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           Mobility Management in a SIP Environment
               Requirements, Functions and Issues
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ABSTRACT

Mobility is rapidly becoming a rule rather than an exception in communication services and SIP is gaining widespread acceptance as the signaling protocol for multimedia applications on the Internet. Thus, it is essential to develop a mobility management scheme that utilizes salient features and capabilities of SIP as well as other protocols (e.g., mobile IP) to support mobile services efficiently. Without providing any specific solution, this document presents preliminary requirements and identifies the issues that need to be resolved in order to develop a mobility management scheme for supporting multimedia applications in a SIP signaling and control environment.

1. **Purpose and Scope**

The increasing demand for mobile telephony, and the explosive growth of the Internet are driving forces behind the current boom in the communication industry. On the one hand, mobile wireless telephony is rapidly becoming ubiquitous. The difference between the prices of mobile and fixed telephone services is diminishing and users demand for continuous connectivity is on the rise. Thus, mobility is rapidly becoming a rule rather than an exception, and mobile wireless applications and appliances are becoming predominant. Several technical forums (e.g., 3GPP, 3GPP2, and MWIF) that are working on the specifications of a mobile wireless Internet have chosen SIP as the basic session management protocol. On the other hand, service/network providers/operators are rapidly expanding their IP infrastructure to support the explosive growth of the data traffic of the Internet users. The growth of data service market is much faster than that of telephony, and providers will invest much more in expanding the IP infrastructure than in expanding PSTN. Due to this lop-sided growth of the IP infrastructure, it is reasonable to expect that mobile and fixed Internet telephony will initially complement the 1G/2G mobile and PSTN services in the near future and will inevitably displace them in a much longer term. Since SIP [1] is gaining acceptance as the signaling protocol of multimedia and Internet telephony, it is essential to develop a mechanism for supporting multimedia mobile applications in a SIP signaling and control environment.

The key objectives of this document are to

** describe the frame work requirements for mobility management in general, as well as the mobility management functions and requirements in particular,

** identify open issues involved in supporting application of roaming users in a SIP signaling and control environment, and

   ** include the relevant issues in the agenda of the SIP WG and/or
      other appropriate WGs in the IETF.

   This document is organized as follows: Section 2 provides the overview
   of the end-to-end wireless/wireline IP infrastructure of a mobile Internet.
   In Section 3, we define the terminal, service and personal aspects of
   mobility. Section 4 includes the general system requirements and
   considerations for mobility management. Section 5 focuses on necessary
   functions for supporting mobility as well as their requirements.
   Section 6 identifies some of the open issues involved in supporting
   roaming users in a SIP environment, and Section 7 summarizes the document.

2. Architecture of a Mobile Internet

   We envision that all services, real-time and non-real-time will
   eventually migrate onto a mobile Internet. The users have IP
   stationary or mobile appliances and use end-to-end IP transport and
   signaling/control from user terminal to user terminal including possible
   use of IP transport and control on the air interface.

   Figure 1 depicts the end-to-end packet platform of a mobile Internet
   which comprises all IP wireless access networks and a packet switched
   IP backbone network. The IP backbone network is an end-to-end wireline
   IP infrastructure that will comprise regional providers' wireline IP
   networks that are connected through the wireline Internet. Besides mobile
   stations/terminals, a wireless access network also comprises a radio
   access network (RAN), and an edge router and controller (ERC) [2]. In order
   to support the needs of its users, a wireless access network interacts
   with the network control entities that are shown as Domain Control
   Agent (DCA) in Figure 1. What follows is a brief description of these
   elements and their functions.

2.1. Mobile Station (MS)

   It is the user mobile terminal that allows users to communicate,
   and also provides means of interactions and control between users
   and the network.

