Thierry Ernst, WIDE and INRIA
Hong-Yon Lach, Motorola Labs Paris
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Network Mobility Support Terminology
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Status of This Memo

Abstract

This document proposes a terminology for defining network mobility problems and solution requirements. Network mobility occurs when an entire network changes its point of attachment to the Internet and thus its reachability in the topology, which is referred to as a mobile network.

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inter-domain mobility
Idle MNN
Idle Mobile Network

4. Changes since previous draft

Acknowledgments

References

1. Introduction

A mobile network is an entire network, moving as a unit, which changes its point of attachment to the Internet and thus its reachability in the topology. A mobile network may be composed by one or more IP-subnets and is connected to the global Internet via one or more Mobile Routers (MR). Nodes behind the MR primarily comprise fixed nodes (nodes unable to change their point of attachment while maintaining ongoing sessions), and additionally mobile nodes (nodes able to change their point of attachment while maintaining ongoing sessions). The internal configuration of the mobile network is assumed to be relatively stable with respect to the MR.

If network mobility is not explicitly supported by some mechanisms once a MR changes its point of attachment, existing sessions between CNs and nodes behind the MR are broken, and connectivity to the global Internet is lost. In addition, fixed nodes behind the MR are faced with sub-optimal routing with their correspondents in the global Internet, whereas multiple levels of mobility may cause extremely sub-optimal routing.

Traditional work on mobility support as conducted in the Mobile IP working group is to provide continuous Internet connectivity to mobile hosts only (host mobility support) and are unable to support network mobility. The NEMO working group has therefore been created to specify solutions specific for network mobility support.

To describe the problems and to define the requirements that will have to be met by the solutions, a new terminology is needed, which is the object of the present document. This terminology is supposed to serve as the base document produced by the NEMO WG and shall be refined once we agree on the requirements.

2. Applications

Cases of mobile networks include networks attached to people (Personal Area Network or PAN, i.e. a network composed by all Internet appliances carried by people, like a PDA, a mobile phone, a digital camera, a laptop, etc.) and networks of sensors deployed in aircrafts, boats, busses, cars, trains, etc. An airline company that provides permanent on-board Internet access is an example of a mobile network. This allows passengers to use their laptops (this scenario is mentioned in [Tanenbaum] under section 1.2.4 and section 5.5.8; [Perkins] under section 5.12; [Solomon] under section 11.2; and [RFC2002] section 4.5), PDA, or mobile phone to connect to remote hosts, download music or video, browse the web. Passengers could themselves carry a network with them (a PAN). At the same time, air control traffic could be exchanged between the aircraft and air

traffic control stations (this scenario has already been investigated by Eurocontrol, the European Organization for the safety of air navigation. During a transatlantic flight, the aircraft changes its point of attachment to the Internet and may be reachable by distinct Internet Service Providers (ISPs). Over the oceans, the aircraft gets connected to the Internet through a geostationary satellite; over the ground, it's through a radio link. Handoffs do typically not occur very often (a radio link may cover 400-500 kilometers). Another similar scenario mentioning ships and aircrafts can be found in [RFC1726, section 5.15]. Similarly, a bus, the metropolitan public transport, or the taxi company could allow passengers to connect their PAN to the Internet via the embarked network, therefore ensuring, while on-board, an alternative to the metropolitan cellular network, in terms of price or available bandwidth, access control, etc. Meanwhile, a number of Internet appliances deployed in the mobile network are used to collect traffic and navigation data from the Internet while sensors within the mobile network collect and transmit to the Internet live information, like the current number of passengers, expected time to arrival, the amount of petrol left in the tank, etc. For a number of reasons (network management, security, performance,...), it is desirable to interconnect the Internet appliances deployed in cars, trains, busses by means of, for instance, an Ethernet cable, instead of connecting them individually and directly to the Internet, therefore exhibiting the need to displace an entire network.

3. Terminology

Terms introduced in this draft comply with the terminology already defined in the IPv6 [RFC2460] and Mobile IPv6 [MIPv6] specifications. Our terminology is primarily targeted toward IPv6 but is not necessarily limited to it. Terms defined in [Mobility] may also be useful.

