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                 "Network Mobility Support Requirements"
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Abstract

   The purpose of traditional mobility support is to provide continuous
   Internet connectivity to mobile hosts (host mobility support). In
   contrast, network mobility support is concerned with situations where
   an entire network changes its point of attachment to the Internet and
   thus its reachability in the topology. We shall refer to such a
   network as a mobile network (MONET). This document tries to identify
   what constraints limit the implementation and the deployment of a
   potentially and ideally good solution, and what requirements
   solutions must comply to. Our main aim is to raise the discussion on
   the mailing list.

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1. Introduction

   This document assumes that the reader is familiar with the
   terminology defined in [TERMINOLOGY] while reading [SCOPE] for a
   description of the problems is recommended.

   The purpose of traditional mobility support is to provide continuous
   Internet connectivity to mobile hosts (host mobility support). In
   contrast, network mobility support is concerned with situations where
   an entire network changes its point of attachment to the Internet and
   thus its reachability in the topology. We shall refer to such a
   network as a mobile network (MONET). Cases of mobile networks include
   networks attached to people (Personal Area Networks or PAN), and
   networks of sensors deployed in aircrafts, boats, busses, cars,
   train, etc that need a permanent Internet connection. Those mobile
   networks may also provide Internet access to devices carried by
   people (laptop, camera, mobile phone, etc, and PAN).

   As exhibited by the scenarios depicted in [TERMINOLOGY] and [SCOPE],
   there is a desire to achieve two levels of mobility: node mobility
   and network mobility. A passenger is a mobile node which visits a
   mobile network (VMN in a MONET), and passengers may themselves be
   mobile IP-subnets (MONET in a MONET), for example when carrying a
   PAN. Since people move from a MONET to another, and since instances
   of MONETs like trains, car, aircrafts cross country boundaries, both
   VMNs and MONETs are also most likely to cross ISP boundaries and
   therefore to move between topologically distant parts of the
   Internet. This means we must allow VMNs belonging to potentially
   different administrative domains to visit the MONET. The instances
   highlighted above also justify the need to consider potentially large
   MONETs containing hundreds of hosts and several routers. The train
   example highlights that the number of correspondent nodes could also
   be very large, and that these may be sparsely distributed in the
   Internet. It also justifies the need for true worldwide mobility in
   the Internet. A MONET may attach to very distant parts of the
   Internet topology, provided it is granted access to it, therefore

requiring both Local-Area Mobility support and Wide-Area Mobility
support.

The problems that need to be addressed are illustrated in [SCOPE]
while the purpose of this document is to raise discussion in order to
identify what constraints limit the implementation and the deployment
of a potentially and ideally good solution, and what requirements
solutions must comply to. Most constraints and requirements that we
have listed are equally applicable to host mobility support and
network mobility support. Some of them have been debated in the
literature as far as host mobility support was concerned; we have
extended this list to include those related to network mobility

support.

The material presented in this document is based on [Ernst01] and on
our former internet-draft that was submitted in July 2001 [OLD-draft]
for the consideration of the Mobile IP Working Group. This former
draft was defining the terminology that is now found in [TERMINOLOGY]
and a list of requirements and issues as an attempt to clarify the
problem caused by networks in motion and now found in this present
document. It was also mentioning a number of issues (impact on
addressing, routing, and existing network protocols). We have decided
to split this former document in two because requirements are more
subject to discussion and disagreements that the terminology on which
we must agree on to base our discussions. More information may be
found on the MONET web page [WEB-MONET]. Note that this list of
requirements is primarily targeted to IPv6 [RFC2460], but is not
limited to it, and that the already existing network mobility support
proposals [MONET-PSBU], [HMIPv6], and [MOBRTR] don't necessarily meet
these requirements.

 2. Important Disclaimer

   The stated opinions in this draft come from various sources and are
   not necessarily the opinions of the authors. The purpose of this
   draft is for open discussions.

 3. Design Requirements

This section details what requirements MUST or SHOULD be fulfilled by solutions, and what constraints may limit the deployment of a potentially good solution. Most requirements discussed for host mobility support, like for instance [Bhagwat96], [Myles93], [Castelluccia97] or [Caceres96], are equally applicable to network mobility support. However, they must be extended and refined to comply with the specific characteristics. All requirements we have listed may not be satisfied by a single solution. For the sake of modularity, we may decide to use separate solutions for different aspects of the problem space. Moreover, some of them are controversial and are subject to discussions on the mailing list [WEB-MONET]. It is assumed that the reader has read [TERMINOLOGY].

3.1. Migration Transparency (Permanent Connectivity)

Network mobility support MUST provide permanent and continuous Internet connectivity to all MNNs without disruption of service for MNNs. This means that all MNNs MUST always be reachable regardless of the point of attachment of the MONET.