2.2. Radio Access Network (RAN)

   The radio access network (RAN) represents the wireless and
   back-haul infrastructure that provides MSs with wireless access to
   the wireline infrastructure. A RAN usually comprises a set of base
   stations and base station controllers. In IMT-2000 [3, 4], RANs
   use programmable software radios to provide flexibility across
   frequency bands at the MS and across the RAN. It is desirable to
   remain independent from the underlying RAN technology and to
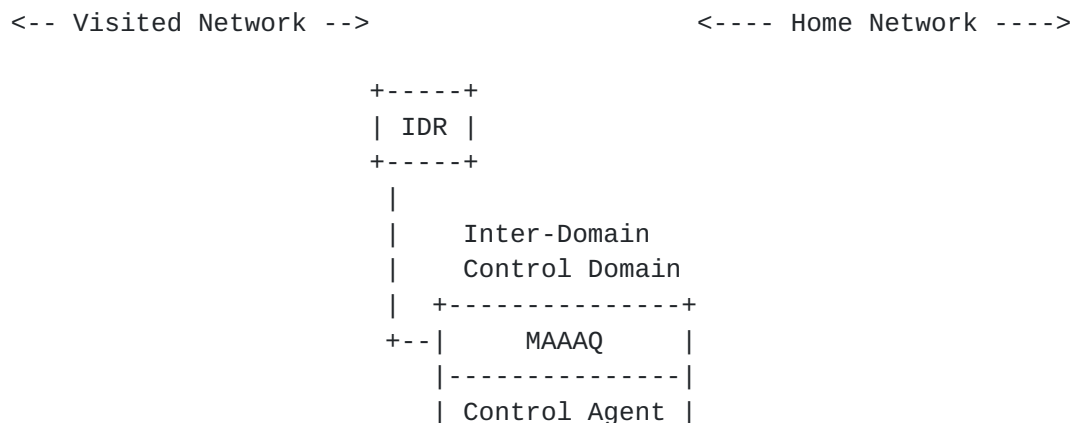   minimize the restriction (or requirements) that it places on (or

expects from) a RAN.

[2.3](). Edge Router & Controller (ERC)

An ERC is a routing and control system that connects a wireless
access network to a regional wireline IP network. Although Figure 1
depicts one RAN per ERC, in practice, each ERC may support several
RANs. An ERC comprises two functional entities, an edge router
(ER) and an edge control agent (ECA). The ER is an IP router,
while the ECA is an intelligent agent that interacts with the
domain control agent (DCA) to control the RANs as well as support
necessary network-wide control tasks. In the IP parlance, each ERC
is the default gateway of all IP MSs that are supported by RANs
that are connected to it.

[2.4](). Domain Control Agent (DCA)