Some terms introduced in the present draft will only be useful for the purpose of defining the problem scope and functional requirements of network mobility support and shall be removed or refined once we agree on the requirements. Terms redundant with the terminology defined in [Mobility] shall also be removed.

The first section introduces terms to define the architecture components; the second introduces terms to discuss the requirements, the third, terms to discuss nested mobility; the forth defines multihoming, and the last, miscellaneous terms which do not fit in either sections.

The terminology is summarized in fig.1 to 5. Fig.1 shows a single mobile subnetwork. Fig.2. shows a larger mobile network comprising

several subnetworks, attached on a foreign link. Fig.3 illustrates a node changing its point of attachment within the mobile network. Fig.4 and 5 illustrate nested mobility.

3.1. Architecture Components

Mobile Network

An entire network, moving as a unit, which dynamically changes its point of attachment to the Internet and thus its reachability in the topology. The mobile network is connected to the global Internet via one or more mobile router(s) (MRs). From the fixed Internet, the mobile network is a cloud. The internal configuration of the mobile network is assumed to be relatively stable with respect to the MR and is not a matter of concern. The internal of the mobile network will therefore not affect network mobility support protocols.

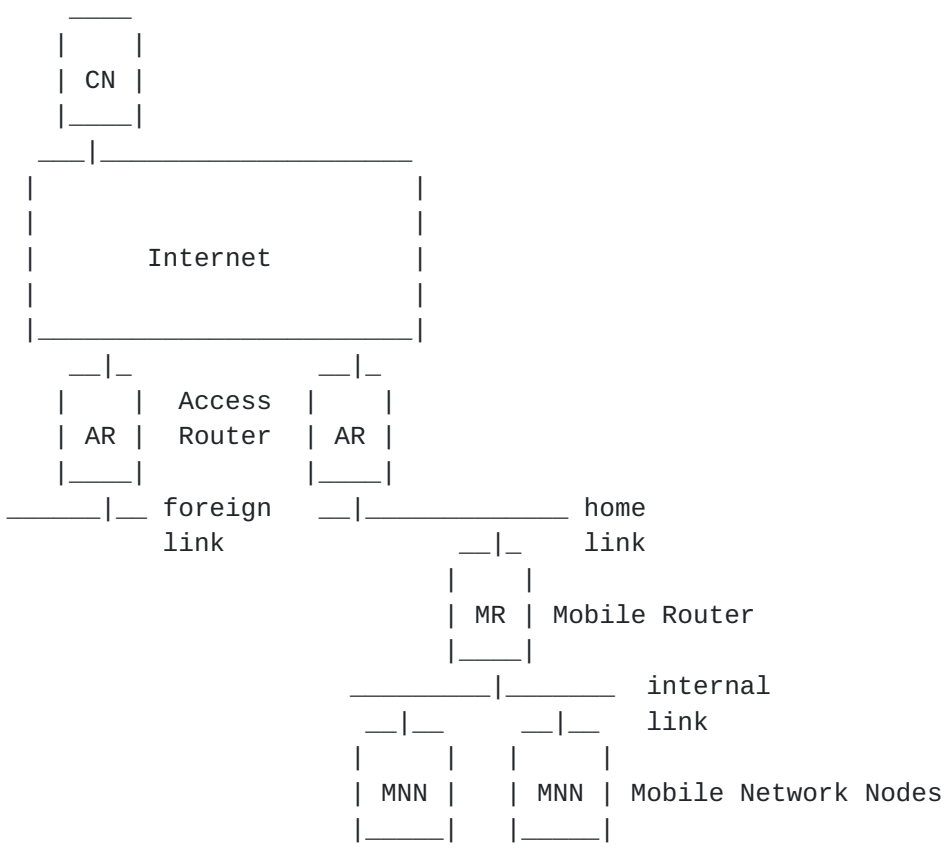

Fig.1: Architecture Components

Mobile Network Node (MNN)

Any host or router located within the mobile network, either

permanently or temporarily. A MNN could be any of a MR, LFN, VMN, or LMN. The distinction between LFN, LMN and VMN is necessary to discuss issues related to mobility management and access control, but does not preclude that mobility should be handled differently. Nodes are classified according to their function and capabilities.

