Integration of Gsm With Ipv6

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ABSTRACT
Consumers are demanding world-wide cellular access to the internet. This requires a global standard and effective means of accessing the internet from wireless devices. Integrating the two successful domains, viz, cellular networks and the Internet, provide anytime, anywhere access in third generation (3G) cellular networks. In this paper a hierarchical architecture for integration of cellular network (GSM) and Mobile IPv6 as mobility management is proposed. GSM is the most widely used cellular network and Mobile IP allows transparent routing of IP datagrams in the Internet to the Mobile node irrespective of its physical location. Mobile IP provides an elegant solution for inter-domain, or macro-mobility management, but does not perform well for micro-mobility or intra-domain management. The transition of IPv4 to IPv6 is studied and its improvements are incorporated in the proposed architecture. The proposed hierarchical architecture improves the performance of Mobile IP in GSM networks in terms of fast intra-domain hand-offs.

Keywords
GSM; Mobile IPv6; IPv6 addressing scheme, neighbour discovery

1. INTRODUCTION
There are two major trends emerging in the world of telecommunications: an increase in the usage of mobile wireless devices, and an increase in usage of the internet . For example, the total number of Global System for Mobile Communications (GSM) subscribers has recently surpassed 110 million world wide. This, coupled with the high growth in IP data traffic, is leading the cellular industry to consider ways of combining these trends into one worldwide service. However, two major problems are holding up the development of wireless intemet access.. The Internet Protocol (IP) is the basic building block on which all Internet protocols are built. With the high growth in IP data traffic, combining the trends into one worldwide service is a research focus. The third generation (3G) networks intend to make the Internet mobile – accessible anytime and anywhere, providing complete access to time-sensitive data, regardless of the physical location. 3G cellular network architectures are being developed worldwide. The two bodies working towards 3G standards, 3GPP and 3GPP2, have introduced IP-based core network architectures. Though IP-based networks form part of 3G networks, there is still no agreement on any particular mobility management scheme .Mobile IP extends IP to support computing on the move and it is gaining wide acceptability. Most of the Internet traffic uses TCP (Transmission Control Protocol) connections. A TCP connection is defined by the combination of IP address and port number of both end-points of the communication. If one of these four number changes, the communication is disrupted and has to be reestablished. If a mobile node connects through a different access point to the network, it needs a new IP address Mobile IP [1][1][3] addresses the challenges of moving a node to a different connection point without changing its IP address. by assigning the mobile node with two different IP addresses.Mobile IP being an extension of IP for mobile networks, it is well suited for the mobility management.

GSM (Global System for Mobile Communication) is the most successful digital mobile telecommunications system with over 100 million users in more than 130 countries using the GSM network. In GSM, system architectures and protocols, used for user-network signaling and global roaming are identical all over the world and hence enable worldwide development, manufacturing and marketing of products. There are usually three types of mobility encountered in IP based cellular networks- micro-mobility, macro-mobility and global mobility.

2. MOBILE IP
Mobile IP can be thought of as the cooperation of three major subsystems. First, there is a discovery mechanism defined so that mobile computers can determine their new attachment points (new IP addresses) as they move from place to place within the Internet. Second, once the mobile computer knows the IP address at its new attachment point, it registers with an agent representing it at its home network .Lastly, mobile IP defines simple mechanisms to deliver datagrams to the mobile node when it is away from its home network. Mobile IP, through the use of sockets in the networking layer, supports application running on mobile devices. Thelogic behind choosing the network layer is to allow the mobility related issues to be treated as routing problem. Itassigns two different IP addresses to the MN. One is the homeaddress,which is static and does not change. It is thereforeused to identify the TCP connection. The second IP address iscalled the care-of-address (CoA). It changes depending on thenetwork to which the node is currently attached. If the mobileuser moves away from its home network, the Home agent (HA) forwards the packetfrom the home address to the CoA. Homeagent is a specially designated server that intercepts andforwards packets for absent subscribers. When away fromhome, the mobile unit sends its location information to its home agent via the Internet control message protocol(ICMPv6). This is called binding update.

