                Mobile IPv6 Fast Handovers for 3G CDMA Networks

Status of This Memo

Abstract

   Mobile IPv6 is designed to maintain its connectivity while moving
   from one network to another. It is adopted in 3G CDMA networks as a
   way to maintain connectivity when the mobile node (MN) moves between
   access routers. However, this handover procedure requires not only
   movement detection by the MN, but also the acquisition of a new
   Care-of Address and Mobile IPv6 registration with the new care-of
   address before the traffic can be sent or received in the target
   network. During this period, packets destined for the mobile node
   may be lost, which may not be acceptable for a real-time application
   such as Voice over IP (VoIP) or video telephony. This document
   specifies fast handover methods in the 3G CDMA networks in order to
   reduce latency and packet loss during handover.

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[1](#). Introduction

   Mobile IPv6 [[2](#)] allows mobile nodes (MNs) to maintain persistent IP
   connectivity while the MN moves around in the IPv6 network. It is
   adopted in 3G CDMA networks for handling host-based mobility
   management [[12](#)]. During handover, however, the mobile node (MN)
   needs to switch the radio link to obtain a new Care-of Address (CoA)
   and to re-register with the home agent (HA), which may cause a
   communication disruption. This is not desirable for real-time
   applications such as VoIP and video telephony. To reduce this
   disruption time or latency, a fast handover protocol for Mobile IPv6
   [[3](#)] is proposed. [RFC 4260](#) [[7](#)] further describes how this Mobile IPv6
   Fast Handover could be implemented on link layers conforming to the
   IEEE 802.11 suite of specifications. However, 3G CDMA and IEEE
   802.11 networks are substantially different in the radio access, the
   representations of the network nodes or parameters, and the network
   attachment procedures; for example, the beacon scanning or New Access
   Router (NAR) discovery based on [Access Point Identifier, Access
   Router-info (AP-ID, AR-info)] tuples specified in [RFC 4260](#) can not be
   directly applied to 3G CDMA networks. This document therefore
   specifies how Mobile IPv6 fast handovers can be applied in the 3G
   CDMA networks.

2. Requirements Notation

   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 [1].

3. Terminology

   This document refers to [3] for Mobile IPv6 fast handover
   terminology. Terms that first appear in this document are defined
   below:

   Access Network Identifier (ANID): An identifier that is used by the
      Packet Data Serving Node (PDSN) to determine whether the MN is
      being handed off from the access network that was not previously
      using this PDSN. Anytime the MN crosses into a new region, which
      is defined by the ANID, it must re-register with that access
      network. The ANID is further composed of the System ID (SID),
      Network ID (NID), and Packet Zone ID (PZID) and these values are
      administered by the operator. The lengths of the SID, NID, and
      PZID are 2 octets, 2 octets, and 1 octet, respectively. Thus,
      that of the ANID occupies 5 octets [11].

   Forward Pilot Channel: A portion of the Forward Channel that carries
      the pilot. The Forward Channel is a portion of the physical layer
      channels transmitted from the 3G CDMA access network to the MN.
      Further, several sets of pilots (e.g., the active set or neighbor
      set) are defined to determine when and where to handover.

   Home Link Prefix (HLP): The prefix address assigned to the home link
      where the MN should send the binding update message. This is also
      called Home Network Prefix (HNP) and one of the bootstrap
      parameters for the MN.

   International Mobile Subscriber Identity (IMSI): The IMSI is a
      string of decimal digits, up to a maximum of 15 digits, that
      identifies a unique mobile terminal or mobile subscriber
      internationally. The IMSI consists of three fields: the Mobile
      Country Code (MCC), the Mobile Network Code (MNC), and the Mobile
      Subscriber Identification Number (MSIN). An example of the IMSI
      is "440701234567890", where "440" is the MCC, "70" is the MNC, and
      "1234567890" is the MSIN. The IMSI conforms to the ITU-T E.212
      numbering standard [6]. In this specification, IMSI is an ASCII
      string that consists of not more than 15 decimal digits (ASCII
      values between 30 and 39 hexadecimal), one character per IMSI
      digit. The above example would therefore be encoded as "34 34 30
      37 30 31 32 33 34 35 36 37 38 39 30" in hexadecimal notation.

   Mobile Identity (MN ID): An identifier of the Mobile Node that is
      used by the access network. The value (e.g., IMSI) is unique
      within the operator's network.

   Packet Data Serving Node (PDSN): An entity that routes MN originated
      or MN terminated packet data traffic. A PDSN establishes,
      maintains, and terminates link-layer sessions to MNs. A PDSN is
      the access router in the visited access provider network.

   Sector Address Identifier (SectorID): A typical cell divides its
      coverage area into several sectors. In 3G CDMA systems, each
      sector uses a different PN (Pseudo Noise) code offset and is
      associated with SectorID. The SectorID is 128 bits long and can
      be represented in the IPv6 address format [8].