Mobile Router (MR)

A router which changes its point of attachment to the Internet. The MR has one or more egress interface(s) and one or more ingress interface(s) and acts as a gateway between the mobile network and the rest of the Internet. The MR thus maintains the Internet connectivity for the entire mobile network. When forwarding a packet to the Internet (i.e. upstream), the packet transmitted through one MR's egress interface; when forwarding a packet to the mobile network (i.e. downstream), the packet is transmitted through one of the MR's ingress interface.

Fixed Node (FN)

A node, either a host or a router, unable to change its point of attachment and its IP address without breaking open sessions. FNs are standard IPv6 nodes as defined in [IPv6-NODE] which do not support the MN functionality defined in [MIPv6] section 8.5 nor any other form of mobility support (also see [IPv6-NODE] section 7 "Mobility").

Mobile Node (MN)

A node, either a host or a router, which is able to change its point of attachment and maintain continuous sessions.

Node behind the MR

Any MNN in a mobile network, beside the MRs connecting the mobile network to the Internet.

Correspondent Node (CN)

Any node that is communicating with one or more MNNs. A CN could itself be located within the mobile network.

Access Router (AR)

Any subsequent point of attachment of the MR at the network layer. Basically, a router on the home link or the foreign link. An AR may itself be located in a mobile network and provide access to mobile nodes.

Egress Interface of a MR

The interface attached to the home link if the MR is at home, or attached to a foreign link if the MR is in a foreign network.

Ingress Interface of a MR

The interface attached to a link inside the mobile network. This interface is configured with the Mobile Network Prefix.

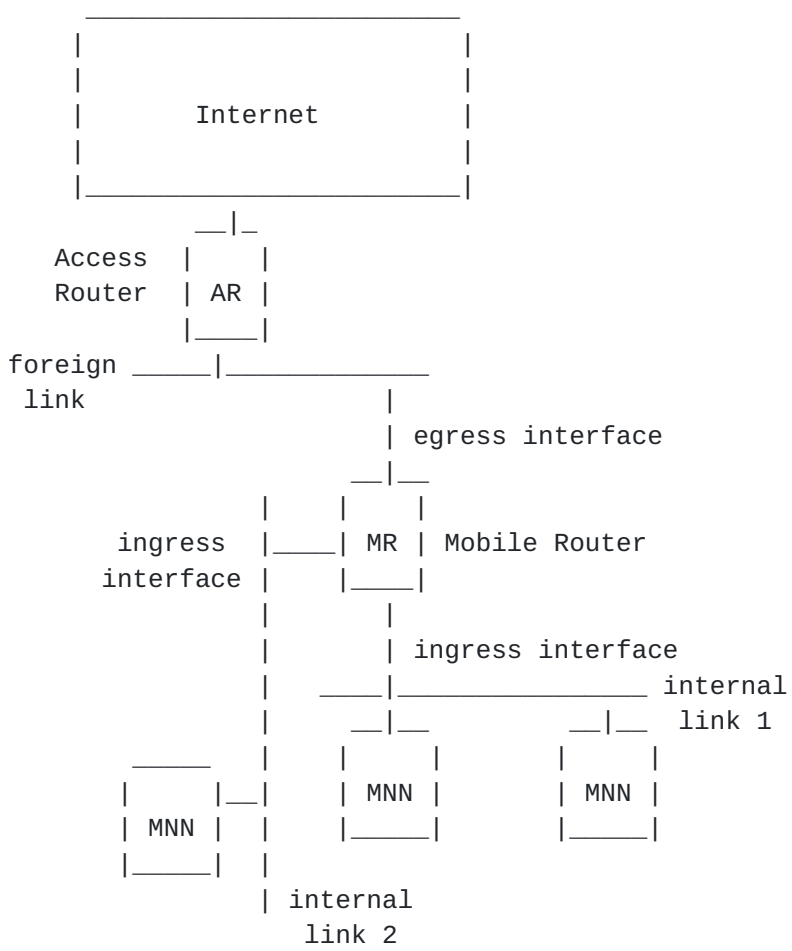

Fig.2: Larger Mobile Network with 2 subnets

Home subnet prefix

A bit string that consists of some number of initial bits of an IP address which identifies the MR's home link within the Internet topology (i.e. the IP subnet prefix corresponding to the mobile node's home address, as defined in [MIPv6]).

Foreign subnet prefix

A bit string that consists of some number of initial bits of an IP address which identifies the MR's foreign link within the Internet topology.