3. MOBILE IPv6
Mobile IPv6 [3], [6], is an evolutionary process and tries to eliminate the difficulties faced in IPv4. Much of theirdevelopments have been influenced by lessons learned in the existing Internet. As a technology it promises a number of advances such as larger address space (128 bits) which can support 128addresses and enables hierarchical routing infrastructure, flexible addressing scheme, more efficient packet forwarding, inherent support for secure communications with IPSec, ability for differentiated services (QoS), better support for mobility and ease of management.

The operation of Mobile IPv6 [10] is shown in Fig. 1 and can be summarized as follows: If the mobile node is in a Home network, it acts like any fixed host or router when connected to its home link.If it is in a foreign network, a mobile node determines its current location and acquires its care-of address using Neighborhood Discovery Protocol and address autoconfiguration.A mobile node uses IPv6-defined address autoconfiguration to acquire a collocated care-of address on the foreign link either by stateless autoconfiguration or by stateful address configuration like DHCPv6. The mobile node notifies its care-of-address to its home agent via ICMPv6 by binding

Packets sent by correspondents that know the mobile node's care-of address are sent directly to the mobile node using an IPv6 Routing Header, which specifies the mobile node's care-of address as an intermediate destination. In the reverse direction, packets sent by a mobile node are routed directly to their destination using no special mechanisms. In Mobile IPv6, extension headers are used to allow the sending of packets to the mobile node's care-of address directly by cashing the binding of a mobile node's home address with its care-of address. The mobile nodeattached to a foreign network now uses its care-of address as asource address when sending packets. The mobile node's homeaddress is carried in a Destination Options header, whichmeans the session control information is piggybacked onto thesame packet[10][3].

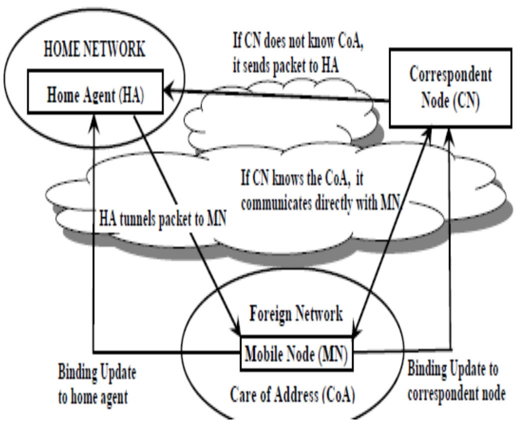

Fig (1) Working of Mobile IPv6

4. INTEGRATING GSM AND MOBILE IPv6

In order to understand the integrated architecture, let us first discuss how GSM will work in conjunction with IPv6 addressing scheme[11,3].

A. GSM Architecture

The GSM architecture is shown in Fig. 2. The architecture is divided into sub-systems like mobile station, base station subsystem and network subsystem. The different components in Fig. 2 are explained as below