[4](#). Network Reference Model for Mobile IPv6 over 3G CDMA Networks

   Figure 1 shows a simplified reference model of the Mobile IP enabled
   3G CDMA networks. The home agent (HA) and Authentication,
   Authorization, and Accounting (AAA) server of the mobile node (MN)
   reside in the home IP network, and the MN roams within or between the
   access provider network(s). Usually, the home IP network is not
   populated by the MNs, which are instead connected only to the access
   provider networks. Prior to the Mobile IPv6 registration, the MN
   establishes a 3G CDMA access technology specific link-layer
   connection with the access router (AR). When the MN moves from one
   AR to another, the link-layer connection is re-established, and a
   Mobile IPv6 handover is performed. Those ARs reside in either the
   same or different access provider network(s). The figure shows the
   situation, where the MN moves from the Previous Access Router (PAR)
   to the New Access Router (NAR) via the radio access network (RAN).

```
                        Home IP Network
                  +........................+
                  . +--------+  +--------+ .
                  . |   HA   |--|  AAA   | .
                  . +--------+  +--------+ .
                  +../......\..............+
                    /         \
              Access Provider Network(s)
        +............+        +............+
        . +--------+ .        . +--------+ .
        . |  PAR   | .        . |  NAR   | .
        . +--------+ .        . +--------+ .
        .      |:    .        .     :|     .
        .      |:L2link       L2link:|     .
        .      |:    .        .     :|     .
        . +----+:---+ .        . +---:+----+ .
        . |  RAN   | .        . |  RAN   | .
        . +----+:---+ .        . +---:+----+ .
        .      |:    .        .     :|     .
        .    +----+   .        .   +----+    .
        .    | MN |  --------->  | MN |    .
        .    +----+   .        .   +----+    .
        +............+        +............+
```
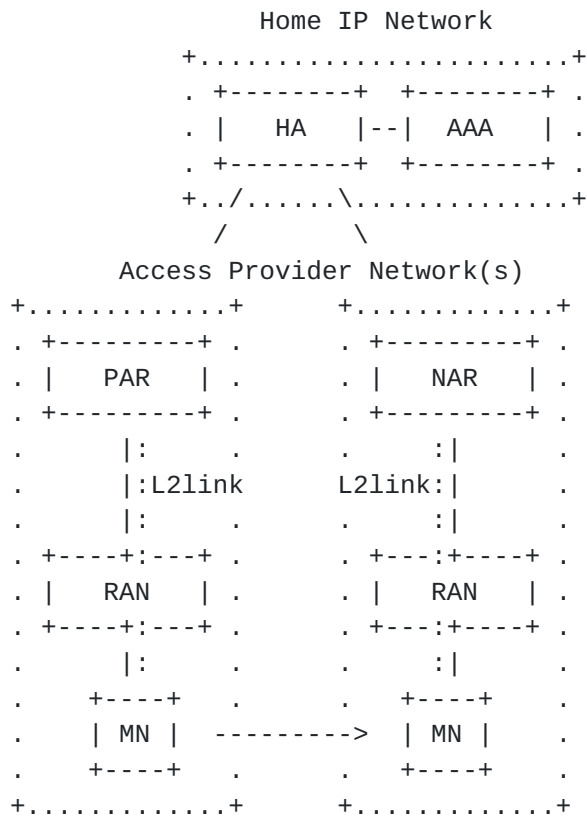
        Figure 1: Reference Model for Mobile IP

   In 3G CDMA networks, pilot channels transmitted by base stations
   allow the MN to obtain a rapid and accurate C/I (carrier to
   interference) estimate. This estimate is based on measuring the
   strength of the Forward Pilot Channel or the pilot, which is
   associated with a sector of a base station (BS). The MN searches for
   the pilots and maintains those with sufficient signal strength in the
   pilot sets. The MN sends measurement results, which include the
   offsets of the PN code in use and the C/Is in the pilot sets, to
   provide the radio access network (RAN) with the estimate of sectors
   in its neighborhood. There are several triggers for the MN to send
   those estimates, e.g., when the strength of a pilot in the pilot sets
   exceeds that of the current pilot, the MN sends the estimates to the
   access network. As long as the sector to which the MN is going to
   move belongs to the same access network, the mobility within that
   access network is handled by the access-specific interfaces [10] and
   the link-layer connection between the MN and AR can be maintained
   without a re-establishment. The MN can continually search for pilots
   without disrupting the data communication and a timely handover is
   assisted by the network. If, however, the serving access network
   finds that the sector associated with the highest pilot strength
   belongs to a different AR, it attempts to close the connection with
   the MN. The MN then attempts to get a new traffic channel assigned

in the new access network, which is followed by establishing a new
connection with the new AR. This could cause a noticeable
communication disruption and lead to a serious degradation of the
user experience. In order to minimize the service degradation,
during the handover between ARs, an IP-level fast handover approach
as defined in RFC 5268 needs to be involved. If the air interface
information can be used as a trigger for the handover between access
routers, fast and smooth handover of Mobile IPv6 can be realized in
3G CDMA networks. The MN can continually search for pilots without
disrupting the data communication and a timely handover is assisted
by the network.

To assist the handover of the MN to the new AR, various types of
information can be considered: the pilot sets, which include the
candidates of the target sectors or BSs, the cell information where
the MN resides, the serving nodes in the radio access network, and
the location of the MN, if available. To identify the access network
that the MN moves to or from, the Access Network Identifiers (ANID)
or the subnet information can be used [9][10]. In this document, a
collection of such information is called "handover assist
information". In 3G CDMA networks, the Link-Layer Address of the New
Access Point (AP) defined in [3] may not be available. If this is
the case, the Handover Assist Information option defined in this
document SHOULD be used instead.

