Mobile SCTP for Transport Layer Mobility

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Abstract

   This document discusses the architecture of mobile SCTP (mSCTP) for
   IP mobility support. The SCTP is the third transport layer protocol
   next to TCP/UDP. It can also be used for IP mobility from the multi-
   homing features. The SCTP with the ADDIP extension (or mSCTP) would
   provide seamless or soft handover for the mobile host without support
   of routers or agents in the networks. For location management, the
   mSCTP could be used along with Mobile IP, Session Initiation Protocol
   or Reliable Server Pooling.

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1. Introduction

   SCTP (Stream Control Transmission Protocol), as defined in RFC 2960
   [3], is the third transport layer protocol following TCP and UDP. The
   SCTP is featured multi-streaming and multihoming, differently from
   TCP. It is noted that the multihoming feature of SCTP enables the
   SCTP to support the IP mobility.

   More specifically, the SCTP with the ADDIP extension [4], which is
   called mobile SCTP (mSCTP) in this document, can be used to provide
   seamless handover for mobile hosts that are moving into different IP
   network regions during the active session [5, 6].

   The mSCTP may be used as an alternative scheme against the handover
   schemes based on Mobile IP [7, 8]. Differently from the Mobile IP
   based handover schemes, which rely on the support of network routers
   for tunneling between access routers, the mobile SCTP provides the
   handover management at the transport layer without help of routers.

   The mSCTP can be used to provide seamless handover for mobile hosts
   that are moving in to different IP networks. In other words, the
   mSCTP is targeted for the client-server services, in which the mobile
   client initiates an SCTP session with the fixed server. For
   supporting the peer-to-peer services, in which a session is
   terminated at the mobile host, the mSCTP must be used along with an
   additional location management scheme such as Mobile IP [9], Session
   Initiation Protocol (SIP), Reliable Server Pooling (RSerPool) [11] or
   Dynamic DNS (DDNS).

   This document describes the architecture of SCTP for IP mobility
   support. Specifically, we describe the use of SCTP for seamless
   handover by using the SCTP ADDIP extension [5]. We also discuss how
   to integrate SCTP with SIP, MIP or RSerPool for location management.

   This document is intended to continue discussion to explore the use
   of SCTP for IP mobility support. Please send comments to the mailing
   list <mobile@sctp.de>. To subscribe to this mailing list, please send
   a mail to <mobile-request@sctp.de>.

2. Terminology

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in RFC 2119 [2].

   In this document, "mSCTP" is short for "mobile SCTP".

3. Motivations on Mobile SCTP

   In this section, we discuss motivations on the use of SCTP for IP
   mobility support, in the viewpoint of IP mobility management issues.

3.1 IP Mobility Issues

   IP mobility issues have been focused and are regarded as a core
   technology required for providing seamless mobility in the wireless
   mobile networks such as WLAN, 3G Cellular. IP mobility issues can be
   classified into Location Management and Handover Management.

3.1.1 Location Management

   Location Management is used to identify the current location of
   mobile nodes and also to keep track of the their location changes as
   they move on.

   In Mobile IP [7, 8], the mobility agents such as Home Agent (HA) and
   Foreign Agent (only for IPv4) are employed for location management as
   well as data transport. In the schemes, Home Address (HoA) and Care-
   of Address (CoA) are used for a terminal identifier and a location
   identifier of the IP host, respectively. For location management, the
   Mobile IP uses the binding update messages, in which a mobile node
   has to inform its current location (CoA) to its HA.

   SIP can also be used for location management. In SIP, a UA registers
   its new location with the location database via SIP Registrar server
   by sending an SIP Register message containing a Contact Header.

   So far, the Dynamic DNS (DDNS) has also been discussed as one of the
   candidate approaches for location management, which would not require
   special servers or procedures for mSCTP client.

3.1.2 Handover Management

   The handover management is targeted to provide the mobile hosts for
   seamless handover whenever they change their point of attachment to
   IP networks (as represented by cell regions or IP subnets). The main
   objective of the handover management is to minimize the service
   disruption due to data loss and/or handover latency during handover.

   In Mobile IP, the Low Latency or Fast handover schemes have been
   designed for handover management. These schemes rely on the tunneling
   between old and new access routers for seamless handover.

The mobile SCTP can be used as an alternative scheme against such
Mobile IP based handover schemes. Differently from the Mobile IP
handover schemes that rely on the help of network routers for
tunneling between access routers, the mobile SCTP provides the
handover management at the transport layer without help of routers.