Mobile Network Prefix

A bit string that consists of some number of initial bits of an IP address which identifies the entire mobile network within the Internet topology. All MNNs necessarily have an address named after this prefix.

3.2. Functional Terms

The distinction of MNNs between LFN, LMN, and VMN as defined below is a property of how different types of nodes can move in the topology. The rationale here is that nodes with different properties (may) have different requirements. This distinction may not be useful once we agree on the requirements. They are listed here as a means to ease and clarify the requirement discussion.

Local Fixed Node (LFN)

A fixed node (FN) that belongs to the mobile network and which doesn't move topologically with respect to the MR.

Local Mobile Node (LMN)

A mobile node (MN) or a mobile router (MR) that belongs to the mobile network (i.e. its home link is within the mobile network). It can move topologically with respect to the MR.

Visiting Mobile Node (VMN)

A mobile node (MN) or a mobile router (MR) that doesn't belong to the mobile network (i.e. its home link is not within the mobile network). A VMN that gets attached to a link within the mobile network obtains an address on that link and can move topologically with respect to the MR.

NEMO-enabled (NEMO-node)

A node that has been extended with network mobility support capabilities and that may take special actions based on that. (details of the capabilities are not known yet, but it may be implementing some sort of Route Optimization).

MIPv6-enabled (MIPv6-node)

A mobile node (MN) which is able to change its point of attachment and maintains continuous sessions thanks to the MN functionality as defined in [MIPv6] section 8.5.

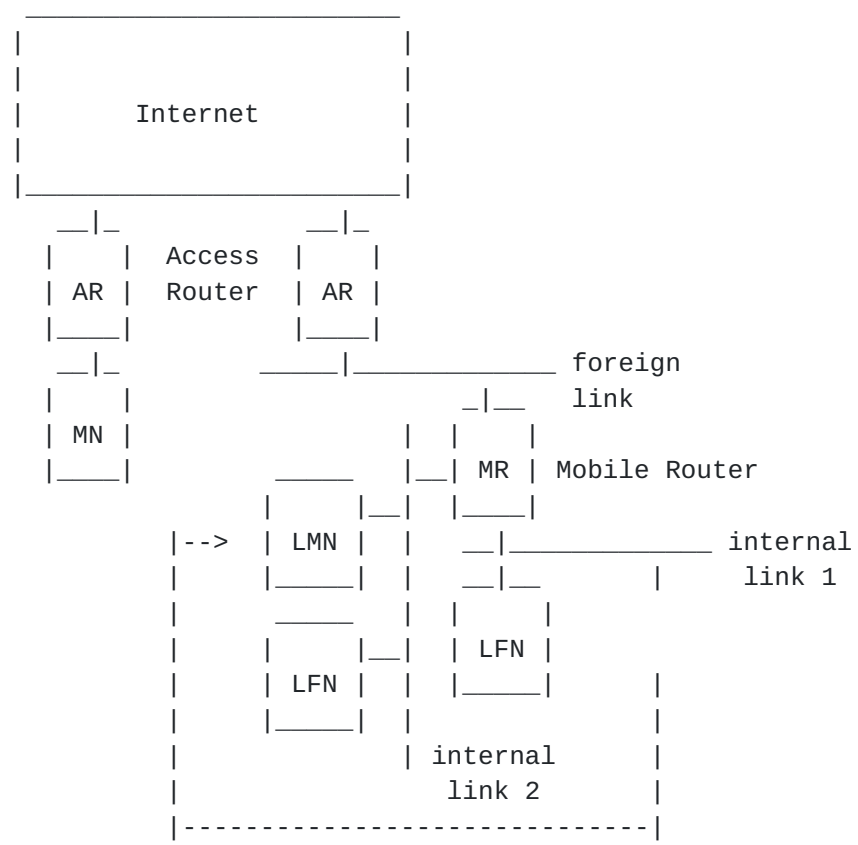

Fig.3: LFN and LMN: LMN changing subnet

3.3. Nested Mobility

Nested mobility occurs when there are more than one level of mobility. A MNN acts as an Access Router and allows visiting nodes to get attached to it. There are two cases of nested mobility:

- when the attaching node is a single node: VMN (see figure 4). For instance, when a passenger carrying a mobile phone gets Internet access from the public access network deployed into a bus.