5. Fast Handover Procedures

There are two modes defined in [3] according to the time of sending
the FBU (Fast Binding Update); one is called "predictive mode", where
the MN sends the FBU and receives the FBAck (Fast Binding
Acknowledgment) on the PAR's (Previous Access Router's) link and the
other is called "reactive mode", where the MN sends the FBU from the
NAR's (New Access Router's) link. In the predictive mode, the time
and place the MN hands off must be indicated sufficiently before the
time it actually happens. In cellular systems, since handovers are
controlled by the network, the predictive mode is well applied.
However, if the network is not configured to be able to identify the
new AR, to which the MN is moving next, in a timely manner, the
reactive mode is better applied.

Section 2 of RFC 4907 [20] suggests architectural principles on the
link indication and the effectiveness of the optimization. The link
indication of this document relies on 3G CDMA networks and the
effectiveness of the optimization is attributed to RFC 5268. The
above principles are thus considered by the related specifications
referenced in this document.

5.1. Predictive Fast Handover

   Figure 2 shows the predictive mode of MIPv6 fast handover operation.
   When the MN finds a sector or a BS whose pilot signal is sufficiently
   strong, it initiates handover according to the following sequence:

   (a) A router solicitation for proxy router advertisement is sent to
        the PAR. Handover assist information for the target 3G CDMA
        network is attached to this message.

   (b) Based on the received handover assist information, the NAR is
        determined and a proxy router advertisement (PrRtAdv) containing
        the prefix of the NAR is sent back to the MN. The MN also
        checks that the R flag is not set in the PrRtAdv message, which
        indicates the network supports the predictive fast handover mode
        (defined later).

   (c) The MN creates an NCoA (new CoA) and sends the Fast Binding
        Update (FBU) with the NCoA to the PAR, which in turn sends the
        Handover Initiate (HI) to the NAR.

   (d) The NAR sends the Handover Acknowledge (HAck) back to the PAR,
        which in turn sends the FBU acknowledgment (FBAck) to the MN.

   (e) The PAR starts forwarding packets toward the NCoA and the NAR
        captures and buffers them.

   (f) The link-layer connection associated with the PAR is closed and
        a new traffic channel is assigned in the new access network.

   (g) The MN attaches to the new access network. The attachment
        procedure is access technology specific and that for 3G CDMA
        network including the PPP transactions is described later.

   (h) The MN sends the Unsolicited Neighbor Advertisement (UNA).

   (i) The NAR starts delivering packets to the MN.

   (j) The MN sends the Binding Update (BU) to the HA to update the
        Binding Cache Entry (BCE) with the NCoA, and the HA sends back
        the Binding Acknowledgment (BA) to the MN.

```
           MN              PAR              NAR            HA            AAA
           |    RtSolPr    |                |              |              |
     (a)   |------------->|                |              |              |
           |    PrRtAdv    |                |              |              |
     (b)   |<-------------|                |              |              |
           |     FBU      |      Hl        |              |              |
     (c)   |------------->|-------------->|               |              |
           |    FBack     |     HAck       |              |              |
     (d)   |<-------------|<-------------|                |              |
           |              |forward packets|               |              |
     (e)   |              |=============>|(buffering)     |              |
           |              |               |               |              |
     (f) handover         |               |               |              |
           |              |               |               |              |
        +------------------------------------------------------------------+
     (g) |                      Attachment procedure                       |
        +------------------------------------------------------------------+
           |              UNA               |              |              |
     (h)   |----------------------------->|                |              |
           |       deliver packets          |              |              |
     (i)   |<=============================|                |              |
           |              |        BU/BA   |               |              |
     (j)   |<-------------------------------------------->|               |
           |              |               |               |              |
```
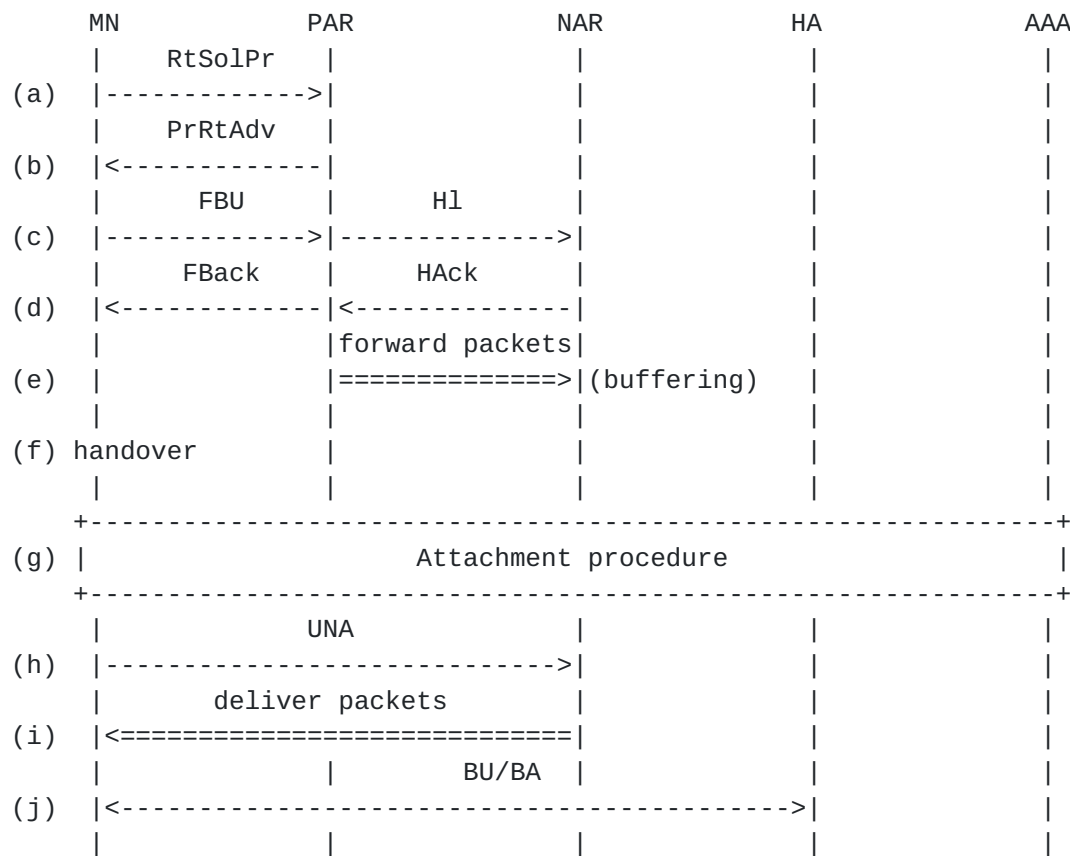
                Figure 2: MIPv6 Fast Handover Operation (Predictive Mode)