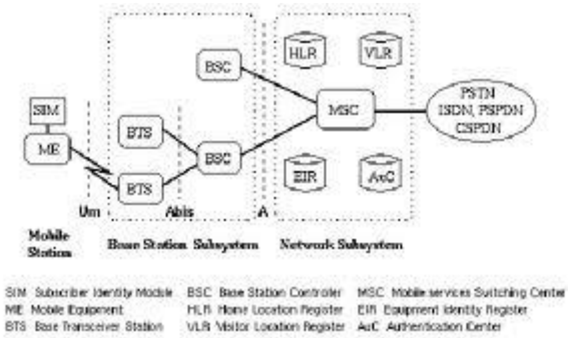

Fig. (2) GSM Architecture

By using the Subscriber Identity Module (SIM) card with aGSM terminal, the user is able to receive and make calls fromthat terminal. Each mobile terminal has been assigned a 15-digit International Mobile Subscriber Identity (IMSI) using theSIM card. Each ME (mobile equipment) is also assigned aunique 15-digit International Mobile Equipment Identity(IMEI) at the time of manufacture.The Base Transceiver station (BTS) contains the radio transceivers for acell and implements radio-link protocols tointerface with the mobile station. The mobile equipment andthe BTS are connected through aUm interface. The BaseStation Controller (BSC) manages one or more BTSs. Itperforms radio-channel setup, frequency hopping, andhandovers. There is Ais interface between BTS and BSC. TheBSC connects the mobile station with mobile services switching center (MSC). The MSC is the most importantcomponent of Network Subsystem. Its functions are to provide services related to registration, authentication, location updating, handovers, and call routing. Call routing is achieved by using the home location register (HLR) and visitor locationregister (VLR) along with the MSC. HLR contains the registration information of subscribers and their present location. The HLR is a database and could be implemented as a distributed database. The VLR associated to each MSC is a very dynamic database which stores all important information needed for theMS users currently in the Location Area (LA)that is associated to the MSC. This key is used for authentication and encryption. There is an A interface between base station subsystem and network subsystem.

B. IPv6 Addressing Scheme

IPv6 addresses are assigned to interfaces, not to nodes, as inOSI (Open System Interconnection), so each interface of anode needs at least one unicast address. A node can thereforebe identified by the address of any of its interfaces. An IPv6address has 128 bits, or 16 bytes. The address is divided intoeight, 16-bit hexadecimal blocks, separated by colons. For example:

FE80:0000:0000:0000:0202:B3FF: FE1E: 8329 A typical IPv6 address [11] consists of three parts – theglobal routing prefix, the subnet ID, and the interface ID, as shown in Fig. 3.

Global Routing prefix Length= *n* bits	Subnet ID *m* bits	Interface ID *128-n-m*

Fig (3) IPv6 address structure

The global routing prefix is used to identify a special address, such as multi-cast, or an address range assigned to asite. A subnet ID is used to identify a link within a site. Thesubnet ID may also be referred to as subnet prefix or simply“subnet”. A subnet ID is associated with one link. Multiplesubnet IDs may be assigned to one link. An interface ID is usedto identify an interface on a link and needs to be unique on thatlink. Addresses in the prefix range 001 to 111 should use a 64-bit interface identifier that follows the EUI-64 (ExtendedUnique Identifier) format (except for multicast addresses withthe prefix 1111 1111). The notation for prefixes has beenspecified as:

IPv6 address / prefix length

An IPv6 unicast address uniquely identifies an interface ofan IPv6 node. A packet sent to a unicast address is delivered tothe interface identified by that address. Aggregatable globalunicast addresses are identified by binary prefix 001. Theformat of global-scope IPv6 unicast address is as shown in Fig.(4)

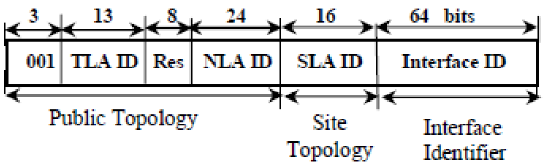

Fig. (4) Global Scope IPv6 Unicast Address

TLA ID (Top-Level Aggregation Identifier): The TLA IDidentifies the highest level in the routing hierarchy. TLA IDsare administered by the Internet Assigned Numbers Authority(IANA) and allocated to local Internet registries that in turnallocate individual TLA IDs to large, long haul ISPs.Res (Reserved): Bits that are reserved for future use inexpanding the size of either the TLA ID or the NLA ID(defined next). NLA ID (Next-Level Aggregation Identifier): The NLA IDallows an ISP to create multiple levels of addressing hierarchywithin its network to both organize addressing and routing fordownstream ISPs and identify organization sites.
SLA ID (Site-Level Aggregation Identifier): The SLA ID isused by an individual organization to identify subnets within itssite.
Interface ID — It indicates the interface on a specificsubnet. The size of this field is 64 bits. The interface ID in IPv6is equivalent to the node ID or host ID in IPv4.