- when the attaching node is a router with nodes behind it, i.e. a mobile network (see figure 5). For instance, when a passenger carrying a PAN gets Internet access from the public access network

deployed in the bus.

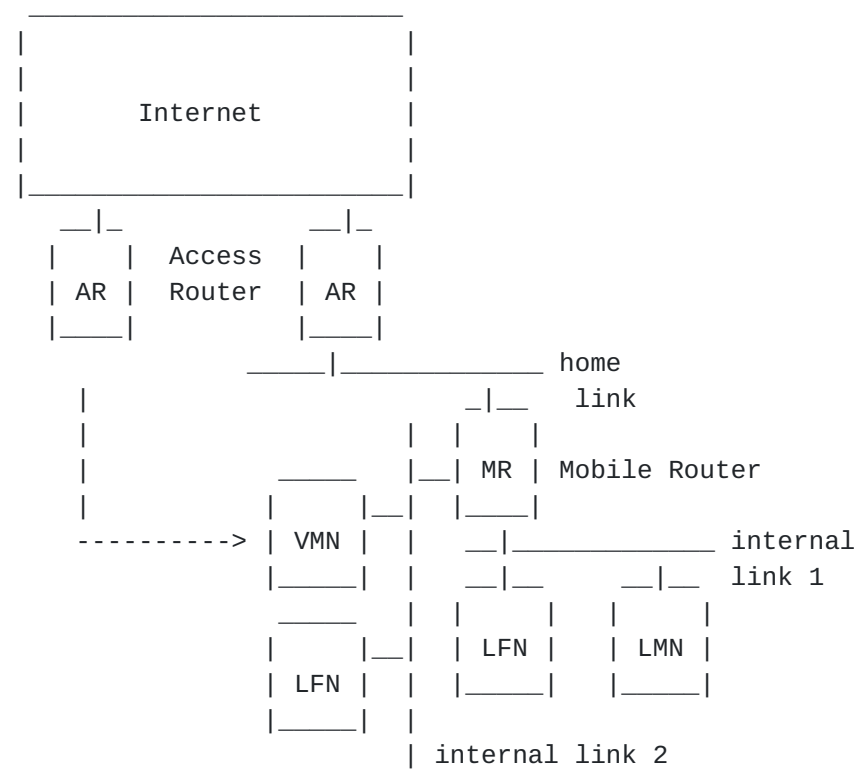

Fig.4: Nested Mobility: single VMN attached to a mobile network

For the second case, we introduce the following terms:

Nested Mobile Network

A mobile network is said to be nested when a mobile network is getting attached to a larger mobile network. The aggregated hierarchy of mobile networks becomes a single nested mobile network.

root-NEMO

The mobile network at the top of the hierarchy connecting the aggregated nested mobile network to the Internet.

parent-NEMO

The upstream mobile network providing Internet access to a mobile network down the hierarchy.

sub-NEMO

The downstream mobile network attached to a mobile network up the hierarchy. It becomes a subservient of the parent-NEMO. The sub-NEMO is getting Internet access through the parent-NEMO and does not provide Internet access to the parent-NEMO.

root-MR (was TLMR: Top-Level Mobile Router)

The MR(s) of the root-NEMO used to connect the nested mobile network to the fixed Internet.

parent-MR

The MR(s) of the parent-NEMO.

