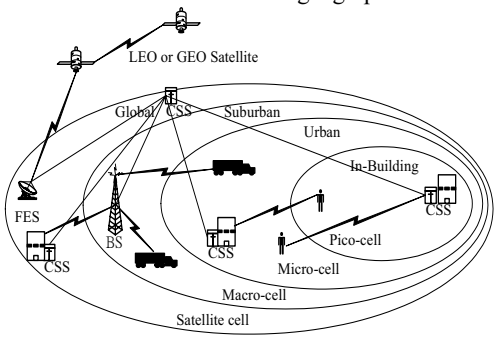

Figure2.1 Multi-tier Cellular Architecture

Mobile IP [3][4]was optimized for macromobility and relatively slow-moving MNs.

Cellular IP [5][6] represents a new mobile node protocol that is optimized to provide access a mobile IP enabled Internet in support of fast moving wireless

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nodes. It can offer fast handoff, less delay, a few or even no packet loss between base stations.

3. Location Management and Handoff Strategy

3.1. Location Management

The basic conception of this paper focuses on multi-tier architecture constructed as macro-tier and micro-tier. Figure 3.1 illustrates the way of data transmission on the proposed communication architecture. In which, *A*, *B*, *C*, *D*, *E*, and *F* are base stations (BS) of micro-cell, while *R1*, *R2* and *R3* are BSs of macro-cell. In the same cell type, macro-cell is separated into two levels of tiers. However, micro-cells may be located on same level or distinguished on more than one levels. Thus, this multi-tier architecture includes the characteristics of "Hierarchy". In the proposed architecture, the location information of MN is stored into cell table. In the micro-cell, such as *A*, *B*, *C*, *D*, *E*, and *F*, has a **micro_table**. Macro-cell, *R1*, *R2*, and *R3* not only have a **macro_table**, but also have a **micro_tables** of micro-cells under its control region. The location information and related information of each MN will be stored into one of these two tables. When system needs to track the location of MNs, BSS (Base Station System) just search its cell table. Macro-cell will search its micro_table first, if not find, its macro_table will be searched.

To maintain the correctness of these two tables, MNs need to send a *"Location Message"* to the most upper layer of macro-tier while it uses the BS services of micro-cell. For example, there is a MN(*X*) (shown as Fig.3.1) in the coverage of BS(*B*) and there will have a location information (*X*, *B*) store in the micro_table of *B*. When *X* send a location information to micro-tier periodical, the micro_table of *A*, *R1* and *R3* will keep this record (*X*, *B*), (*X*, *A*) and (*X*, *R1*) in its micro_table, respectively. All records in micro_table and macro_table have a specific time-limitation. Over the limit time and does not have any location information from this MN, the location record of the MN will be erased from the cell tables.

3.2. Handoff Strategy

This multi-tier architecture defines a domain to be coverage of macro-tier. Hence, handoff strategies can be distinguished into Inter-domain handoff and Intra-domain handoff:

- **Inter-domain Handoff:**

When MN moves from one domain to the other, Inter-domain handoff is happened and it has two following situations:

a. The upper layer BS of these two domains is same

Shown as Fig. 3.1, when MN moves to a new domain, it needs to ask the BS of macro-tier for handoff. If macro-tier has no free channels for handoff, MN turns to ask micro-tier for handoff. MN will send a location message to *R3* through micro-tier or macro-tier BS to update its location information after successful handoff.

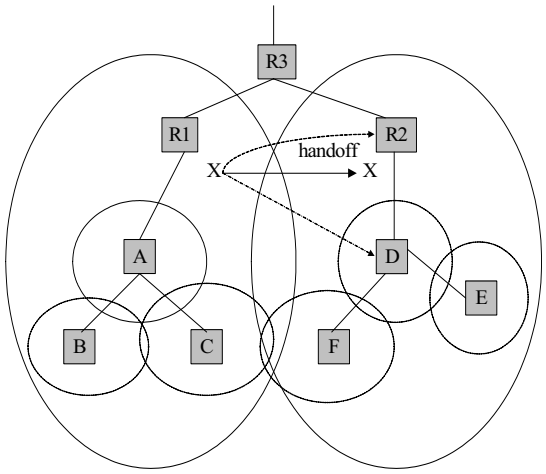

Figure 3.1 the upper BS of these two domains is the same

b. The upper layer BS of these two domains is different

While new domain permits handoff, as shown as Fig. 3.2, MN sends an update-location-message to new macro-tier, and macro-tier will send this message to its upper layer. Due to the upper layer BS of these two domains is different, the most upper layer BS needs to deliver this message to home network of MN. Then, home network will reply new location information to original domain. However, this record will keep a while until MN has completed handoff.