The domain control agent (DCA) provides session management as well
as means for interaction between users and network control system
and interaction among network control entities. Furthermore, the
DCA also supports: (1) Mobility management, (2) Authentication,
Authorization, and Accounting (AAA), and (3) QoS management, in
summary MAAAQ, functions for mobile users. These functional
entities usually reside on the wireline backbone, and are part of
the overall control system of the end-to-end platform. As Figure 1
indicates the home and visited DCA entities may either interact
directly or via a third party Inter-Domain Control Agent (IDCA) on
the global Internet. In the latter case, the IDCA entity serves as
a trusted broker between the home and visiting network DCAs.

```
    <-- Visited Network -->                    <---- Home Network ---->

                        +-----+
                        | IDR |
                        +-----+
                         |
                         |     Inter-Domain
                         |     Control Domain
                         |   +---------------+
                        +--|      MAAAQ      |
                           |---------------|
                           | Control Agent |
```

```
                           +---------------+
        +----+             |               |        +----+
        | VR |             |               |        | HR |
        +----+             |               |        +----+
          |                |               |          |
          |                |               |          |
       Domain|             |            Domain|       |
       Control|Agent       |            Control|Agent
      +---------------+     |           +---------------+
      |    MAAAQ      |     |           |    MAAAQ      |
      +---------------+     |           +---------------+
      |  SIP Server   |     |           |  SIP Server   |
      +---------------+     |           +---------------+
            |               |                 |
          __|__           __|__             __|__
         /     \         /     \           /     \
        /       \       /       \         /       \
       /Regional IP_____/ Internet _____/Regional IP\
       \  Network  /         \           /         \  Network  /
        \         /           \         /           \         /
       ---_____/---          _____/          ---_____/---
         |       |                                    |       |
      +-----+  +-----+                             +-----+  +-----+
      | ERC |  | ERC |                             | ERC |  | ERC |
      +-----+  +-----+                             +-----+  +-----+
         |       |                                    |       |
         |       |                                    |       |
         |       |                                    |       |
        _|_     _|_                                  _|_     _|_
       /   \   /   \                                /   \   /   \
      / Radio \ / Radio \                          / Radio \ / Radio \
      / Access \ / Access \                        / Access \ / Access \
      \ Network / \ Network /                      \ Network / \ Network /
       \     /   \     /                            \     /   \     /
        \___/     \___/                              \___/     \___/
         |         |                                  |         |
         |         |                                  |         |
       +----+    +----+                             +----+    +----+
       | MS |    | MS |                             | MS |    | MS |
       +----+    +----+                             +----+    +----+
```
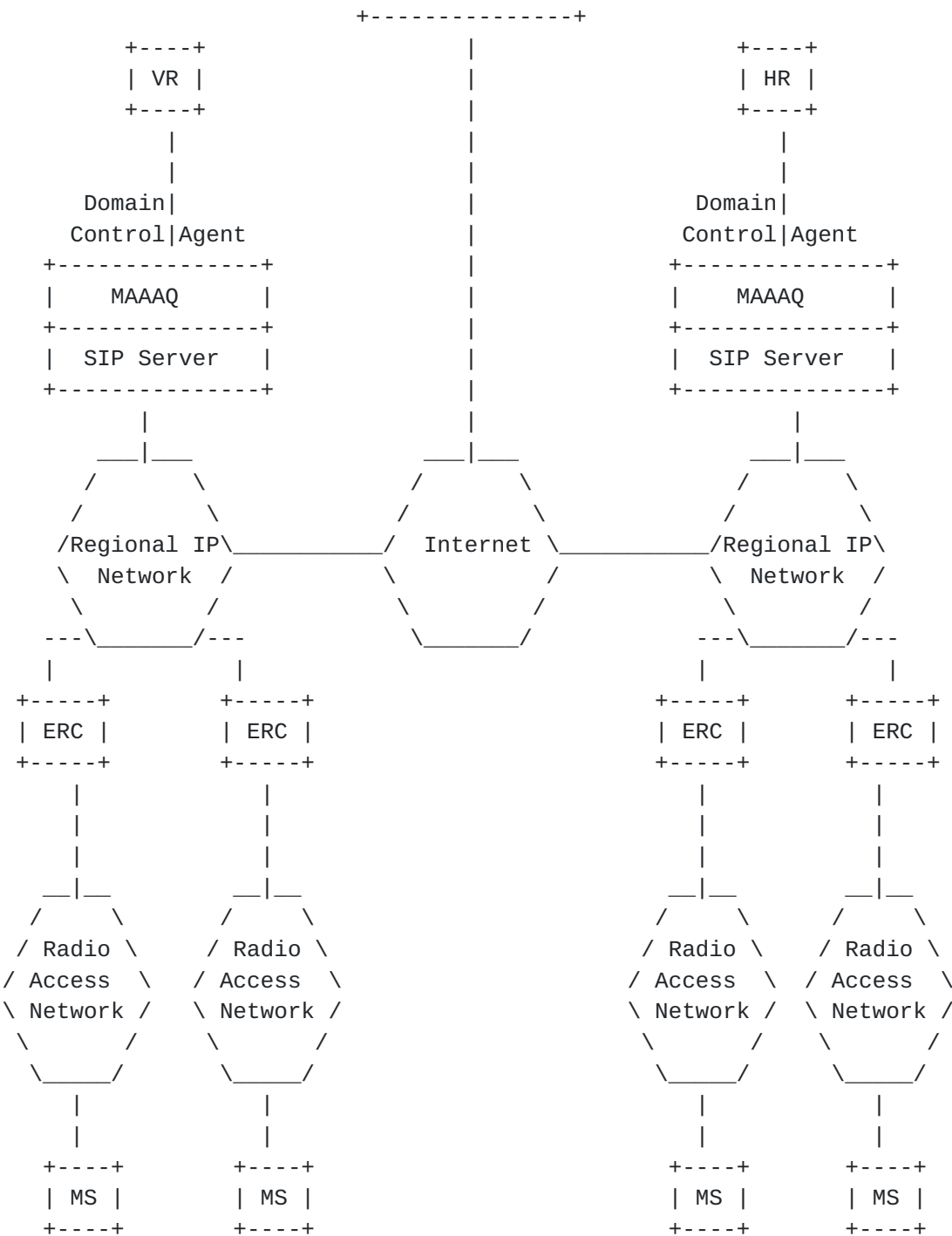
        Figure 1. Architecture of a mobile Internet