sub-MR

The MR(s) of the sub-NEMO connected to a parent-NEMO

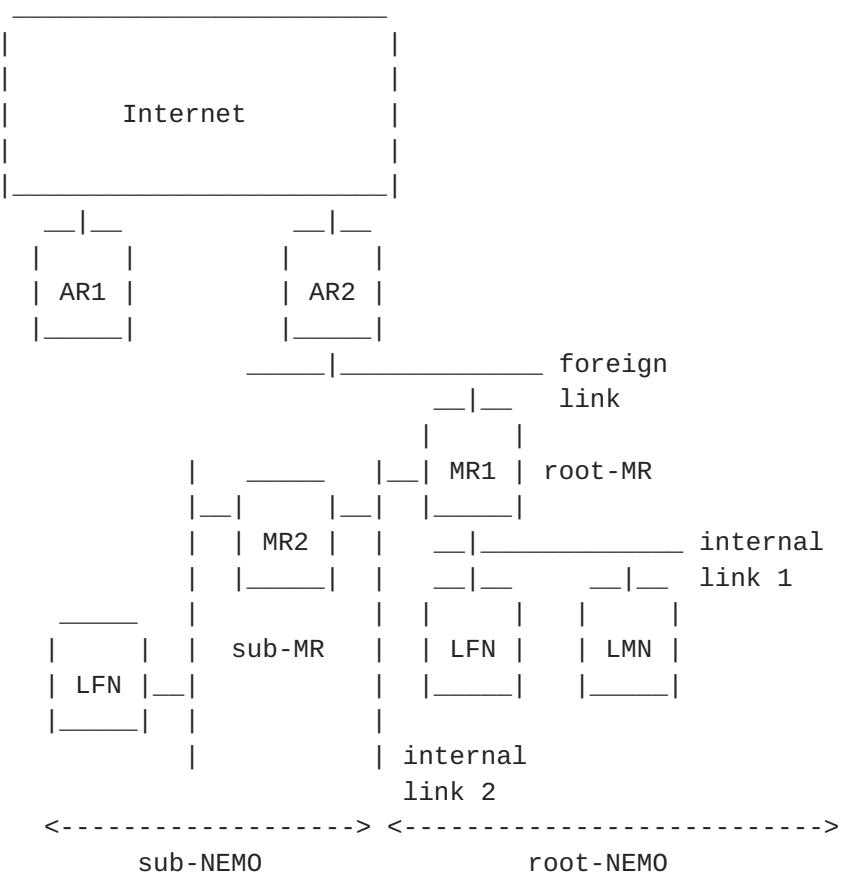

Fig.5: Nested Mobility: sub-NEMO attached to a larger mobile network

3.4. Multihoming

Multihomed Host

Multihoming, as currently defined by the IETF, covers site-multihoming [MULTI6] and host multihoming. Within host-multihoming, a host may be either:

- multi-addressed: multiple source addresses to choose between on a given interface; all IPv6 nodes are multi-addressed due to the presence of link-local addresses on all interfaces.

- multi-interfaced: multiple interfaces according to [RFC2460] definition.

- multi-linked: just like multi-interfaced but all interfaces are NOT connected to the same link.

- multi-sited: when using IPv6 site-local address and attached to different sites

Multihomed Mobile Network

From 3.4.1, a mobile network is multihomed when either:

- a MR has multiple egress interfaces on the same link, or

- a MR has multiple egress interfaces on distinct link, or

- there are more than one MR in the mobile network

Multihomed Nested Mobile Network

From 3.4.1, a nested mobile network is multihomed when either:

- a root-MR has multiple egress interfaces on the same link, or

- a root-MR has multiple egress interfaces on distinct link. or

- there are more than one root-MR in the mobile network

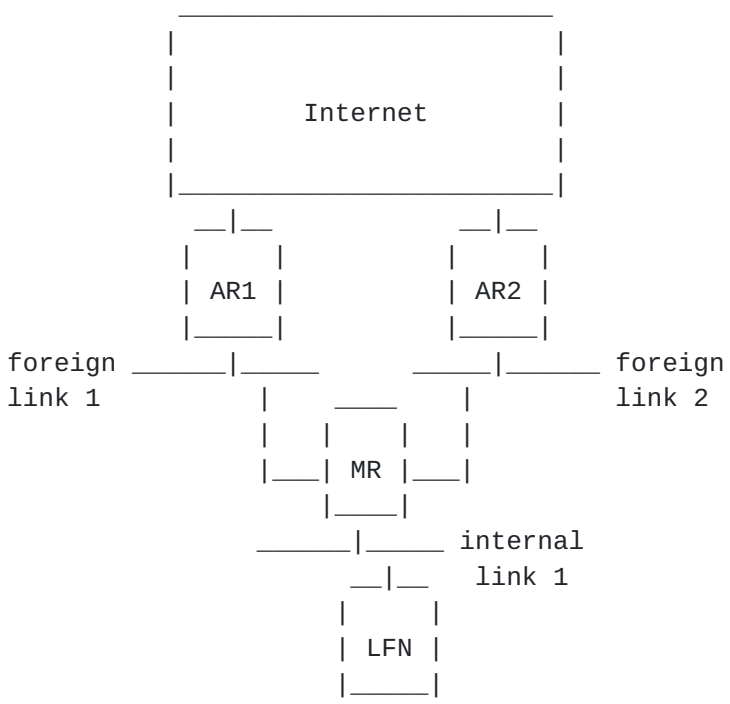

Fig.6: Multihomed Mobile Network: Multi-interfaced MR

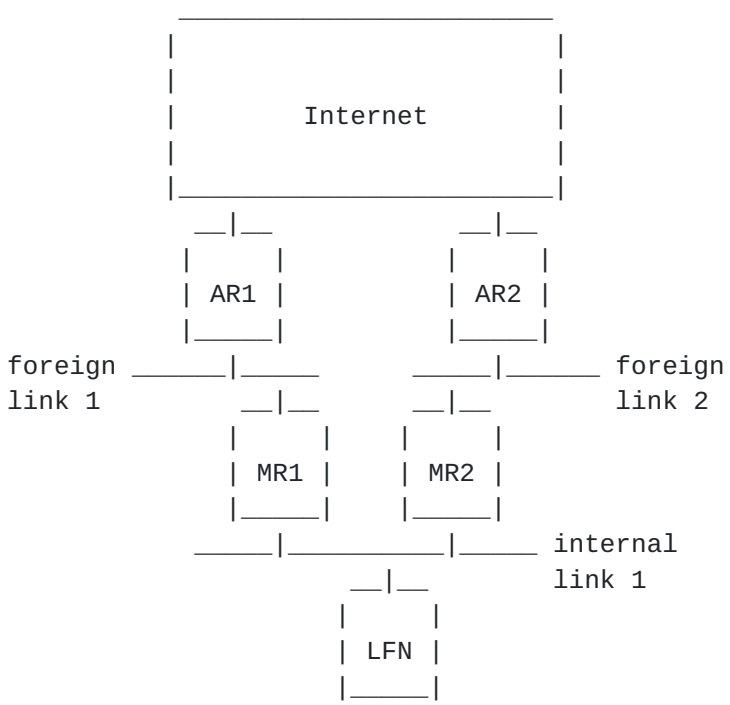

Fig.7: Multihomed Mobile Network: Multiple MRs

Illustration

Fig.6 and 7 show two examples of multihomed mobile networks. Fig.8. shows two independent mobile networks. mobile_network_1 is single-homed to the Internet through MR1. mobile_network_2 is multihomed to the Internet through MR2a and MR2b.

Let's consider the two following nested scenarios:

Scenario 1: what happens when MR2a. attaches to AR1 ?

- mobile_network_2 becomes a subservient of mobile_network_1
- mobile_network_1 is the parent-NEMO (and also the root-NEMO)
- mobile_network_2 is the sub-NEMO
- MR1 is the root-MR for the aggregated nested mobile network
- MR2a is a sub-MR in the aggregated nested mobile network
- mobile_network_2 is still multihomed to the Internet, but to AR1 and ARz
- the aggregated nested mobile network is not multihomed

Scenario 2: what happens when MR1 attaches to AR2 ?

- mobile_network_1 becomes a subservient of mobile_network_2
- mobile_network_1 is the sub-NEMO
- mobile_network_2 is the parent_NEMO (and also the root-NEMO)
- MR2a and MR2b are both root_MRs for the aggregated nested mobile network
- MR1 is a sub-MR in the aggregated nested mobile network
- mobile_network_1 is not multihomed
- the aggregated nested mobile network is multihomed