3.2. Operational Transparency

The network layer MUST be able of supporting connectivity of the MONET in an absolute transparent manner to the application or the user.

3.3. Performance Transparency (Seamless Mobility)

Network mobility support SHOULD exhibit low latency, incur little or no data loss, minimum delays, minimum signaling load, and minimum bandwidth consumption for packet delivery. In other words, network mobility support SHOULD be as seamless as host mobility is supported (no abrupt degradation of service).

3.4. Layers Independence

Handover of IP sessions is performed at the network layer. With respect to the layer separation of the Internet protocol suite, handover MUST be managed at the network layer only and transparently to upper layers, despite the migration of the MONET in the network topology. Therefore, a change of topological location MUST not have an impact on layers above the network layer

other than a transient loss of performance, as depicted in the
above paragraph. If this is respected, compatibility with existing
transport and application layers is maintained. In practice, the
identifiers used at the transport layer should be independent from
the physical IP addresses used at the network layer for routing.
If upper layer protocols require a location independent and
invariant identifier, the network layer MUST provide it with an
identifier irrespective of the actual topological location.

3.5. Mobility Management Transparency for MNNs

We have seen in [TERMINOLOGY] that MNNs don't change their own
point of attachment as a result of the MONET's displacement in the
Internet topology. Mobility management of a MONET SHOULD therefore
be performed transparently to MNNs, at least to LFNs. LFNs SHOULD
(MUST ?) better have no responsibility in network mobility
management, whereas LMNs and VMNs SHOULD only be concerned about
managing their own mobility if they themselves appear to change
their point of attachment. However, MNNs may encounter variable
delays of transmission and loss with their respective CNs as the
network is moving. [WE WANT TO DISCUSS THIS REQUIREMENT IN THE
MAILING LIST]

3.6. Scalability

Scalability has always been an important concern in the design of

new protocols. As far as host mobility is concerned, mobility
support has to take into consideration a growing number of mobile
hosts and should even assume that a major part of the nodes
composing the Internet are mobile in the near future. This means
that signaling load and memory consumption should scale to an
important number of mobile nodes. However, network mobility
support is concerned by scalability differently, and in three
ways:

    o large number of MONETs (e.g. PAN comprising a few devices and
    carried by every human being).

    o large MONETs comprising several subnetworks and a large
    number of MNNs on each subnetwork (e.g. a train)

o the number of CNs is somewhat a function of the size of the
MONET; the more MNNs a MONET has, the more CNs the MONET is
most likely to have. (e.g. each MNN in a train communicating
with a few CNs)

Network mobility support MUST thus be able to support large
MONETs, a very large number of small MONETs, and a large number of
CNs. Scaling to a large number of CNs may indeed deserves more
consideration than scaling to a large number of MONETs. This has
never been considered in host mobility support, to the contrary of
the ability to support a large number of mobile nodes.

3.7. Minimum Signaling Overload

Mobility management is usually performed at the cost of control
traffic. Network mobility support MUST minimize this control
traffic, all the more for the reasons outlined in section
"scalability".

3.8. Routing Optimization

Network mobility support SHOULD optimize routing. Non-optimal
routing increases bandwidth consumption and transmission delays.
The amount of traffic intended for the MONET is understandably
more significant than in the case of a single mobile node (see
section "scalability"), then non-optimal routing SHOULD be
considered with more care than for host mobility support. However,
efficient routing is usually performed at the expense of increased
signaling. Thus, the gain of optimal routing MUST be balanced
against the incurred signaling cost.

3.9. Nested Mobility

Network mobility support MUST support nested mobility. It MUST at
least allow single VMNs to enter the MONET, single LMNs to leave
the MONET, and single mobile IP-subnet attach the MONET (instance
of a PAN in a train). Network mobility support must therefore
consider both MONETs and mobile nodes, otherwise it may hardly
interact with host mobility support. In practice, it should handle
VMNs as optimally as if networks were fixed. The working group
needs to agree if it MUST support any number of levels or be

limited to only two levels.

3.10. Backward Compatibility

Network mobility support is constrained by backward compatibility with existing and forthcoming IPv6 standards. As such, it MUST not prevent MNNs to operate any standardized protocol. This particularly includes but is not limited to Mobile IPv6 (host mobility) and IGMP (multicast group membership):

   o Host Mobility Support Constraints: host mobility support in IPv6 is achieved by Mobile IPv6 which is a compulsory component of any IPv6 implementation. This means that network mobility support MUST not prevent LMNs and VMNs from operating Mobile IPv6 once located in a MONET.

   o Multicast Constraints: any IPv6 router is supposed to allow hosts on its attached subnetworks to participate in multicast sessions. Group membership is gathered by the IGMP protocol. Network mobility support MUST not prevent this.

In both cases, the network mobility support MUST provide the necessary extensions to maintain backward compatibility with existing protocols.