    As shown in Figure 1, DCA entity of the mobile wireless/wireless IP
    network is built around SIP [1]. It comprises comprises SIP servers
    and agents, MAAAQ entities, and SIP registrars. All MSs and fixed

hosts have SIP user agents that provide means of interactions with
the SIP servers (i.e., proxy servers, redirect servers, and registrar)
within the network. In Figure 1, the SIP server entity of each DCA
represents the set of SIP proxies and SIP redirect servers within a

regional IP network. Similarly, the registrar represents the server
(or set of servers) that accepts (accept) SIP REGISTER requests and
provides (provide) necessary functions, similar to those of the
home/visiting location registries (HLR/VLR) in today's wireless
telephony to roaming users. As Figure 1 shows the MAAAQ entity
uses SIP features and capabilities to support roaming users. The
illustration of the MAAAQ entities and SIP server as a single module in
Figure 1 should not be interpreted as a requirement for having a
centralized SIP server or MAAAQ entity per regional network. Figure 1
only shows the required functions, though each of the SIP and MAAAQ
entities comprise a set of distributed agents. Similarly, the SIP
registrars (i.e., HR, VR, and IDR) may be implemented as either
central or distributed databases.

The remainder of this document focuses primarily on the requirements,
functions, and issues that arise in supporting roaming users in such
an IP wireless-wireline infrastructure.

[3]. Different Facets of Mobility: Definitions

In principle a mobility management protocol provides means of terminal,
session and service, and personal mobility, where:

1. Terminal Mobility: refers to an end user's ability to use her/his
   own terminal in any location and the ability of the network to
   maintain the user's ongoing communication as she/he roams across
   radio cells within the same subnet, subnets within the same
   administrative and or different administrative domains.

2. Service Mobility: refers to the end user's ability to maintain
   ongoing sessions and obtain services in a transparent manner.
   For instance, the user of a mobile terminal should be able to
   move a specific session to a laptop/DSL terminal without losing
   the session. The service mobility includes the ability of the
   home service provider to either maintain control the services it
   provides to the user in the visited network or transfer their
   control to the visited network.

3. Personal Mobility: refers to the ability of end users to originate
   and receive calls and access subscribed network services on any
   terminal in any location in a transparent manner, and the ability
   of the network to identify end users as they move across
   administrative domains.

[4]. Framework Requirements for Mobility Management

In general, the mobility management scheme of wireless IP networks
satisfies the following requirements [2, 5, 6].

   I. It supports means of personal, service, and terminal mobility,
      i.e., it allows users to access network services anywhere, as
      well as to continue their ongoing communication and to access
      the network services anywhere using their own mobile
      terminal/station (referred to as the mobile station or simply
      MS, hereafter).

  II. It supports global roaming, i.e., it should allow users
      to roam across different technology platforms, and across
      subnets within the same administrative domain as well as across
      subnets that belong to different administrative domains.

 III. It is wireless "technology-independent", i.e., it should
      remain independent of the underlying wireless technology.
      This requirement allows the ISPs and network operators to
      upgrade their sub-systems independently and build multi-vendor
      solutions. Furthermore, this requirement ensures that the
      mobility management scheme can be transported over all members
      of the IMT-2000 family which comprises several wireless
      technologies such as W-CDMA, TDMA, etc. [3, 4].