C. Local-Use IPv6 Unicast Addresses

There are two types of local-use unicast addresses defined.Link-Local and Site-Local addresses. The Link-Local is for use on a single link and the Site-Local is for use in asingle site. Link-local unicast addresses have the hexadecimal prefix Link-Local addresses have the format shown in fig.(5)

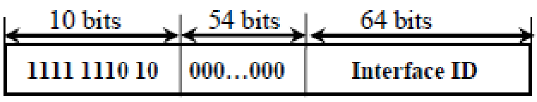

Fig. (5) Link-Local IPv6 Unicast Address

Link-Local addresses are designed to be used for addressing on a single link for purposes such as automaticaddress configuration, neighbor discovery, or when no routersare present. Routers must not forward any packets with linklocalsource or destination addresses to other links.
Site-local unicast addresses have hexadecimal prefix FEC0::/10. Site-Local addresses have the format shown in Fig(6).

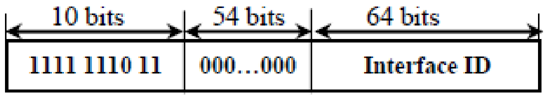

Fig. (6) Site-Local IPv6 Unicast Address

Site-Local addresses have the format shown in Fig. Site-local addresses are designed to be used for addressinginside of a site without the need for a global prefix. Although a subnet ID may be up to 54-bits long, it is expected that globallyconnected sites will use the same subnet IDs for site-local and global prefixes. Routers must not forward any packets with site-local source or destination addresses outside of the site.
D. Neighbor Discovery
Neighbor Discovery and stateless autoconfiguration in IPv6.The IPv6 protocols known collectively as NeighborDiscovery (ND) [12] replace a number of IPv4 protocols thatoffer some autoconfiguration facilities. ND defines newfunctionality as well. In general, ND performs three majorfunctions: First, it provides address resolution service,updating and expanding IPv4’s address resolution protocol (ARP), to determine layer 2 addresses of nodes on the samelink. Second, it allows hosts to discover what neighboringrouters area present and provides a mechanism for obtainingcertain configuration information from them and third, itdefines Neighbor Unreachability Detection (NUD), a mechanism that determines when a neighbor becomesunreachable. If the neighbor is a router, the node invokes arecovery procedure to find an alternate router. ND isimplemented within the Internet Control Message Protocol(ICMP), making all services independent of link technologies.ND defines two main pairs of messages. Neighbor solicitation (NS) and neighbor advertisement (NA) messages are used todetermine the link-layer addresses of neighbors, as well as toverify that a neighbor is reachable. Router solicitation (RS) and router advertisement (RA) messages are used to locate and obtain information from routers. During ND, a node first forms its link-local address by appending its 64-bit interface ID(mostly a MAC in EUI-64 format). It also does DAD(Duplicate Address Detection) Check to ensure that the newly formed address is not already in use by another node on the attached link.

5. HIERARCHICAL ARCHITECTURE

The architecture shown in Fig. 7 is hierarchical and makes use of link-local Unicast address for communicating in a regionunder one BSC and site-local Unicast address forcommunicating in a region under one MSC. The mobile nodecan acquire its unicast addresses by using its IMSI of SIM cardas Interface ID. The SIM card or IMSI number of the mobile device is a 15-digit number. In order to use this SIM asinterface identifier, it is assumed that this number is convertedinto IEEE EUI-64 format for mobile interfaces. Let us call the converted format as SIM-EUI 64. Each roaming mobile nodigits two care-of-addresses, one link-local address to move in aregion under particular BSC and one Site-local address to movein a region under one MSC. For the Home agent and the correspondent node, the care-of address of the mobile node would be the IP address of MSC