3.11. Minimum Impact on Existing Protocols and Infrastructure

Minimum impact on the already deployed infrastructure was an important issue as far as IPv4 was concerned since it was not possible to require all hosts to implement new features. On the other hand, the emergence of IPv6 is an opportunity for making changes, if necessary. An important number of specifications has already been defined, but there is still scope for adding new capabilities if needed since IPv6 deployment is only dawning. However, in order to provide a quickly deployable solution, network mobility support SHOULD better make use of the existing protocols whenever possible and impose minimum changes or extensions on the existing ones. It is also desirable to minimize infrastructure installation costs and complexity.

3.12. No impact on CN or Internet routing

To be able successfully deploy the final solution, session
continuity between a MNN and a CN anywhere in the Internet SHOULD
NOT assume any changes to existing CNs or the Internet routing
architecture. On the other hand, optimizations for performance
enhancement MAY involve some changes to CNs, provided that such
optimizations would not cause any disruption to ongoing sessions,
if not supported by CNs (i.e. backward compatible). [THIS
REQUIREMENT IS TO BE DISCUSSED (in light of the observation made
in section "Minimum Impact on the Existing Protocols and
Infrastructure" here above) BECAUSE IT WOULD PREVENT POTENTIALLY
INTERESTING AND ORTHOGONAL SOLUTIONS TO BE PROPOSED].

3.13. Security

Network mobility support must comply with usual IPv6 security
policies and standardized protocols. In addition, and unlike fixed
nodes, MNNs are more exposed to security threats, particularly
identity usurpation. Network mobility support must provide MNNs
and their CNs with at least as good security as for fixed nodes
and mobile hosts. It particularly shouldn't leave more room for
intruders to usurp an identify nor to perpetrate any kind of
attack against the MNNs nor the CNs. In practice, all control
messages required by network mobility support must be exchanged in
a secure manner and must ensure the following:

3.13.1. Confidentiality

All control messages transmitted in the network MUST ensure
MNNs' confidentiality. Only the recipient of the control
message may be able to decrypt the content of the datagram.

3.13.2. Authentication

All control messages MUST be authenticated by recipients in
order to prevent intruders to usurp the identity of a MNN.

3.13.3. Authorization

The recipient of a control message MUST ensure that the sender
is effectively authorized to perform the mobility support
operation indicated in the control message.

3.13.4. Location Privacy

Network mobility support may provide means for MNNs to hide
their location to any third party. It shouldn't be possible to

determine the succession of topological location of a MONET or
a particular MNN by monitoring the exchange of control
messages. In practice, MNNs may wish to hide their location to
some or all of their CNs, or anyone else but the CNs. It may
also be desirable to hide the location of the entire MONET to
all CNs without discrimination between MNNs.

3.14. Access Control

3.14.1. Access Control for VMNs

Mobile Networks MUST be able to authenticate and authorize VMNs to
gain access to the Internet via the mobile network infrastructure
(MRs).

3.14.2. Access Control Architecture

To be able to comply with the current access control mechanisms
and achieve a scalable solution, the final solution MUST NOT
assume that the fixed network would authenticate VMNs. VMN
authentication and authorization MUST be the responsibility of the
mobile network.

3.14.3. Access Control in the Fixed Network

AAA solutions MUST allow for authenticating an entire network.
This MAY simply be done by ensuring that the Authentication and
Authorization is not necessarily performed for a single IP
address. This is particularly important for IPv6 as each node may
configure multiple addresses. [THIS MAY BE SUGGESTING A SOLUTION
BUT WE WANT IT TO BE DISCUSSED ON THE MAILING LIST].

3.15. Wide-Area Mobility

Network mobility support MUST provide means for a MONET to move
between heterogeneous networks, i.e. Wide-Area Mobility. This is
required in order to ensure permanent and uninterrupted world-wide
mobility. Nothing but administrative and security policies should
prevent a MONET to attach anywhere in the Internet topology. In
practice, a given MONET MUST be able to roam between
administratively distinct access networks (between Internet
Service Providers and corporate networks) and via any available
access technology (802.11b WLAN, Bluetooth, satellite link, GSM,
...). In addition, network mobility support must also accommodate
to CNs deployed in distinct administrative domains.

3.16. Unified Solution

Should different schemes be proposed, a unified mobility support
scheme is required. We must avoid a situation where distinct
network mobility support schemes are deployed and unable to inter-
operate with each other.

3.17. Mobile CNs

Network mobility support MUST be optimized to handle the case
where the CN is itself a MN (as defined by [MIPv6]) or located in
a MONET (particularly if it is a VMN). It must perform efficiently
in both cases.

3.18. Addressing Constraints

The IP address is used for routing and to identify the subnetwork
where an interface is attached to. Each interface on a subnetwork
must therefore be configured with the network prefix of that
subnetwork.

Acknowledgments

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