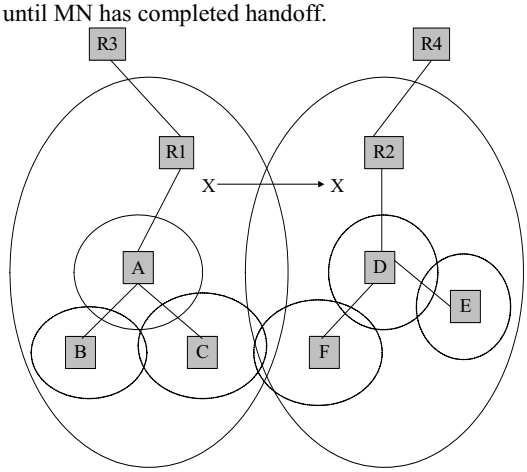

Figure 3.2 the upper BS of these two domains is the different

- **Intra-domain Handoff:**

Due to the proposed multi-tier network architecture is consisting by macro-tier and micro-tier, Intra-domain Handoff can be separated into three conditions as follows:

a. Macro-cell to micro-cell:

When MN moves to the area that macro-cell and micro-cell are overlapping or while MN needs more bandwidth when it was served by a macro-cell, system will switch MN to micro-cell.

If MN demands more bandwidth, it must wait system to accept its request and then start switch to micro-cell. Furthermore, it must send an *"Update Location Message"* to new BS and a *"Delete Location Message*" to old BS in the same time.

For example, MN *X* presented in Fig. 3.4 changes from coverage of macro-tier *R1* to micro-tier *B*, *"Update Location Message"* must send to *R3*. Therefore, Cell *B*, *A*, *R1* and *R3* will store data (*X*, *B*), (*X*, *B*), (*X*, *A*) and (*X*, *R1*) respectively.

b. Micro-cell to macro-cell:

Shown as Fig. 3.4, when MN *Y* moves to the areas that do not cover by micro-cell, it needs switching to the BS of macro-cell. Therefore, MN will send a handoff request message first. If system accepts its request, it will send an *"Update Location Message"* to the BS of macro-cell to store location information of MN in macro_table. It will forward the message to update the macro_table of its parent macro-cell BS.

c. Micro-cell to micro-cell:

When MN *Z* (see Fig. 3.4) moves from one micro-cell *F* to the other *E*, as long as arrival a area that needs to demand a handoff request, it musts send a request message to new BS. After new BS accepts its request, it will send an *"Update Location Message"* to *D* and modify the record of micro_table. If there are no enough bandwidths of micro-cell, it will turn to macro-cell for a handoff request. In this situation, the handoff procedure is same as case ***b.***

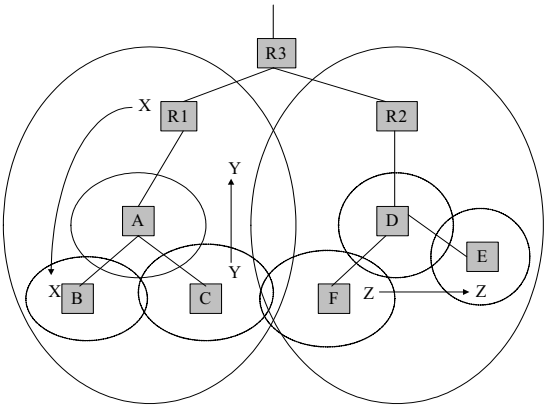

Figure 3.3 three situations of Intra-domain Handoff

4. Multi-tier Architecture Supporting Mobile Multimedia Communications

Multi-tier wireless communication architecture based on Cellular IP to support following capability:

a. Mobile Internet, Seamless Roaming
b. Mobile Multimedia Communication
c. Multimedia Quality of Service
d. Management of Mobile IP

4.1. Resource Switching Management Center

The focused facilities of mobility management and handoff strategy are separated into micro-cell and macro-cell. There are many articles refer to separate micro-tier from macro-tier wireless communication network. The IP policy is that the Mobile IP is used in macro-tier and Cellular IP is used in micro-tier. Moreover, an extra component, Resource Switching Management Center (RSMC), is located in micro-tier to improve capability of Cellular IP network. RSMC is a control center that combines gateway router and cache of BS, which can store the location information of MN, forward data packets to MN, and authenticate identity of MN. The proposed multi-tier architecture is illustrated in Fig. 4.1; it is composed of Pico-cell, Micro-cell, Macro-cell, Resource Switching Management Center (RSMC), Base Stations (BS), Mobile Node (MN), Corresponding Node (CN), Home Agent (HA), Mobile Node Location Database (MNLD) and Internet.

