Micro- Mobility Management Issues and Solution in Next Generation All IP Based Wireless Networks

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Abstract: **Wireless networks of the next generation need the support of all the standards, protocols and advance architectures. Mobility management is an important issue in the field of mobile communications, which can be solved at the network layer. The important feature of the next generation wireless networks is all-IP infrastructure. A mobility management is a hierarchical model, in which the mobility management is divided into two tasks: macro mobility and micro mobility. This paper describes the micro-mobility management issues and solution in next generation all IP based wireless networks. The Mobile IP is a specification for macro mobility management. It is not well suited for micro mobility management. Cellular IP offers tools to solve micro mobility issues in the network layer. Cellular IP supports local mobility. To provide wide area mobility support it can interwork with Mobile IP. Micro mobility issues can also be handled by different protocols such as HMIP, HAWAII and using link layer mechanisms.**

Keywords-**Mobility, cellular IP, hand-off, router, HAWAII, MSC,BSC.**

I.INTRODUCTION

A. Mobility Management

Mobility management is one of the major functions of a GSM or a UMTS network that allows mobile phones to work. The objective of mobility management is to track where the subscribers are, allowing them calls, SMS and other required mobile phone services to be delivered to them. Two kinds of mobility can be defined as Micro-mobility and Macro-mobility.

1) *Micro mobility:* It means mobile node's movements inside a domain. For this intra-domain mobility management solutions are suitable which focus mainly on a fast, efficient mobility support within a restricted coverage [1].

2) *Macro mobility:* It means i.e. mobile node's movements between different domains. For this inter-domain mobility management schemes can be employed, acting as a global mobility solution. It provides advantages of flexibility, robustness, and scalability. [1]

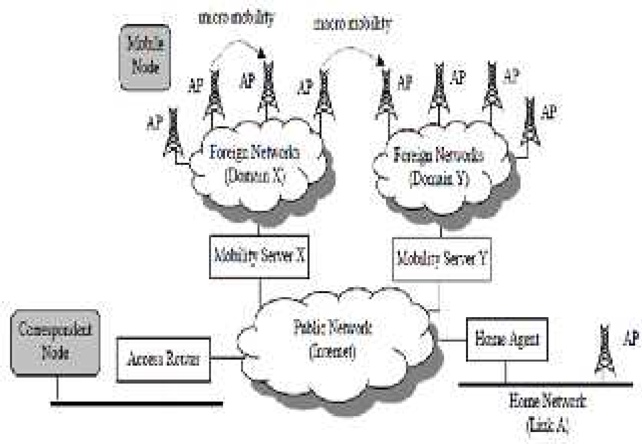

Fig.1.Mobility management model

B. Location Update Procedure

When a mobile device moves from one location to another, it is necessary to inform the cellular network .This procedure is known as location update procedure. Mobiles are responsible for detecting location area codes. When a mobile finds that the location area code is different from its last update, it performs another update by sending to the network, a location update request, together with its previous location, and its Temporary Mobile Subscriber Identity (TMSI). TMSI is the identity that is most commonly sent between the mobile and the network. TMSI is randomly assigned by the VLR (visitor location register) to every mobile in the area, as soon as the mobile is switched on [2]. The number is local to a location area, and so it has to be updated each time the mobile moves to a new geographical area. Each mobile is required to regularly report its location at a set time interval using a periodic location update procedure [4]. Whenever a mobile moves from one location area to the next while not on a call, a random location update is required. Thus a subscriber has reliable access to the network and may be reached with a call, while enjoying the freedom of mobility within the whole coverage area.

When a subscriber is paged in an attempt to deliver a call or SMS and the subscriber does not reply to that page then the subscriber is marked as absent in both the Mobile Switching Center / Visitor Location Register (MSC/VLR) and HLR . The next time the mobile performs a location update the HLR is updated and the mobile not reachable flag is cleared.