3.2 SCTP Multihoming Feature

The SCTP intrinsically provides the multihoming feature [3], in which
a mobile node is allowed to simultaneously bind multiple IP addresses
to its network interface.

The recent works on the SCTP include the ADDIP extension [4]. The
ADDIP extension enables the SCTP to add, delete and change the IP
addresses during active SCTP association.

In this document, the SCTP implementation with the ADDIP extension is
called the mobile SCTP (mSCTP) [5]. The mSCTP can be used for
seamless handover while the mobile node is moving into different IP
network regions over the session period. This document aims at
discussing the use of mSCTP for seamless handover, which includes the
specific handover procedures and associated implementation issues.

3.3 Session Type considered in Mobile SCTP

Sessions considered in mobile communications can be classified into
the following two types:

 a. Session originated from mobile host toward fixed host
 b. Session originated from fixed host toward mobile host

The mobile sessions in (a) seem to be a natural extension of the
client-server model, in which the mobile host originating the session
can be viewed as a client, while the counter endpoint will function
as a server.

On the other hand, the case (b) requires the additional location
management functionality for the session originator to find the
current location of the mobile host and to keep track of the location
changes, which has so far been addressed by Mobile IP [7, 8].

The mobile SCTP, in the present form, is targeted for seamless
handover of mobile session associated with the case (a). To support
the session type of the case (b), the mSCTP must be used along with
an additional location management scheme such as SIP, Mobile IP [9]
or RSerPool.

4. Procedures for mSCTP Handover

    In this section, we describe the generic algorithm of mobile SCTP for
    handover in the procedural manner, which is designed based on the
    scheme in [5].

    The mSCTP handover needs to be triggered by MC because only the MC
    knows the movement of itself and the signal strength from the old and
    new ARs.

    More specifically, we consider a mobile client (MC) that initiates an
    SCTP association with a fixed server (FS), and then moves from
    Location A (2.2.2.x domain) to Location B (3.3.3.x domain), as shown
    in Figure 1.

```
                               [1.1.1.2]
                                +----+
                                | FS |
                                +----+
                                  ||
                              ##########
                              # Router # [1.1.1.1]
                              ##########
                                  ||
                               *******
                             ***        ***
                           **              **
                           **    Internet    **
                           **                **
                           **              **
                             ***        ***
                          ||  ******** ||
                          ||           ||
                       #######        #######
          [2.2.2.1]    # AR1 #        # AR2 #  [3.3.3.1]
                       #######        #######
                          |              |
                 Location A |              | Location B
                          |              |
                       +----+          +----+
                       | MC |========>| MC |
                       +----+          +----+
                      [2.2.2.2]        [3.3.3.2]
```
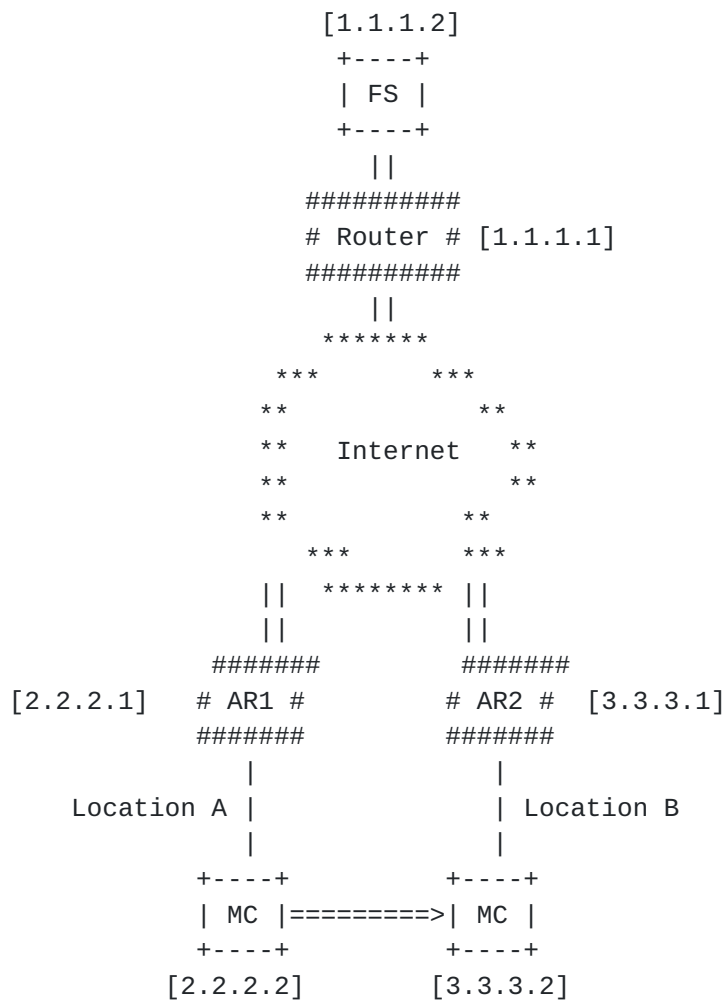
                   Figure 1. SCTP for Seamless Handover

Figure 1 illustrates an example of the use of mobile SCTP for
seamless handover in IPv4 networks. Based on this figure, the
handover procedures are described in the succeeding sections.