   It is assumed that the NAR can be identified by the PAR leveraging
   the handover assist information from the MN. To perform the
   predictive mode, the MN MUST send the FBU before the connection with
   the current access network is closed. If the MN fails to send the
   FBU before handover, it SHOULD fall back to the reactive mode. Even
   if the MN successfully sends the FBU, its reception by the PAR may be
   delayed for various reasons such as congestion. If the NAR receives
   the HI triggered by the delayed FBU after the reception of the UNA
   ((c) comes after (h)), then the NAR SHOULD send the HAck with
   handover not accepted and behave as the reactive mode.

   In (a), Router Solicitation for Proxy Advertisement (RtSolPr) is
   supposed to include the New Access Point and the MN Link-Layer
   Address (LLA) options (Option Code=1 and 2, respectively) according
   to [3]. The New AP-LLA option MAY be replaced by the handover assist
   information option in 3G CDMA networks. As for the MN-LLA option, if
   the LLA for the MN is not available, 3G specific IDs such as IMSI[11]
   MAY be used. If this is the case, the MN ID option defined in
   Section 6.2, which can support other types of IDs and a length that
   is not necessarily multiples of 8 octets, SHOULD be used instead of
   the MN-LLA option.

In (b), PrRtAdv MUST include options for the IP address of the NAR,
which may be the link-local address, and the prefix for the MN. The
PAR SHOULD be able to identify the NAR from the handover assist
information provided by the MN.