  IV. It supports both real-time and non-real-time multimedia
      services such as mobile telephony, mobile web access, and mobile
      data services in a way that their prices and performance are
      comparable to those of their counterparts in today's mobile
      voice and data services. In order to do so, the mobility
      management scheme should interact effectively with the QoS management
      and authentication, authorization, and accounting (AAA) schemes
      of the end-to-end network to verify the users' identities and rights,
      as well as to ensure that the QoS requirements of applications
      are satisfied and maintained as users roam around.

   V. It transparently supports current TCP-based Internet application.
      It should support TCP as is without requiring any changes to TCP
      protocol or TCP-based applications, i.e., it should spoof/maintain
      constant end-points for TCP connections.

  VI. It allows a mobile station/user to decide whether it conveys its
      location to correspondent hosts or not. This requirement allows
      users to enhance their confidentiality and privacy, when necessary.

 VII. It supports multicast and anycast trees efficiently as mobile
      stations/users move around.

VIII. Last but not least, it interworks smoothly with PSTN and today's
      1G/2G wireless telephony to facilitate interworking of new operators'
      all IP platforms with PSTN and the existing 1G/2G wireless telephony
[5].

5. **Mobility Management Functions and Requirements**

   Simply speaking, a roaming MS should be able to receive (and send)
   calls/data from (and to) anyone in any place, and maintain its
   ongoing communications with others with minimal (if any at all) QoS
   degradation regardless of its point of attachment to the network.
   In order to achieve this goal, the mobility management scheme shall
   support hand-off, registration, configuration, dynamic address
   binding, and location management whenever necessary. The remainder
   of this section describes these functions as well as their performance
   requirements in more detail.

5.1 **Hand-off**

   Hand-off (or handover) is a process that allows a established
   call/session to continue when a MS moves from one cell to another
   (intercell) or between radio channels in the same cell (intracell)
   without interruptions in the call/session. The hand-off process can
   be either hard or soft. In the hard hand-off the mobile receives and
   accepts only one radio signal from a radio channel or base station
   within a single cell. As the mobile moves into a new cell, its signal
   is abruptly handed over from its current cell (or base station) to the
   new one rapidly in a few seconds.

   With soft hand-off the MS continues to receive and accept radio
   signals from the base stations within its previous as well as its new
   cell for a limited period of time. Signal reception from the old base
   station ceases when the signal strength drops/reduces below a certain
   threshold. As its name indicates, soft hand-off smoothly transfers the
   MS's session from its old base station to the new one. All third
   generation CDMA wireless technologies use soft hand-off. The soft
   hand-off process can take a relatively long period (i.e., several seconds),
   particularly, when it includes the entire process of pilot strength
   measurement, issuing of pilot strength measurement message (PSMM) on
   the uplink, and addition of new pilot to active set. In principle,
   soft hand-off is NOT always a transient process, and may take a long
   time depending on MS's request and requirements.

   In order to take advantage of the soft hand-off feature of the third
   generation CDMA wirless technologies in mobile IP packet networks,
   during the soft hand-off period, the packets which are destined for
   a MS shall be routed to both its previous and current locations.
   This routing of packets to the current and previous locations of a
   MS constitutes a logical/virtual soft hand-off at the IP layer.

   The hard hand-off process should take only a few second, while the soft
   hand-off process can take much longer (i.e., about several seconds).

Nevertheless, in order to ensure the wireless "technology independence" requirement of mobility management schemes, we require a maximum acceptable hand-off time (MAHT) a few seconds (i.e., MAHT = 2-3 seconds). This requirement is acceptable for both hard and soft hand-off mechanisms, though it can be relieved significantly in the case of soft hand-off.

We identify three levels of logical/virtual hand-off: cell, subnet, and domain.

a. Cell hand-off (or micro-mobility): It allows a MS to move from a cell to another in a subnet within an administrative domain.

b. Subnet hand-off (or macro-mobility): It allows a MS to move from a cell within a subnet to an adjacent cell within another subnet that belongs to the same administrative domain.

c. Domain hand-off (or global mobility): It allows a MS to move from one subnet within an administrative domain to another in a different administrative domain.