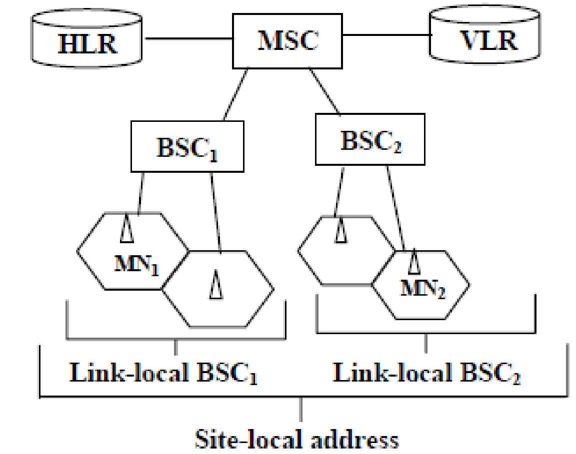

Fig. (7) Proposed Architecture

Each BSC keeps a database of all the nodes in their domainonce the node registers with them. The BSC maintain andmanipulate the tuple <Home address, Link-Local Address,Site-local Address > as and when a node registers or leaves.The Home address is same as the global Unicast address. Thisdatabase at the base station does not differentiate whether themobile terminals registered in it are its own subscribers orroamers. The BSC send updates to MSC each time a particular rnode enters or leaves its domain.A MSC contains list of subscribers in its HLR and roamersin its VLRs. It also maintains the table of tuple <HomeAddress, Site Local Address, Corresponding BSC ID > for all mobile nodes in its region.

6. FUNCTIONALITY OF PROPOSED ARCHITECTURE

Let us consider the different cases that might arise due tothe mobility of the node. Here subscriber refers to the node thatis in its home network and roamer refers to the node in foreign network.

Case 1: When the mobile node is subscriber (it is in its home network): When the Mobile node is in its home network, it does not have any care-of-address and uses its Home address. It acquires its global-scope home address as shown in Fig. 8.

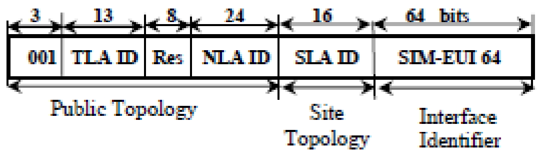

Fig.(8) Global scope address for proposed Architecture

Case 2: When the mobile node is a roamer (it is in a foreignnetwork): When a Mobile node is in away from its homenetwork, it sends the IP address of current MSC as its care-of -address to the home agent and the correspondent nodes.Whenever it is in another domain, it uses addressautoconfiguration and acquires a link-local address from a BSCin that domain as shown in Fig. 9. BSC ID management bitsand BTS ID management bits identify the BSCs and BTSs.

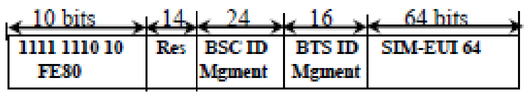

Fig.(9) Link-local address for proposed architecture

At the same time, the mobile node acquires its site-local address as shown in Fig. 10. The MSC Management bitsidentify the particular MSC the MN

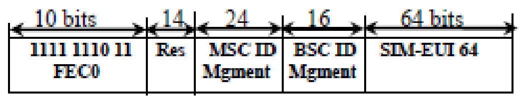

Fig. (10) Site-local address for proposed architecture

The working can be explained as following: Mobile Node-1(MN1) is the sender and Mobile Node –2 (MN2) is the receiver.It is assumed that both MN1 and MN2 are roamers under singleMSC. If MN1 wants to communicate with MN2, packets aresent with MN2's home address as destination. At the BSC,these packets are intercepted and the home address of MN2 ischecked in the database. If it is present in the same BSC, thenthe link-local address of the MN2 is used as destination addressand communication is established as shown in Fig. 11.

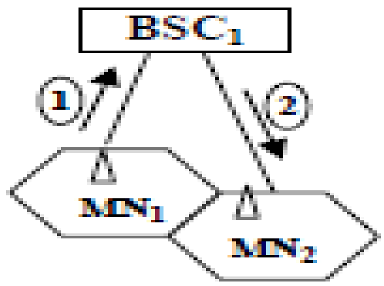

Fig.(11). MN1 & MN2 are under same BSC

If the MN2 is not in the same BSC, then that packet isforwarded to MSC. MSC checks whether MN2 is in its database using its home address. IF it is present, then MSCuses the site-local address for MN2 as CoA and forwards thepacket to MN2 as shown in Fig. 12.