Figure 3 shows the call flow for the initial attachment in the 3G
CDMA network [12]. After the traffic channel is assigned, the MN
first establishes a link-layer connection between itself and the
access router. As a link-layer protocol, PPP is considered in this
figure, and a PPP handshake is depicted as an example. After a
link-layer connection is established, the MN registers with the HA by
sending a Binding Update message. There are several parameters for
using Mobile IPv6 such as the home address (HoA), the Care-of Address
(CoA), the home agent address (HA), and the home link prefix (HLP).
In [12], obtaining these values is called bootstrapping, and the
bootstrapping information can be obtained during the link-layer
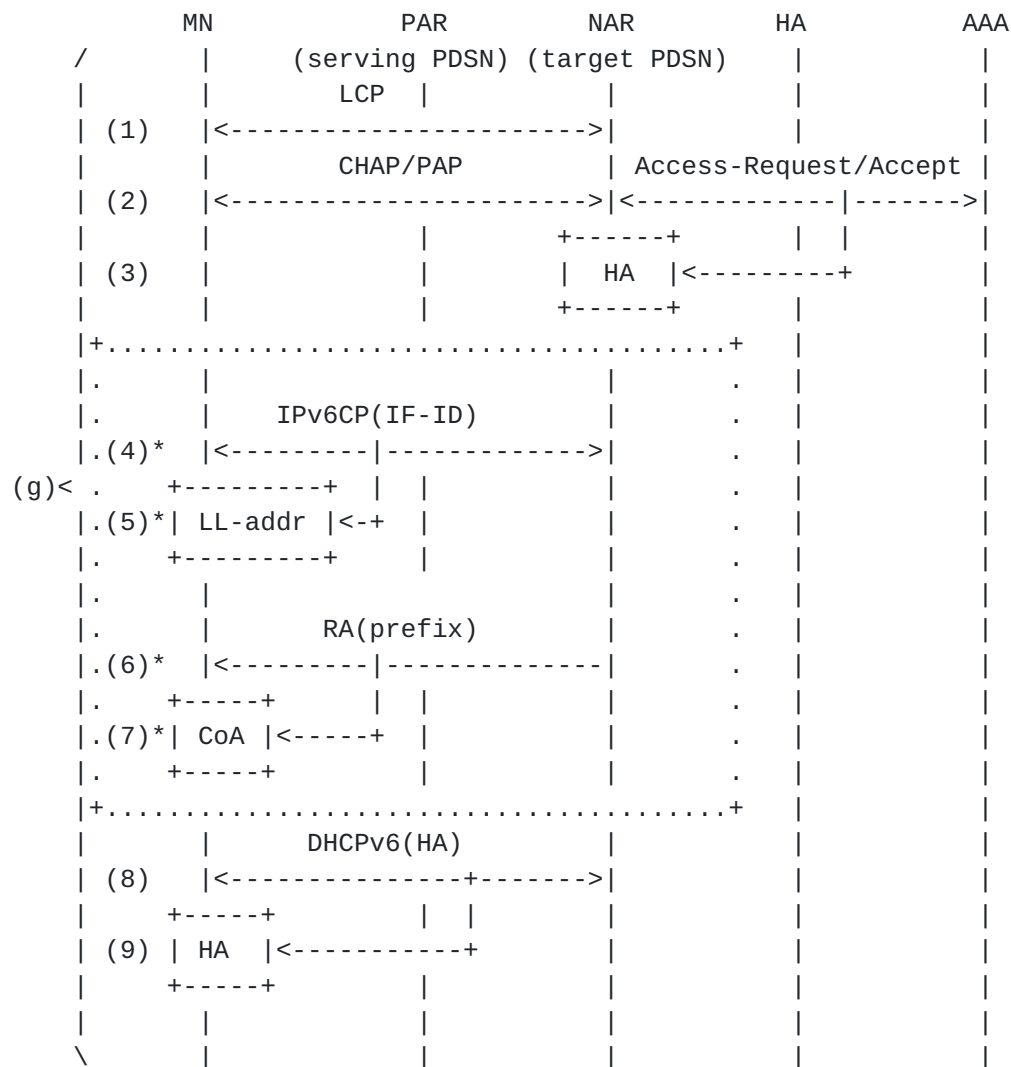establishment phase and/or the mobility binding phase [13].

```
               MN           PAR          NAR          HA          AAA
      /         |      (serving PDSN) (target PDSN)   |           |
      |         |          LCP   |            |       |           |
      | (1)     |<---------------------->|            |           |
      |         |        CHAP/PAP         | Access-Request/Accept |
      | (2)     |<---------------------->|<-------------|------->|
      |         |                 |    +------+      |  |        |
      | (3)     |                 |    |  HA  |<---------+        |
      |         |                 |    +------+         |         |
      |+...................................+   |        |
      |.        |                         |      .  |        |
      |.        |     IPv6CP(IF-ID)       |      .  |        |
      |.(4)*    |<---------|------------->|      .  |        |
   (g)< .     +---------+  |  |           |      .  |        |
      |.(5)*| LL-addr |<-+  |           |      .  |        |
      |.    +---------+     |           |      .  |        |
      |.        |           |           |      .  |        |
      |.        |     RA(prefix)        |      .  |        |
      |.(6)*    |<---------|------------|      .  |        |
      |.    +-----+       |  |          |      .  |        |
      |.(7)*| CoA |<-----+  |          |      .  |        |
      |.    +-----+          |          |      .  |        |
      |+...................................+   |        |
      |         |     DHCPv6(HA)        |      |        |
      | (8)     |<--------------+------>|      |        |
      |       +-----+           |  |    |      |        |
      | (9) | HA  |<-----------+      |      |        |
      |       +-----+           |      |      |        |
      |         |               |      |      |        |
      \         |               |      |      |        |
```

                Figure 3: Attachment Procedure in 3G CDMA Network

   The procedure for the initial attachment is as follows:

   (g)   The link-layer connection establishment and the bootstrapping
           phase.

   (g-1)   The LCP (Link Control Protocol) configure-request/response
           messages are exchanged.

   (g-2)   User authentication (e.g., Challenge Handshake Authentication
           Protocol (CHAP) or Password Authentication Protocol (PAP)) is
           conducted.

(g-3)   The static bootstrapping information is conveyed from the AAA
        and stored in the NAR (target PDSN). The HoA and HLP can be
        dynamically assigned by the HA in the mobility binding phase.
        This step can be skipped in the handover case.

(g-4)   Unique interface IDs are negotiated in IPv6 Control Protocol
        (IPv6CP).

(g-5)   The MN configures its link-local address based on the obtained
        interface ID.

(g-6)   A router advertisement containing the prefix is received by
        the MN.

(g-7)   The MN configures its CoA based on the obtained prefix.

(g-8)   DHCPv6 is used to obtain the static bootstrap information
        (e.g., the HA address). This step is performed in the initial
        attachment and can be skipped once the MN obtains those
        parameters.

(g-9)   The MN installs the bootstrap information for further
        procedures (e.g., the mobility binding).

As is shown in Figure 3, it takes a considerable amount of time to
establish a link-layer connection and almost all of the above
sequences run every time the MN attaches to a new access network. It
is therefore beneficial if packets in transit to the MN are saved not
only during the time period when the MN switches to the new radio
channel but also during the time period when the MN establishes the
link-layer connection.

There are several ways to configure a unique IP address for the MN.
If a globally unique prefix is assigned per link as introduced in
[12], the MN can use any interface ID except that of the other peer
(the AR to which the MN is attached) to create a unique IP address.
If this is the case, however, the PAR cannot provide the MN with a
correct prefix for the new network in the PrRtAdv since such a prefix
is selected by the NAR and provided in the router advertisement. The
MN therefore configures a temporary NCoA with the prefix provided by
the PAR and the correct NCoA MUST be assigned by the NAR. Therefore,
in 3G CDMA network, the PAR MUST send the HI with the S flag set when
it receives the FBU from the MN at step (c) in Figure 2.