In general, the cell hand-off is more frequent than subnet hand-off and subnet hand-off is more frequent than the domain hand-off. The hand-off process is built upon the registration, configuration, dynamic address binding, and location management functions. Hand-off process is transparent to users and satisfies the following requirements.

  i. All three hand-off processes ensure the integrity, privacy and confidentiality of users' information as well as prevent fraud and theft of service. They

    - ensure the security of signaling (e.g., registration) messages to prevent eavesdropping and theft of users' data and service profiles as well as maintain confidentiality of users' locations, and

    - perform the necessary AAA process to verify users' identities and their rights to requested resources, and ensure correct and non-repudiatable accounting.

  ii. All three hand-off processes strive ensure service mobility as the MS roams around. In order to do so, they strive to

    a. maintain the QoS of ongoing sessions, when mandatory, through minimizing the loss of transient data during the hand-off,

as well as satisfying the delay requirements of real-time
applications as a MS roams around, and

b. ensure that MS has access to all of its subscribed network
services

and features (e.g., pre-paid services) regardless of its point of
attachement.

iii. The domain hand-off latency should not exceed MAHT to ensure continuity
of real-time sessions.

iv. The subnet hand-off latency shall not exceed MAHT, though it should be
much less than domain hand-off latency because it does not usually
involve AAA process.

A few points are worth noting. First, the domain hand-off process is
functionally equivalent to the sum of subnet hand-off and AAA processes.

Second, the domain hand-off latency is the sum of the registration,
configuration, and address binding latencies, while location management
process can be performed after (or concurrent with) the hand-off. Let
us use a qualitative and intuitive discussion to estimate rough upper
bounds of the registration and configuration latencies. Let us assume that
processing delay is negligible, and the upper bound on the soft hand-off
latency, MAHT is about 2-3 seconds. The address binding latency is at
most an end-to-end (source - destination - source) round trip queueing and
propagation delay. The round trip propagation delay for continental U.S.
is about 50 ms (i.e., New Seattle - Miami - Seattle). Assuming an address
binding delay of 1 second, we are left with less than 1-2 seconds
for both registration and configuration delays. The goal is to get the
configuration latency down to millisecond (e.g., a few hundred milliseconds,
and bounded mostly by the speed of the access link) [15]. Thus, with soft
hand-off registration latency shall not exceed 1-2 seconds. The preceding
back of the envelop calculation indicates that that registration and
configuration should take roughly 1-2 seconds though thorough measurements
are needed to establish precise upper bounds on the registration and
configuration latencies.

Third, in order to satisfy the "wireless-independence" and global roaming
requirements, the hand-off processes minimize their reliance on the
link layer. To achieve this goal, the subnet and domain hand-off processes
remain completely independent from the link layer, while the cell hand-off
(i.e., micro-mobility) strives to minimize its dependence on the link layer
specifications.

5.2 Registration

Registration is a process by which a network becomes aware of the existence
and the location of an MS and its associated user. When an MS becomes active

   (i.e., is turned on) in a network or roams into a new subnet or domain, it
   shall register with the network. This process comprises sending a
   registration request from the MS to the network, and performing an AAA
   (i.e., authentication, authorization, and accounting) process by the
network,
   and sending appropriate responses to the MS as well as location management
   entities to ensure that the network is aware of MS's current location.
   There are two types of registration, complete and expedited (or partial).

   a. Complete Registration: This process occurs when a user turn on its MS
      or roams into a new administrative domain (i.e., during domain hand-off).
      In this case, the network shall perform AAA, and send appropriate
      responses to the MS and location management entities.

   b. Expedited/Partial Registration: This process is invoked when a user
      moves from one subnet to another within the same administrative domain
      (i.e., subnet hand-off). It does not include AAA process of complete
      registration, and its main objective is to keep the location information
      up to date.

   The complete registration process should not take more than 1-2 seconds
   to be performed. The expedited registration process usually takes much less
   than the complete registration process.

5.3 Configuration

   Configuration is a process by which a MS updates its IP address as it roams
   between subnets either within the same administrative domain or in different
   administrative domains. As an MS moves between subnets (either within the
   same domain or in different ones), it needs to acquire a new IP address,
   possibly new default gateway, subnet mask, etc. as well, and to reconfigure
   itself accordingly.