Roaming is one of the fundamental mobility management procedures of all cellular networks. Roaming is defined as the ability for a cellular customer to automatically make and receive voice calls, send and receive data, or access other services, including home data services, when travelling outside the geographical coverage area of the home network [2]. This can be done by using a communication terminal or else just by using the subscriber identity in the visited network. Roaming is technically supported by mobility management, authentication, authorization and billing procedures. Cellular IP defines also many mobility management concepts which are similar to those applied in existing cellular networks. The following sections describe the micro mobility management in existing IETF documentation.

A "location area" is a set of base stations that are grouped together to optimize signaling. Typically, tens or even hundreds of base stations share a single Base Station Controller (BSC) in GSM, or a Radio Network Controller (RNC) in UMTS. The BSC handles allocation of radio channels, receives measurements from the mobile phones, and controls handovers from base station to base station. A “location area code “which is a unique number, is assigned to each location area. The location area code is broadcast by each base station, known as a "base transceiver station" at regular intervals [1].

II. CURRENT ISSUES

Micro-mobility management has some issues related to mobility which cannot be solved by macro-mobility .In this section we will discuss those issues.

A. *Mobility Management States*

There are two mobility management states -1) Active state and 2) Idle state.

1) Active state: If any mobile device is transmitting or receiving IP packets, it is said to be in active state. [1]. This state is similar to ready state in GPRS as also in GPRS ready state mobile station may send and receive packets[1].

2) Idle state: If a mobile host has not recently transmitted or received IP packets and then idle state is applied [1]. This state has similarities to standby state in GPRS. In GPRS standby state, data reception and transmission are not possible [1].

A ready state is supervised with a timer which is not statistically defined. MSC may change the ready timer by transmitting a new value. Mobility management state functionality is important to minimize the battery consumption in a mobile station. The base station periodically transmits information to power saving stations if they have frames buffered at the base station. If there is a frame buffered at the access point, then the station sends a polling message to the base station to get these frames. As the buffering information is sent periodically, this function requires that stations are synchronized [5].

B. *Paging Area Concept*

Mobile hosts which are not actively transmitting or receiving data but want to be reachable for incoming packets, maintain paging cache mappings [3]. There is a re-association procedure, where a station which is roaming from one base station to another becomes associated with the new one [5]. Both in GPRS and Cellular IP, the need for paging is related to the mobility management states. When a mobile host is in active state, the network must follow its movement from base station to base station to be able to deliver packets without searching for the mobile host. Thus, those hosts which are in active state must notify the network about each handoff [3]. This basic principle applies for both Cellular IP and GPRS. In Cellular IP, paging area is a set of base stations. Idle mobile hosts crossing cell boundaries within a paging area do not need to transmit control packets to update their position .In GPRS similar functionality is provided by a routing area concept. An idle mobile host moving to a new base station transmits a paging update packet only if the new base station is in a new Paging Area [3].

In Cellular IP, wide area mobility occurs when the mobile host moves between Cellular IP networks. The mobile host can identify Cellular IP networks by the Cellular IP network identifier contained in the base stations' beacon signals. The beacon signal also contains the IP address of the gateway. When a mobile host has received this broadcast information, it can send a registration request to the gateway [3]. Mobile host can also send a Mobile IP registration message to its home agent, specifying the gateway's IP address as the care-of address. Alternatively, the gateway can register at the home agent on behalf of the mobile host [3].

C. *Lower Layer Issues*

Cellular IP provides some tools to solve micro mobility issues in the network layer. Cellular IP does assume that a random access layer 2 protocols covers the air interface [3]. Those layer 2 protocols which are applied over radio interface, typically acknowledge transported data. IP as such does not acknowledge received packets and typically it is better to carry out retransmission as soon as possible. In IEEE 802.11, one carrier provides a transmission medium which supports 2 Mbps per second in a shared access manner [5]. In many ways, this transmission medium is similar to a segment in a fixed LANs. Instead of collision detection which is used in Ethernet, IEEE 802.11 applies collision avoidance with a positive acknowledge mechanism [5]. Typically no explicit resource allocations are made, but the usage of radio resource is based on shared access principles. If a mobile host does not have anything to send or to receive, it uses radio resources only for control signaling. In WLAN there is not this kind of logical channel structure. All control information and signaling is transmitted over the same shared channel.