The UNA is supposed to include the MN-LLA [3], but the point-to-point
link-layer connection may be able to uniquely identify the MN. The
most required information by the UNA is the NCoA to check if there is
a corresponding buffer. Therefore, in (h), the function of the UNA
can be realized in several ways:

o Since the establishment of the link-layer connection in (g)
   indicates readiness of data communication on the MN side, the NAR
   immediately checks if there is a buffer that has packets destined
   for the NCoA, which was configured at steps (c) - (d), and starts
   delivering, if any (substitution of UNA).

o The MN sends the UNA as defined in [3]. Instead of the MN-LLA in
   the LLA option, the MN ID MAY be included in the MN ID option
   (standard implementation of UNA).

The primary benefit of the predictive fast handover mode is that the
packets destined for the MN can be buffered at the NAR, and packet
loss due to handover will be much lower than that of the normal MIPv6
operation. Regarding the bootstrapping, the following benefit can be
obtained, too:

o Since the NCoA can be configured via the fast handover procedures,
   a router advertisement is not required.

Therefore, the procedures (g-4) to (g-7) can be skipped from the
standard MIPv6 operation in Figure 3.

5.2. Reactive Fast Handover

When the network does not support the predictive fast handover mode,
the reactive fast handover is applied. In this document, a new flag
is defined in PrRtAdv to inform the MN about the capability of the
network (see Section 6.4). To minimize packet loss in this
situation, the PAR instead of the NAR can buffer packets for the MN
until the MN regains connectivity with the NAR. The NAR obtains the
information of the PAR from the MN on the NAR's link and receives
packets buffered at the PAR. In this case, the PAR does not need to
know the IP address of the NAR or the NCoA and just waits for the NAR
to contact the PAR. However, since the PAR needs to know when to
buffer packets for the MN, the PAR obtains the timing of buffering
from the MN via the FBU or the lower-layer signaling, e.g., an
indication of the release of the connection with the MN. Details of
the procedure are as follows:

(a) A router solicitation for proxy router advertisement MAY be sent
     to the PAR.

(b) The proxy router advertisement MAY be sent to the MN. If the
     information on the NAR is not available by the PAR, "0::0" MUST
     be used for the options related to the NAR (e.g., IP address of
     the NAR).

(c) The MN sends the FBU or the access network indicates the close
     of the connection with the MN by the lower-layer signaling. If
     the MN cannot formulate the NCoA, "0::0", MUST be used for the
     NCoA in the FBU. If the B flag is set in the FBU, the PAR
     SHOULD start buffering packets destined for the PCoA.

(d) The link-layer connection associated with the PAR is closed and
     a new traffic channel is assigned in the new access network.

(e) The MN attaches to the new access network. This part is the
     same as described in Section 5.1 and illustrated in Figure 3.

(f) The MN sends the UNA to the NAR.

(g) The MN sends the Fast Binding Update (FBU) to the PAR via the
     NAR.

(h) The NAR forwards the FBU from the MN to the PAR.

(i) The PAR sends the Handover Initiate (HI) to the NAR with the
     Code set to 1.

(j) The NAR sends the Handover Acknowledge (HAck) back to the PAR.

(k) The PAR sends the FBAck to the NAR.

(l) If the PAR is buffering packets destined for the PCoA, it starts
     forwarding them as well as newly arriving ones to the NAR.

(m) The NAR delivers the packets to the MN.