   The key requirements of the reconfiguration process are that it

   ** should not take more than a few hundred milliseconds to complete, and

   ** should update the DNS to reflect the current address to name and name
      to address mappings [21, 22], if necessary.

   The latter is necessary when the MS is a server for a protocol, and also
   ensures that the new TCP connections are established using MS's current
   address. If the underlying wireless platform supports soft hand-off,
   the reconfiguration process can take more time. However, a few hundred
   milliseconds upper bound should be acceptable for both soft hand-off
   and hard hand-off.

5.4 Dynamic Address Binding

Dynamic address binding is a process for allowing an MS to maintain a
constant identifier (e.g., a constant URL) regardless of its point of
attachment to the network (e.g., its IP address). Dynamic address
binding

** allows a user to maintain a universal identifier (e.g., a SIP URL)
   regardless of its point of attachment to the network (e.g., its IP
   address), and

** facilitates support of TCP-based applications by informing each endpoint
   about the current address of the other one.

Needless to say that required signaling for dynamic address binding should
be secure to ensure privacy and location confidentiality and protect users
against fraud.

5.5 Location Management

Location management is a process by which the network updates the location
database and supports location/redirect services to authorized users and
authorities. The location service is essential only for new inbound
sessions.
Key requirements of location management are accuracy, being up to date,
and confidentiality of the location information. The location information

** should be up to date and accurate, e.g., the domain name service shall
   ensure correct name to address and/or address to name mapping as soon
   as possible, and

** should only be disclosed to authorized users and relevant authorities
   within the scope of the law.

5.6 Required Functions for Cell, Subnet, and Domain Hand-off

Table 1 summarizes the functions that are needed for supporting each level
of hand-off, cell, subnet and domain.

Hand-off type	Registration	Configuration	Address Binding	Location Management
Cell	NO	NO	Yes (link layer)	Yes
Subnet Intra-domain	NO	Yes	Yes	Yes
Domain Inter-domain	Yes	Yes	Yes	Yes

Table 1. Required functions for supporting different levels of hand-off

6. Issues in Supporting Mobility in a SIP Environment

Having described mobility management and its requirements, let us identify a preliminary list of open issues that arise in supporting these requirements in a SIP control environment for further study.

6.1 Supporting macro and global mobility for multimedia applications of roaming users

In principle, mobile IP [8, 9] provides means of macro and global mobility for non-real-time services. It provides means of terminal mobility as well as dynamic address assignment using network access identifier (NAI). However, mobile IP by itself does not provide means of personal mobility and location service. Furthermore, the impact of the triangular routing (in classic mobile IP) and route optimization scheme on the QoS requirements of real-time services requires further study. Different approaches for either coexistence of SIP and mobile IP [8, 15], or the development of a new SIP based mobility management protocol [11] have been proposed. However, the interaction and harmonization of mobile IP with the SIP signaling scheme of real-time services requires further study to determine the best approach for combining the salient features of mobile IP terminal mobility with those of the SIP personal mobility. Such an approach should

** spoof constant endpoints for TCP connections and support TCP as is without
     any modification to TCP protocol or TCP-based applications, and

** require RTP [17] applications to accept packets with the same
     synchronization source (SSRC) but different source IP address.

6.2 Complete registration in less than a few seconds

Registration in a mobile environment has two objectives, informing the network about the MS (or user) and its location, and verifying the MS identity and services that the MS is entitled to. Using SIP REGISTER method, one can adequately achieve the former in the MS's home network. However, the latter is an essential required function that allows MSs to roam among different administrative domains. One can conceive several alternatives for performing complete registration.

One alternative is that the MS utilizes a separate protocol such as DRCP [13] or mobile IP [8] to register with the network, and then uses the SIP REGISTER method to register with a SIP registrar that provides location service as well. In this case, the registration process places no additional requirements on SIP.