4.1 Session Initiation by Mobile Client

We assume that the MC initiates an SCTP association with the FS. The
resulting SCTP association has the set of IP addresses with [2.2.2.2]
for MC and [1.1.1.2] for FS. It is also assumed that the MC can get
an IP address ([2.2.2.2]) with help of DHCP or IPv6 stateless address
auto-configuration.

Note that the FS is in the single homing with [1.1.1.2], and the MC
is also in single homing state, in which the IP address [2.2.2.2] is
set to its primary IP address in the SCTP initiation process.

4.2 Obtaining an IP address for a new location

Let us assume that the MC moves from Location A to B. In this phase,
we also need to assume that the MC can obtain a new IP address
belonging to the Location B, which may be possible with help of the
DHCP or IPv6 address auto-configuration capability in the Location B.

Obtaining a new IP address may also rely on the support of the
wireless signaling control at the physical layer, in order for the MC
to get the IP address information via IP control packets from the
Location B.

By SCTP, the newly obtained IP address ([3.3.3.2] in the figure) MUST
be signaled or informed to the SCTP protocol stack, and then the SCTP
will bind the new IP address to the existing SCTP association.

4.3 Adding the new IP address to the SCTP association

After obtaining a new IP address, the SCTP of MC MUST inform the
Fixed Server about the new IP address by sending Address
Configuration Change (ASCONF) Chunk to the FS. The MC may receive the
corresponding ASCONF-ACK Chunk from the FS.

4.4 Changing the Primary IP address

While the MC continues to move toward the Location B, it needs to
change its primary IP address to the new IP address according at an
appropriate rule.

Actually, the configuration of a specific rule for changing the primary IP address is a challenging issue of the mobile SCTP.

Some of the possible rules for triggering the primary IP address change are listed below:

a. As soon as a new IP address is detected

   When the MC receives the ASCONF-ACK from FS, it sends another ASCONF with "Address Configuration Parameter" set to "Set Primary Address".

   FS sends back ASCONF-ACK once receives the second ASCONF to confirm the handover successfully.

   This choice may be preferred in terms of the handover latency, in particular, for the fast-moving MC. However, it is less suitable when the MC shows a so-called oscillation (or ping-pong) behavior across those two locations.

b. By using an explicit indication from the underlying layer

   In this case, the underlying PHY layer of MC detects and compares the signal strength, and determines the time on when the SCTP sends an ASCONF with "Set Primary Address".

   If the underlying physical layer can detect and compare the signal strength of the physical media, and also inform the SCTP about a certain indication (possibly by using a up-call), then the MC may trigger the primary address change according to the indication.

   This rule is a more preferred choice, but seems to depend on the wireless system concerned and its implementations.

c. By using an indication from the upper layer

   The change of the primary IP address may also be triggered by an indication from the upper layer of the MC. In particular, this scenario may be considered when an MC is in an overlay mobile communication environment where two or more networks are available at the same time, such as the so-called intersystem handover or vertical handover between WLAN and 3GPPs. In this case, a vertical handover of the MC can be triggered from an upper layer indication by considering a trade-off between connection bandwidth, coverage and cost from the concerned systems/locations.

If once the primary address is changed, the FS will send the upcoming data over the new primary IP address.

There is still a further issue on how the MC should handle the data
packets queued in the outgoing buffer with the source IP address of
the old primary IP address.

4.5 Deleting the old IP address from the SCTP association

As the MC progresses to move toward the Location B, if the old IP
address gets inactive, the MC MUST delete the IP address from the
address list. The rule for determining that the IP address is
inactive may also be implemented by using additional information from
the underlying network or physical layer, as done in the previous
step (for changing the primary address.)

4.6 Repeating the handover procedures

The procedural steps for seamless handover described above will be
repeated whenever the MC moves to a new location, until the SCTP
association will be released.