(n) The MN sends the BU to the HA to update the BCE with the NCoA
     and the HA sends back the BA to the MN.

```
         MN              PAR              NAR              HA             AAA
          |   RtSolPr     |                |                |               |
   (a)    |-------------->|                |                |               |
          |   PrRtAdv     |                |                |               |
   (b)    |<------------- |                |                |               |
          |       FBU     |                |                |               |
   (c)    |- - - - - - ->|(buffering)      |                |               |
          |               |                |                |               |
   (d) handover           |                |                |               |
          |               |                |                |               |
       +----------------------------------------------------------------+
   (e) |                     Attachment procedure                       |
       +----------------------------------------------------------------+
          |               UNA              |                |               |
   (f)    |------------------------------->|                |               |
          |               FBU              |                |               |
   (g)    |------------------------------->|                |               |
          |               |       FBU      |                |               |
   (h)    |               |<-------------- |                |               |
          |               |       HI       |                |               |
   (i)    |               |--------------->|                |               |
          |               |      HAck      |                |               |
   (j)    |               |<-------------- |                |               |
          |               |      FBack     |                |               |
   (k)    |               |--------------->|                |               |
          |               |forward packets |                |               |
   (l)    |               |===============>|                |               |
          |        deliver packets         |                |               |
   (m)    |<==============================|                |               |
          |               |      BU/BA     |                |               |
   (n)    |<-------------------------------------------------->|           |
          |               |                |                |               |
```
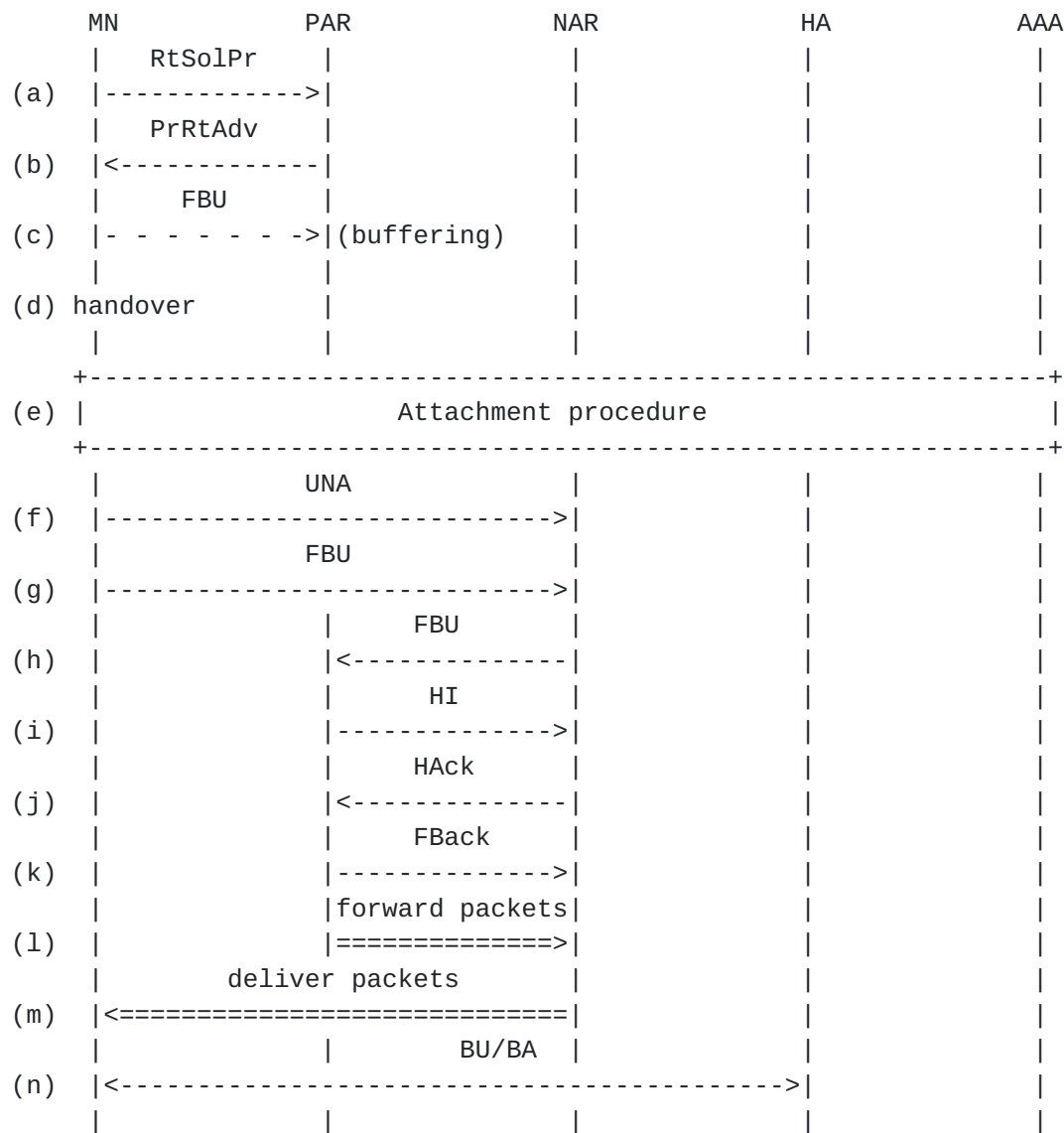
             Figure 4: MIPv6 Fast Handover Operation (Reactive Mode)

   To indicate the PAR to buffer packets destined for the PCoA, in step
   (c), a new flag 'B' is defined in the FBU. When the PAR receives the
   FBU with this flag set, it SHOULD buffer packets for the MN. The PAR
   MAY also start buffering packets for the MN based on lower layer
   signal during handover. Since the packets are buffered at the PAR in
   this scenario, the UNA, which is received and processed by the NAR,
   can not be used to trigger to forward the buffered packets at the
   PAR. In Figure 4, the HAck from the NAR is used as the trigger for
   the forwarding of any buffered packets.

   The handover indication from the lower layer of 3G CDMA system is
   reasonably reliable by the periodical reports from the MN; however,
   there are several situations where the target link is not available

   after the handover (step (d)) and the MN comes back to the PAR, or
   the MN is not able to move to the target link for some reason after
   the connection was closed. If this is the case, the attachment
   procedure is performed on the previous link. The packets buffered at
   the PAR SHOULD be delivered to the MN after the connection is
   re-established.

5.3. Considerations on the Link Indications

   This section discusses if the link indications assumed in this
   document meet the principles defined in Section 2 of RFC 4907[20],
   which suggests 11 architectural principles on the link indication and
   the effectiveness of the optimization. This document relies on the
   3G CDMA network regarding the link indication, which is precisely
   specified by 3GPP2. Therefore, principles (1) to (5), (7), (8), and
   (11), that is, "Model Validation", "Clear Definition", "Robustness",
   "Recovery from Invalid Indications", "Congestion Control",
   "Interoperability", "Race Condition", and "Transport of Link
   Indications" are considered by those specs. Principle (6)
   "Effectiveness" mentions the effectiveness of the optimization. This
   document bases its effectiveness on RFC 5268. Therefore, this
   principle is dealt by that RFC. Principle (9) "Metric Consistency"
   mentions inconsistencies between link and routing layer metrics. The
   spec of this document does not change the routing metrics and
   multi-homing is not considered. Finally, principle (10) "Layer
   Compression", mentions an overhead reduction scheme and
   interoperability. This document does not deal with overhead
   reduction and therefore this principle does not apply.