Another alternative is the SIP registration process [12] that uses SIP
REGISTER method and possible interactions of SIP registrars of different
domains with one another through the AAA entities of the home and
visited networks to verify a user's identity and rights and grant or
or deny the registration. In this case, SIP registrars should be
able to utilize/interact with an AAA scheme to adequately perform
mobile registration. Moreover, though NOT necessarily a SIP issue,
it essential to have a fast and scalable AAA mechanism for wide area
networks that can authenticate and authorize a MS and its user in
less than a few seconds. See McAuley, et al. [14] and Basilier,
et al. [20] for further details on AAA requirements and constraints.

6.3 Reconfiguration in fractions of a second

This requirement is an important one. It does not seem to impose any
requirements on SIP, however, it places significant requirements on
DHCP (see McAuley, et al. [16] for further details). As the MS roams
into a new subnet or a new administrative domain, it may need to acquire
a new address before being able to register. In order to do so, the MS
interacts with DHCP [7] to obtain a new IP address, and reconfigure
itself. Currently, due to its collision detection procedure, it takes
DHCP several seconds to reconfigure a host. This latency is usually
too much for mobile users. Different schemes such as fast DHCP that
does not perform conflict resolution, and or novel schemes such as
dynamic registration and configuration (DRCP) [13] have been proposed
to reduce the reconfiguration delay of a MS. Moreover, DHCP may need
to interact with DNS and update it dynamically so that the name
to address mappings remain current. Further study is needed to arrive
at appropriate solutions for these issues. The rationale for the
dynamic updating of DNS is to ensure that new non-SIP (e.g., TCP)
in-bound sessions are established with correct and current address
of the MS.

6.4 Providing location service

As the MS roams around it should update its location so that authorized
users can direct their new calls/sessions to the MS's current location.
Among the approaches for providing location service are

 a. the dynamic update of the DNS, and

 b. the development of a brand new protocol that allows applications
    to use SIP registrar for name to address and address to name
    mappings.

Neither of these approaches seems to have any impact on SIP specifications,
though the latter should be built upon the SIP specifications and use

SIP methods.

6.5 Supporting the soft hand-off procedure

The third generation CDMA wireless technologies all support soft hand-off
procedure which allows a roaming MS to receive and accept signals from
both its new base station as well the old one simultaneously during the
soft hand-off period (about several seconds). In order to utilize this
feature the macro and global mobility scheme shall emulate a virtual soft
hand-off at the IP layer via forwarding the session's packets to the old
as well as the new location of the MS during the soft hand-off. Since the
correct realization of the soft hand-off procedure in IP-centric
environments
is complex, some have suggested not to use it in IP wireless networks [18].
However, we believe supporting soft-hand-off is essential because it
improves the capacity and performance of CDMA wireless networks. We have
developed a virtual soft hand-off scheme [19] that uses SIP to extend the
ongoing session to the new location of the MS, and drop the old location
after a limited period of time. The performance - complexity trade-off of
the proposed virtual soft hand-off schemes requires further study.

6.6 Providing secure signaling for mobile users

Due to the ease of "wire-tapping" in a wireless environment, the signaling
and user data should be encrypted to ensure privacy and confidentiality of
users and protect them against fraud and theft of service. SIP messages can
already be encrypted. Nevertheless, the SIP WG has chartered a task force to
identify and address issues (e.g., key management) that arise in enhancing
SIP security mechanisms. This task force should address security issues
in the context of wireline as well as wireless networks.

7. Summary and Conclusions

This document focused on supporting mobility in a SIP signaling and
control environment. It identified the functions, requirements, and
open issues so that they are included in the agenda of the SIP WG as
well as other appropriate WGs of IETF in a timely manner.

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(TM): ITSUMO (Internet Technology Supporting Universal Mobile
Operation) is a trademark of Telcordia. It is a joint research
project of Telcordia Technologies and Toshiba America Research Inc.
(TARI). It envisions an end-to-end wireless/wireline IP platform for
supporting real-time and non-real-time multimedia services in the
future. Its goal is to use IP and third generation wireless
technologies to design a wireless platform that allows mobile users
to access multimedia services on a next generation Internet. In
Japanese, ITSUMO means anytime, all the time.

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