One particular further consideration in the handover procedures is
that Steps 4.3 (adding), 4.4 (primary change) and 4.5 (deleting) can
possibly be performed at the same time, which may depend on a
specific implementation of mSCTP or network environment concerned.
This issue needs to be investigated for further study.

5. Further Considerations for mSCTP Handover

5.1 Requirement for Mobile SCTP

The only requirement for providing the seamless handover based on
SCTP is that the MC and FS hosts are equipped with the Mobile SCTP
implementations, (i.e., SCTP with ADDIP extension.)

5.2 Number of IP addresses used by Fixed Server

In this document, we assume that the FS is in the single homing, i.e.
the FS and MC are in a 1-to-2 asymmetric multi-homing configuration
[10]. In a certain case, we may need to consider the multi-homed FS.

It is noted that there are still many further issues on how to handle
the mSCTP handover or which is better in the performance aspect for
each of the single-homed and multi-homed FS cases. For more
information on this issue, please refer to [5, 6].

5.3 Dynamic IP address configuration

   The basic assumption for seamless handover to a new IP subnet region
   is that the MC is able to obtain a new IP address from the new
   location. Typically, this will be implemented by using DHCP in IPv4
   networks and DHCPv6 or Stateless address auto-configuration in IPv6
   networks.

   The handover latency incurred for obtaining the new IP address via
   DHCP or IPv6 needs to be examined by experiments. The concerned
   handover latency also includes the delay required for the handover
   delay between the wireless links.

5.4 AAA Functionality

   It is envisioned that the deployment of mSCTP will be done along with
   the appropriate AAA server in the respective access network domains.
   The AAA server is used to authenticate and the MC in the locations,
   and also to authorize the new IP address configuration via DHCP and
   IPv6 stateless configuration. However, this issue is outside the
   scope of this document.

5.5 Link Layer Support for Multi-homing

   To support the multi-homing capability for Mobile Client, we need to
   consider the characteristics of the wireless links such as WLAN and
   Cellular systems. It is noted that Cellular systems are expected to
   easily support the link-level multi-homing features, whereas the WLAN
   system case is for further study.

   The multi-homing feature enables the mSCTP to support seamless
   handover by simultaneous binding of two different addresses while
   staying the overlapping region. Time interval for an MC to stay in
   the overlapping region will give impact on the performance of the
   handover procedures.

   It is also noted that the handover based on mSCTP depends on the
   support of the underlying physical and link layers to measure the
   wireless signal strength. The measured signal strength information
   can helpfully used for the SCTP to trigger the addition and deletion
   of IP addresses, and the change of the primary address. The handover
   performance will depend on such capability in terms of data loss and
   delay during handover.

6. Location Management for mSCTP

   The mSCTP can provide only the handover for mobile hosts or the
   sessions initiated by mobile hosts. To support the mobile sessions
   that are terminated at mobile hosts, the mSCTP needs to be used along
   with a location management scheme such as Mobile IP or SIP.

6.1 Use of mSCTP with Mobile IP

   In this scenario, Mobile IP will be used to locate a mobile host and
   then for Home Agent to forward the data packet (SCTP INIT chunk) to
   the mobile host. The succeeding process for SCTP association
   initiation, including SCTP INIT-ACK, COOKIE-ECHO, and COOKIE-ACK,
   will be done directly between the mobile host and the peering host,
   not via Home Agent.

   After an SCTP association is successfully setup, the mSCTP will be
   used for providing seamless handover for the mobile host. Details of
   SCTP with MIP are described in [9].

6.2 Use of SCTP with SIP

   In this scenario, each host uses SCTP instead of TCP/UDP as the
   transport protocol. After the call setup by SIP signaling, the SCTP
   will be used for data transport and seamless handover.

   The SIP provides location management functionality by using SIP
   REGISTER messages. When a mobile host moves into a visiting network,
   it will update its current location (e.g., IP address or SIP URL) by
   sending a SIP Register (with a Contact Header) to the (home) SIP
   Registrar server. The Registrar server will then update the location
   database as indicated by the REGISTER message.

   When a call setup is requested with a mobile host, the (home) SIP
   proxy server will interrogate the location database to locate the
   mobile host and then relay the SIP INVITE message to the (visiting)
   SIP Proxy server up to the mobile host. If once the SCTP association
   is established via the SIP signaling, the data transport between two
   concerned hosts will be done according to the mSCTP handover
   mechanisms.