D. Packet Routing

Route Cache is maintained by all Cellular IP nodes and it is used to route packets to mobile hosts. Packets transmitted by the mobile host create and update entries in each node's cache. An entry maps the mobile host's IP address to the neighbor from which the packet arrived to the node. The chain of cached mappings referring to a single mobile host forms a reverse path for downlink packets addressed to the same mobile host. As an active host approaches a new base station, it transmits a route update packet and redirects its packets from the old to the new base station. The route update packet will configure route caches along the way from the new base station to the gateway. Packets transmitted by a mobile host are routed from the base station to the gateway by hop-by-hop shortest path routing, regardless of the destination address [3].

In GSM/GPRS radio access network IP packet is encapsulated over GPRS specific frame structures. Routing of these frames is partially based on topology. One base station is always connected to one base station controller. This topology information is used to route the uplink frames. When mobile station is in ready state base station controller is aware on which cell mobile station is attached. Based on this information it is possible to route the downlink frames to a mobile station in ready state.

In Cellular IP, paging cache is maintained by some Cellular IP nodes and it is used to route packets to mobile hosts. By arranging two caches (paging cache and routing cache), the granularity of location tracking can be different for idle and active mobile hosts. IP packets addressed to these mobile hosts will be routed by paging caches. Paging caches have a longer time-out value than route caches and are not necessarily maintained in every node. On the path from the gateway toward the mobile host, the paging packet is broadcast by all nodes it passes. The paging packet is an ordinary IP packet. The set of cells that are reached by the paging packet forms a paging area [3].

Packet acknowledgment and buffering functionality typically have interactions. If a packet is not acknowledged in certain period of time, it can be retransmitted if it is still stored in a buffer. Buffering can be carried out on different network elements. It is typically preferable that buffering is not carried out very far away from that place where handoff takes place. IEEE 802.11 acknowledges on MAC layer. IEEE 802.11 MAC layer is typically implemented in the base station [4].Thus, one obvious location where buffering can be implemented is the base station. How much buffering is to be applied, should be a flexible network configuration parameter. There are certain limits on how much delay different higher level protocols and applications can tolerate. For example Voice over IP and streaming technologies require a real time data at a receiver with a strict tolerance. If this tolerance is missed, buffering does not bring any additional benefit. []On another hand, some other protocols might tolerate longer packet delays but not any packet loss.

In Cellular IP, when a mobile host switches to a new base station it sends a route update packet .This makes the chain of cache bindings to point to the new base station. Packets that are traveling on the old path will be delivered to the old base station and will be lost. Even though this loss may be small it can potentially degrade TCP throughput.

E. Handoff Decision

When a mobile user travels from one area of coverage or cell to another cell within calls duration, the call should be transferred to new cell’s base station. Otherwise the call will be dropped because the link with current base station becomes too weak. This ability for transmission is called as “handoff”. [4][10]There are two basic types of handoffs-Hard handoff and soft handoff. When the mobile switches all at once to new base station, it is hard hand-off .In soft hand-off a mobile host may be in contact with either of the old and new base stations and receive packets from them. Packets intended to the mobile host are sent to both base stations, so when the mobile host eventually moves to the new location it can continue to receive packets without interruption [3][10].

The decision making process of handoff may be centralized or decentralized (i.e. the handoff decision may be made at the mobile station or network) [8]. From decision process point of view there are at least three different kind of handoff:

i. In a network controlled handoff protocol, the network makes a handoff decision based on measurements of the mobile stations at a number of base stations. In general, the handoff process takes 100-200 ms. Information about the signal quality for all users is available at a single point in the network. Network controlled handoff is used in first generation analog systems such as AMPS, TACS and NMT [8].

ii. In a mobile assisted handoff process the mobile station makes measurements, and the network makes decision. In circuit switched GSM, base station controller is in charge of the radio interface management. The handoff time (time between handoff decision and execution) in circuit switched GSM is approximately 1 s [8].

iii. In mobile controlled handoff the mobile station is completely in control of the handoff process. This type of handoff has a short reaction time (on the order of 0.1s). The mobile station measures the signal strengths from surrounding base stations and interference levels on all channels. A handoff can be initiated if the signal strength of the serving base station is lower than that of another base station by certain threshold [8].