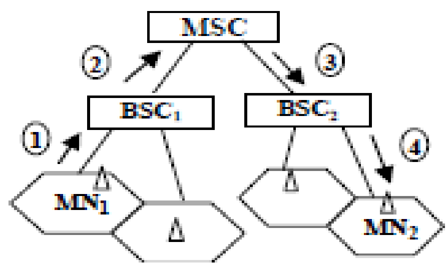

Fig.(12) MN1 & MN2 are under different BSCs but same MSC.

If MN2 is not present in the database of MSC, then MSCforwards that packet to other networks as in conventionalMobile IP networks (macro-mobility case). It is as shown inFig. 13

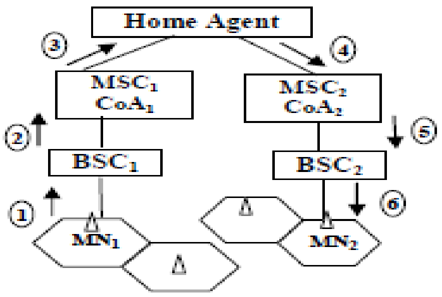

Fig.(13) MN1 & MN2 are under different MSCs (Macro-mobility case)

7. ADVANTAGES OF THIS SCHEME

Whenever the mobile node moves from one BSC to anotherBSC under the same MSC, it changes link-local care-ofaddress, but retains the same site-local care-of address andhence it need not have to send the binding update to its homeagent each time it changes its BSC. The MSC handles thishand-off as it handles for normal hand-off in cellular networks.So MSC handles the intra-domain mobility. Whenever themobile node changes its MSC, then it sends the binding updateto its home agent with the care-of address as the new MSCs IPaddress. This way, the mobile node does not have to send thebinding updates each time it changes its point of attachment.As the number of binding updates to home-agent is reduced,the latency is decreased. Consider this case. MN1 and MN2 areboth roamers, but both are roamers under the same BSC. Inconventional Mobile IP, the routing of packets from MN1 toMN2 will be from the subnet of MN1 to home agent of MN1,from home agent of MN1 to home agent of MN2, from homeagent of MN2 to subnet of MN2 (which is same as that of MN1)and then communication is established. This increases latency.Using the proposed architecture, the communication betweenMN1 and MN2 is established in one go only, due to thedatabase in BSC. It is consistent with the GSM architecture.All the entities in GSM are used with few modifications. As theGSM subscribers now use SIM card, they can still use the SIMcard with slight modification to adapt to this IP basedarchitecture, as it achieves the address using SIM card number**.**

8. ANALYTICAL COMPARISON

Analytical comparisons of different architectures in termsof number of location updates are shown in Table 1. M is the totalnumber of MSCs, HN is Home Network, FN is ForeignNetwork, P is number of mobiles visiting "N" BSCs one byone, N being the total number of BSCs and R is number ofBSCs under one MSC. It is seen that the proposed architectureachieves same efficiency in terms of location updates as that ofTeleMIP, but our proposed architecture takes into considerationMobile IP version 6 and does not make use of separate MobileAgents (MA) and DHCP servers, which helps in decreasedimplementation cost compared to TeleMIP. It is seen that thehigh latency during location update can be reduced if there aremore BSCs under each MSC. Reducing this latency makes itpossible for real-time data to be communicated over wireless channels.

9. CONCLUSIONS

Mobile IP in general and Mobile IPv6 in detail are studied.An architecture to integrate GSM and Mobile IPv6 is proposedwhich can improve the performance of Mobile IP in micromobilityenvironments. The proposed architecture is compared with other architectures. It is observed that the latency can beminimized using this architecture, as the binding updates are not sent to the home agent (and correspondent nodes) each time the MN changes its point of attachment.

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