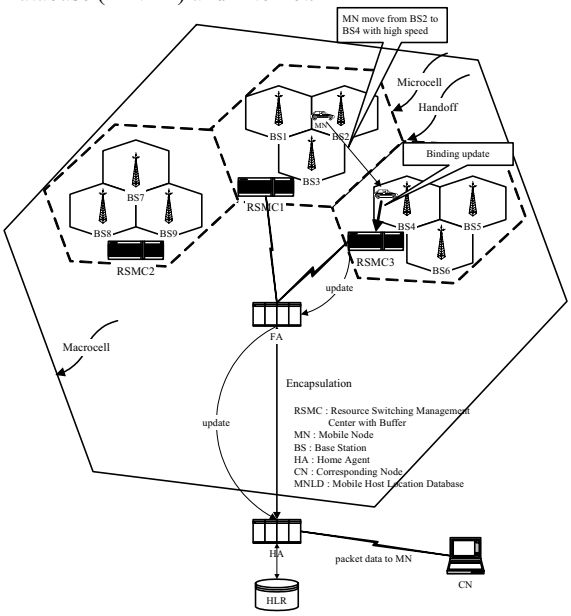

Figure 4.1 the Architecture of Cellular IP with RSMC

If MN moves from BS1 to BS2, it needs to send a route-update-packet to RSMC during route-update-time.

Then RSMC will update the location information of MN after got this packet, and send a message to notify HA and CN. Thus, packets sent by CN will reach MN correctly via RSMC. A RSMC keeps track of its own micro-cell which inside macro-cell, and communicates with others through Foreign Agent (FA). No matter MN is idle (no data transmit), or active (data transmit), it won't waste system resource. In this architecture, the routing, paging and location management of Cellular IP are combined by RSMC. Because it is in a limited area, the load of RSMC is very low. And then the FA of Mobile IP communicates to different RSMC.

4.2. Soft-Handoff of Multi-tier Architecture

In Fig. 4.2, we use soft-handoff method to guarantee the data integrity of mobile multimedia communication services. Real-time data packets sent by CN routing to correctly location of MN via RSMC. When data packets arrives RSMC, it will deliver to both MN's old BS and new BS. And then, we can reduce the probability of data packets loss. After soft-handoff finished, packets send to MN's new location only, this will promise Quality of Service. If MN moves over macrocell, we can use FA to send data packets to both old RSMC and new RSMC. And then new RSMC will deliver to new BS. By using soft-handoff method and multi-tier architecture, we firmly believe that mobile multimedia communication services in 3G can be done successfully.

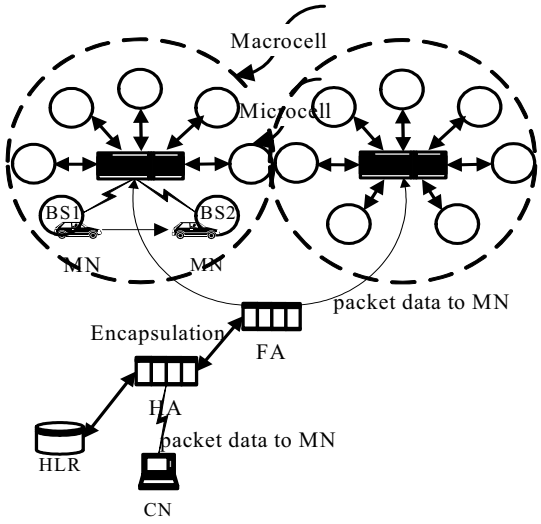

Figure 4.2 Soft-handoff of Multi-tier Architecture

5. Conclusion and Future Works

This paper proposes a multi-tier solution base on the current IP (IPv4) and is compatible with IPv4. In 3G, mobile multimedia communication is an important issue. Hence, mobile IP and cellular IP network architecture are combined for data packets transfer. By supplying this IP-based multi-tier network, cellular IP procedures are simplified and provide access to a mobile IP enabled Internet in support of fast moving wireless nodes. A Soft-handoff method is also presented to improve Quality of Service (QoS) and resource switching management to reduce data packet loss.Further studies will focus on a multi-tier mobile IPv6 architecture to discuss handoff and QoS issues. How to ensure the Quality of Services in a real time demands, and what's the transfer-coding mode of multimedia data packets.

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