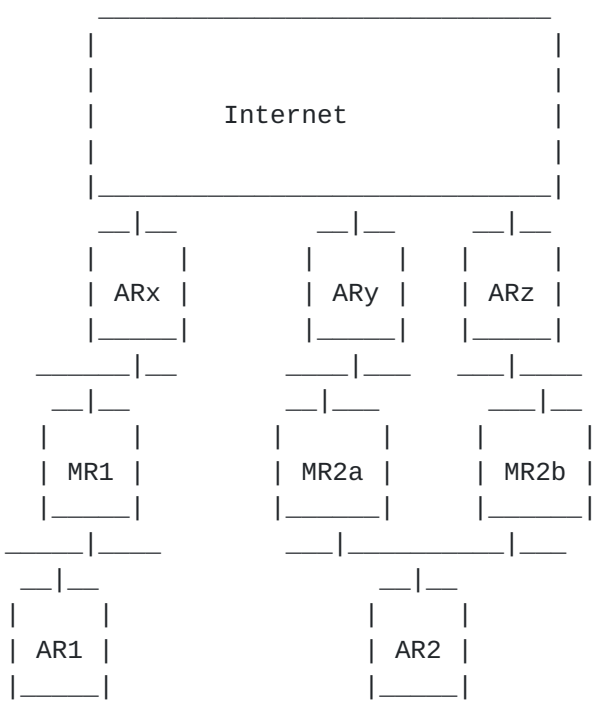

Fig.8: Multihomed Nested Mobile Network

3.5. Miscellaneous Terms

Host mobility support

Host Mobility Support allows mobile nodes to maintain session continuity. In IPv6, it is achieved by Mobile IPv6

Network Mobility support (NEMO Support)

Network mobility support allows mobile networks to maintain session continuity. Solutions developed to support NEtwork MObility will be referred to as "NEMO support".

In Basic support, each Mobile Router has a Home Agent, and uses bidirectional tunneling between the MR and HA to preserve session continuity while the MR moves. The MR will acquire a Care-of-address from its attachment point much like what is done for Mobile Nodes using Mobile IP. This approach allows nesting of mobile networks, since each MR will appear to its attachment point as a single node.

In Extended support, we will seek to optimize routing between MNNs and arbitrary CNs by some means which details are not known yet.

intra-domain mobility

Mobility within a single administrative domain, i.e. between subnetworks topologically close in the IP hierarchy. As an instance, the displacement of a node within a limited vicinity of adjacent subnetworks, like in a campus, that belong to the same organization or between ARs that belong to the same ISP. In the literature, and depending on the definition of ``closeness'', this is also termed intra-site mobility, local mobility or micro-mobility.

inter-domain mobility

Mobility across administrative domain boundaries, i.e. between subnetworks topologically distant in the IP hierarchy. As an instance of Wide-Area Mobility, displacement of a node between distinct ISPs or organizations, or between widely separated sites of a single organization. In the literature, and depending on the definition of ``remoteness'', this is also termed inter-site mobility, global mobility, or macro-mobility.

Idle MNN

A MNN that does not engage in any communication.

Idle Mobile Network

A mobile network that does not engage in any communication outside the network may be considered idle from the global Internet. This doesn't preclude that MNNs are themselves idle. Internal traffic between any two MNNs located in the same mobile network is not concerned by this statement.

4. Changes since last draft

- replace TLMR with root-MR

- add sub-MR, and parent-MR

- add a definition for "Multihomed Nested Mobile Network"

Acknowledgments

The material presented in this document takes most of the text from our former internet-drafts submitted to MobileIP WG and to the former MONET BOF, which where themselves built on original text from [Ernst01]. Authors would therefore like to thank both Motorola Labs Paris and INRIA (PLANETE team, Grenoble, France), for the opportunity to bring this terminology to the IETF, and particularly Claude Castelluccia (INRIA) for his advices, suggestions, and direction, Alexandru Petrescu (Motorola) and Christophe Janneteau (Motorola). We also acknowledge the input from Hesham Soliman (Ericsson), Mattias Petterson (Ericsson), and numerous other people on the NEMO (formerly MONET) mailing list.

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Author's Addresses

Questions about this document can be directed to the authors:

Thierry Ernst,
INRIA, visiting researcher at WIDE
Jun Murai lab. Faculty of Environmental Information,
Keio University.
5322 Endo, Fujisawa-shi, Kanagawa 252-8520, Japan.
Phone : +81-466-49-1100
Fax : +81-466-49-1395
E-mail: ernst@sfc.wide.ad.jp
Web: http://www.sfc.wide.ad.jp/~ernst/

Hong-Yon Lach
Motorola Labs Paris, Lab Manager,
Networking and Applications Lab (NAL)
Espace Technologique - Saint Aubin
91193 Gif-sur-Yvette Cedex, France
Phone: +33-169-35-25-36
Email: Hong-Yon.Lach@crm.mot.com