Especially network controlled and mobile assisted handoff are typical for handling circuit switched bearers (e.g. in NMT, AMPS, GSM, TACS). Mobile IP does not either support transport of any radio interface specific information (e.g. measurement data) on which handoff decision could be based. Cellular IP, on another hand, explicitly states that handoff is initiated by the mobile host [3].

III. MICRO-MOBILITY SOLUTIONS

Micro mobility solutions are presented for the intra-domain mobility management. MNs usually move frequently between subnets of one domain. The micro mobility protocols ensure that the packets arriving at the mobility server (gateway) can be correctly forwarded to the appropriate access point that the MN currently attaches. To implement a fast and seamless handoff and also to reduce signaling load and delay to home network during movements many micro mobility solutions have been proposed. They can be broadly classified into two groups: tunnel-based and routing- based micro-mobility schemes [8]:

1. Tunnel based: It uses local and hierarchical registration and encapsulation concepts. It reduces the global signaling load and handoff latency. Mobile IP regional registration (MIP-RR) [8], hierarchical Mobile IP (HMIP) [13], and intradomain mobility management protocol (IDMP) [4] are tunnel based protocols.

2. Routing based: It maintains host-specific routes in the routers to forward packets. The host-specific routes are updated based on host mobility. Cellular IP (CIP) [3] and handoff aware wireless access Internet infrastructure mobility. Cellular IP (CIP) [3] and handoff aware wireless access Internet infrastructure (HAWAII) [5] are routing-based micro-mobility protocols.

In this paper we will discuss routing based micro-mobility protocols.

i. *CELLULAR IP -*

CIP [3] is proposed to provide local mobility and handoff support for frequently moving hosts. It supports fast handoff and paging in CIP access networks. For mobility between different CIP networks, it can interwork with MIP to provide wide-area mobility support. The architecture of CIP is shown in Fig. 2. [9]It shows different wireless access networks connected to the Internet through a gateway (GW), which handles the mobility within one domain. Packets destined to a mobile host (MH) reach the GW first. Then the GW forwards the packets to the MH using the host-specific routing path.

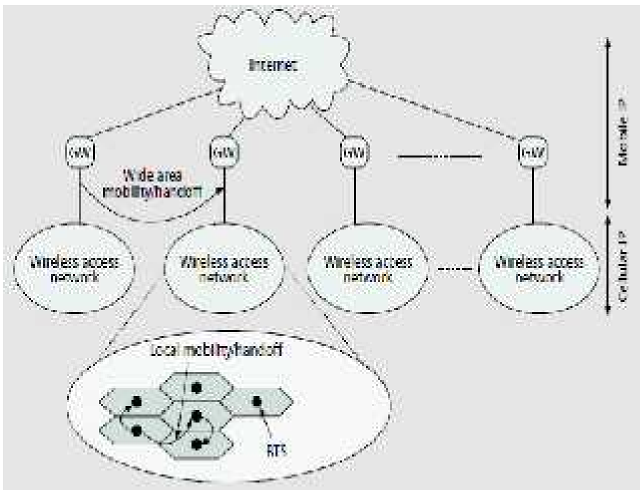

Fig.2.Cellular IP Architecture

The design of CIP is based on four fundamental principles:

• Distributed caches are used to store location information of MHs.

• Location information of an active MH is updated by regular IP datagrams originated by it. For an idle MH, this is achieved by the use of dummy packets that are sent by the idle host at regular intervals.

• Location information is stored as soft states.