6. Message Format

6.1. Handover Assist Information Option

   If the lower layer information of the new point of attachment is not
   represented as the link-layer address, the following option SHOULD be
   used. The primary purpose of this option is to convey the handover
   assist information described in Section 4.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Type       |    Length     |  Option-Code  |  HAI-Length   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |              HAI-Value...
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

Type   29

Length   The size of this option in 8 octets including the
                  Type, Length, Option-Code, and HAI-Length (Handover
                  Assist Information-Length) fields.

Option-Code
                  1: Access Network Identifier (AN ID)
                  2: Sector ID

HAI-Length   The size of the HAI-Value field in octets.

HAI-Value   The value specified by the Option-Code.

If those that received this message do not support this option, they
SHOULD treat this option as opaque and MUST NOT drop it.

Option-Code indicates the particular type of handover assist
information. Currently, two types of information are defined to
assist the discovery of the NAR (see [Section 3](#)).

Depending on the size of the HAI-Value field, appropriate padding
MUST be used to ensure that the entire option size is a multiple of 8
octets. The HAI-Length is used to disambiguate the size of the
HAI-Value.

The handover assist information MAY replace the New Access Point
Link-Layer Address in 3G CDMA networks.

[6.2](#). Mobile Node Identifier Option

This option is used to transfer the Identifier of the MN, which is
not its link-layer address.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+---------------+---------------+---------------+
|     Type      |    Length     |  Option-Code  | MN ID-Length  |
+---------------------------------------------------------------+
|             MN ID ...
+----------------------------
```
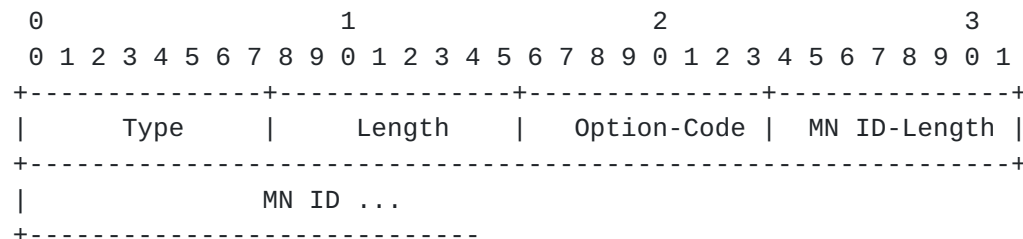
Type   30

Length   The size of this option is in 8 octets including the
                  Type, Length, and Option-Code.

Option-Code
                  1: NAI [[4](#)]
                  2: IMSI (See [Section 3](#))

MN ID-Length   The length of the MN ID in octets.

MN ID   MN ID value

The MN ID MAY replace the MN Link-Layer Address in 3G CDMA networks.

6.3. New Flag Extension to FBU Message

The MN MUST send the FBU to the PAR with the following new (B) flag
set in the previous network to indicate the PAR to buffer packets
destined for the PCoA. The rest of the Binding Update message format
remains the same as defined in [[2](#)] and with the additional (M), (R),
and (P) flags as specified in [[14](#)], [[15](#)], and [[16](#)], respectively.

```
                              +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                              |            Sequence #         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |A|H|L|K|M|R|P|B|    Reserved    |              Lifetime        |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                              |
 .                                                              .
 .                        Mobility options                      .
 .                                                              .
 |                                                              |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

B flag: If the 'B' flag is set, the PAR SHOULD start buffering
                the packets destined for the MN as specified in
                [Section 5.2](#).

6.4. New Flag Extension to PrRtAdv Message

A new flag 'R' is defined in the PrRtAdv to inform the MN about the
fast handover mode that the network supports.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Type      |     Code      |           Checksum            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |    Subtype    |R|  Reserved   |           Identifier          |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |   Options ...
 +-+-+-+-+-+-+-+-+-+-+-+-
```

R flag: If the 'R' flag is set, the network supports only the
                reactive handover mode. Otherwise, the network
                supports both the predictive and reactive fast
                handover mode.

7. Security Considerations

The security considerations for Mobile IPv6 fast handover are
described in [3]. When a 3G CDMA network is considered, it can be
assumed that the PAR and the NAR have a trust relationship and the
links between them and those between the ARs and the MN are secured.
The MN is authenticated every time it attaches to the new link;
therefore, the AR can securely identify the MN. Depending on the
operator's policy, however, SEcure Neighbor Discovery (SEND) [18] and
the shared handover key defined in [17] can also be applied.

8. IANA Considerations

This document defines two new IPv6 Neighbor Discovery options that
have been assigned from the same space as the IPv6 Neighbor Discovery
Options defined in [19].

   29: Handover Assist Information Option (Section 6.1)

   30: Mobile Node Identifier Option (Section 6.2)

This document creates two new registries for the Option-Code field in
the Handover Assist Information Option and that in the Mobile Node
Identifier Option. The values for the Option-Code must be within the
range 0-255. New values for both registries can be allocated by
Standards Action or IESG approval [5].

The Option-Code values that have been assigned by IANA are as
follows:

 Option-Code for Handover Assist Information Option
 Value Description   Reference
 ----- ---------------------------- ----------
   0   Reserved
   1   ANID   Section 6.1
   2   Sector ID   Section 6.1

```
    Option-Code for Mobile Node Identifier Option
    Value Description                   Reference
    ----- ---------------------------- ----------
      0   Reserved
      1   NAI                           Section 6.2
      2   IMSI                          Section 6.2
```

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