6.3 Use of SCTP with RSerPool

   RSerPool [11] can be used for location management. A mobile server
   registers a pool handle such that it becomes part of a pool. It is
   allowed that a pool consists of one pool element only. A client
   (mobile or not) must know the pool handle of the mobile server it
   wants to talk to. It sends a name resolution request to one of the
   ENRP servers and gets back the current IP-addresses. Since the ENRP

servers within an operational scope share its state it is not
important which ENRP server is contacted. If the MS changes its IP-
address it re registers at the home ENRP server.

So the pool handles can be used to address a server with changing IP-
addresses. If the MC or the MS change their addresses due to
handovers mSCTP can be used to handle this, except for the case were
the MC and the MS change their addresses simultaneously. In this case
mSCTP fails i.e. the SCTP association terminates. The RSerPool
session concept can be used to reestablish a new SCTP association
using the new addresses and continuing the RSerPool session.
Depending on the application the impact of this session failover for
the application can be very small.

7. Comparison of mSCTP with SIP, Mobile IP and RSerPool

Table 1 summarizes the comparison of mSCTP with Mobile IP, SIP and
RSerPool.

Table 1. mSCTP, MIP, SIP and RSerPool for Mobility Support

Category	mSCTP	Mobile IP	SIP	RSerPool
Protocol Layer	Transport	Network	Application	Session
Location Management	Not Supported	Supported	Supported	Supported
Handover Management	Supported	FMIP needed	Supported with mSCTP	Supported with mSCTP
Route Optimization	Provided Bacially	Binding Update needed	Not Provided	Provided with mSCTP
Network Support	Not Required	Required	Not Required	Not Required
Special Agents	No	Home Agent, Foreign Agent	SIP servers, Registrar	ENRP Server

As described in Table 1, the mSCTP can be used for seamless handover
in the transport layer. To use mSCTP, it is required that the CN and
MN hosts should be aware of the mobile SCTP. Instead, mSCTP does not
need the support of network routers for seamless handover.

Furthermore, the mSCTP intrinsically provides the Route Optimization without using any additional Binding Update procedures.

For location management, the mSCTP may be used along with MIP or SIP. In case of using MIP for location management, only the MN needs to be aware of MIP, whereas the CN need not use MIP. Using mSCTP with MIP, the MN must also be able to bind the CoA as well as HoA to its applications. The HoA will be used only for location management. After establishment of an SCTP session, the HoA will not be used for data transport. Instead, the CoA is employed for the SCTP data transport. On the other hand, in MIP, only HoA is bound to the applications of MN regardless of the different CoAs.

The MIP provides the location and management in the network layer, and it can support seamless handover with help of neighboring routers such as tunneling between old and new ARs. On the other hand, SIP is an application signaling protocol that supports the location management for user or personal mobility. SIP itself does not provide seamless handover. It may be used together with mSCTP for seamless handover.

Reliable Server Pooling [11] can be used to provide the location management functionality. Used in combination with mSCTP it provides all functionalities required for a mobility solution. Simultaneous handovers of a MS and a MC will result in a session failover.

8. Security Considerations

This document discusses architecture of SCTP mobility support. The associated security issues will be identified as further works go on.

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10. References

10.1 Normative References

   [1] S. Bradner, " Intellectual Property Rights in IETF Technology",
       BCP 79, RFC 3668, February 2004.

   [2] S. Bradner, "Key words for use in RFCs to Indicate Requirement
       Levels", BCP, RFC 2119, March 1997.

   [3] Stewart, R., et al., "Stream Control Transmission Protocol", RFC
       2960, October 2000.

10.2 Normative References

   [4] Stewart, R., "Stream Control Transmission Protocol (SCTP) Dynamic
       Address Reconfiguration", draft-ietf-tsvwg-addip-sctp-07, February
       2003.

   [5] Riegel, M. and Tuexen M., "Mobile SCTP", draft-riegel-tuexen-
       mobile-sctp-03, August 2003.

   [6] Coene, L. (ed.), "Multihoming issues in the SCTP", draft-coene-
       sctp-multihome-04, June 2003.

   [7] Perkins, C. (ed.), "IP Mobility Support for IPv4", RFC 3344,
       August 2002.

   [8] Johnson, D., et al., "Mobility Support in IPv6", draft-ietf-
       mobileip-ipv6-24, June 2003

   [9] Koh, S. J., et al., "mSCTP with Mobile IP for Transport Layer
       Mobility", draft-sjkoh-mobile-sctp-mobileip-04, June 2004

   [10] Stewart, R. Xie, Q., "Stream Control Transmission Protocol: A
       Reference Guide", Addison Wesley Longman, 2001.

   [11] Tuexen, M. et al., "Requirements for Reliable Server Pooling",
       RFC 3237, January 2002.

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