• Location management for idle MHs is separated from location management of MHs that are actively transmitting/receiving data.[9]

CIP uses distributed paging cache and distributed routing cache for location management and routing, respectively. Distributed paging cache coarsely maintains the position of the idle MHs for efficient paging, whereas the routing cache maintains the position of an active MH up to subnet level accuracy. When an MH performs handoff, the routing states in the routing cache are dynamically updated. The handoff process of CIP is automatic and transparent to the upper layers. When the strength of the beacon signals from the serving BS is lower than that of a neighboring BS, the MH initiates a handoff. The first packet that travels to the GW through the new BS configures a new path through the new BS. These results in two parallel paths from the GW to the MH: one through the old BS and one through the new BS. If the MH is capable of listening to both BSs at the same time, the handoff is soft; otherwise, the handoff is hard. The path through the old BS will be active for duration equal to the timeout of route caches. After timeout, the entries corresponding to the MH in the nodes that belong only to the old path are deleted. Thereafter, only the new path exists between the GW and the MH.

ii. HAWAII -

HAWAII [9] is a domain-based approach to mobility support. The network architecture of HAWAII is shown in Fig. 4. All issues related to mobility management within one domain are handled by a gateway called a domain root router. When an MH is in its home domain, packets destined to the MH are routed using typical IP routing. When the MH is in a foreign domain, packets for the MH are intercepted by its HA first. The HA tunnel the packets to the domain root router. The domain root router routes the packets to the MH using the host-based routing entries.

When the MH moves between different subnets of the same domain, only the route from the domain root router to the BS serving the MH is modified, and the remaining path remains the same. Thus, during an intra-domain handoff, the global signaling message load and handoff latency is reduced.

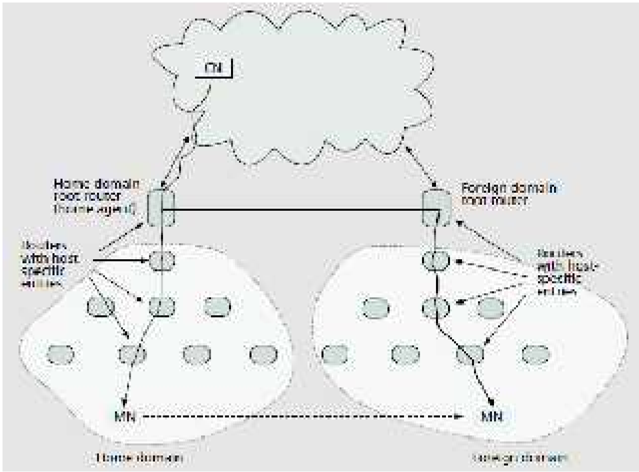

Fig.3. the architecture of HAWAII

To establish and maintain a dynamic path to the MH, HAWAII uses three types of messages: power up, path refresh, and path update [9].The path setup messages after power up establish the host specific path from the domain root router to the MH by creating host-specific forwarding entries in the routers along the path. When the MH is in its home domain, once the host-specific forwarding entries are created in the routers along the path from the domain root router to the MH, the power up procedure is complete. When the MH is in a foreign domain, it registers its CoA with its HA upon receipt of the acknowledgment from the domain root router in reply to the path setup message. Once the host-specific forwarding entries are created for an MH, they remain active for a time period. The MH periodically sends path refresh messages to its current BS before timeout occurs. In response to the path refresh messages, the BS sends aggregate hop-by-hop refresh messages to the next-hop router toward the domain root router[9].The path update messages are used to maintain end-to-end connectivity when an MH moves from one BS to another within the same domain. HAWAII also supports IP paging. It uses IP multicasting to page idle MHs when packets destined to an MH arrive at the domain root router and no recent routing information is available.

IV.SUMMARY

Micro-mobility is one of the tasks in mobility management. It is having some issues such as hand-off, mobility states, paging cache etc. Even though these issues are small, these can affect the mobility throughput. To solve this issue different protocols are available such as tunnel based and routing based. Cellular IP and HAWAII are routing based protocols. The operation principle of all these protocols is same. Domain route routers are designed in each protocol. All these protocols try to localize most of the signaling traffic into one domain to reduce global signaling. Routing based schemes avoid tunneling overhead but suffer from high cost.

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