IETF INTERNET-DRAFT

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Network Mobility Support Terminology
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Status of This Memo

Abstract

This document proposes a terminology for defining the problem faced by network mobility. Network mobility 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. Network mobility support is to maintain session continuity between nodes in the mobile network and nodes in the global Internet.

Contents

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 may experiment dog-leg routing, whereas multiple levels of mobility may cause multiple dog-leg 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. It is thus proposed to create a NEMO working group that would specify solutions for network mobility support (the proposed name for the working group was renamed from MONET to NEMO).

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 [Tanenbaum96] under section 1.2.4 and section 5.5.8; [Perkins98] under section 5.12; [Solomon98] 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, [Quinot98]). 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.

To describe such kind of scenarios, we need to agree on a terminology. However, there is presently no existing terminology to define the issues, goals, architecture elements, problems and requirements pertaining to the scenarios outlined here above, but one is needed. It is therefore the object of this document to propose such a new terminology and to highlight some characteristics of mobile networks.

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. In addition to the present terminology, this former draft was also presenting a set of requirements and issues as an attempt to clarify the problem caused by network mobility. We decided to split this former document in two because requirements are more subject to discussion and disagreements than the terminology on which we must agree on to base our discussion. Our proposed requirements can therefore now be found in [REQUIREMENTS-1]. Additional requirements may be found in [REQUIREMENTS-2] and [REQUIREMENTS-3]. A comprehensive description of the problem and issues posed by network mobility is discussed in [SCOPE]. More information may be found on the MONET web page [WEB-MONET].

2. Terminology

The new terms we introduce comply with the terminology already defined in the IPv6 [RFC2460] and Mobile IPv6 [MIPv6] specifications. Although our terminology is primarily targeted toward IPv6, it is not necessarily limited to it. This list comprises terms that appeared on the mailing list for the purpose of explaining the problem scope. Some of them may only be useful for the purpose of defining the problem scope and functional requirements of network mobility support. Definitions will have to be refined once we agree on the problem scope.

The first section introduces terms to define the architecture components; the second introduces terms to discuss nested mobility;

the last section introduces a number of other terms useful to discuss requirements.

2.1. Architecture Components

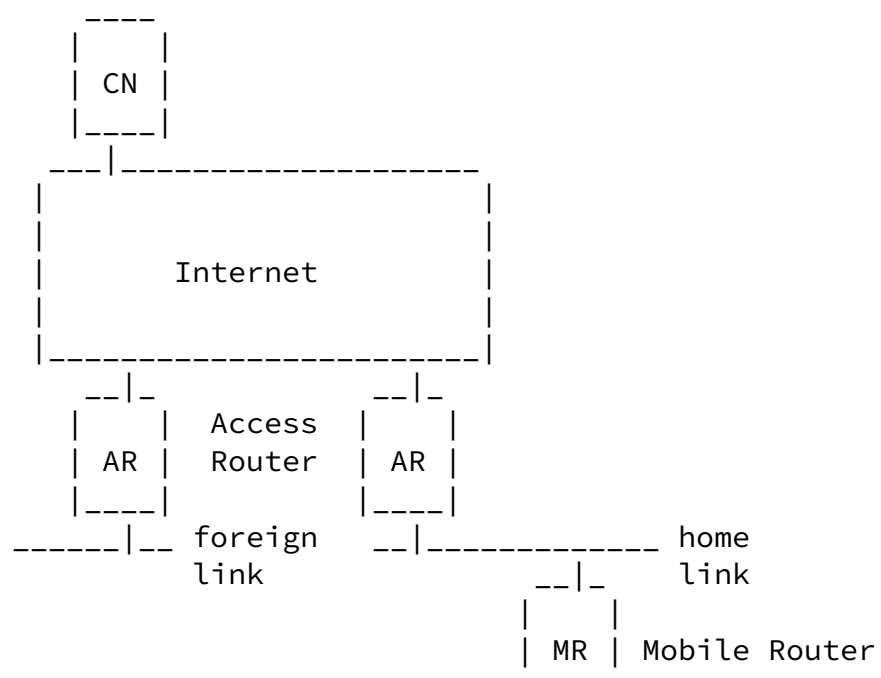
Mobile Network

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) (MR). 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.

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.



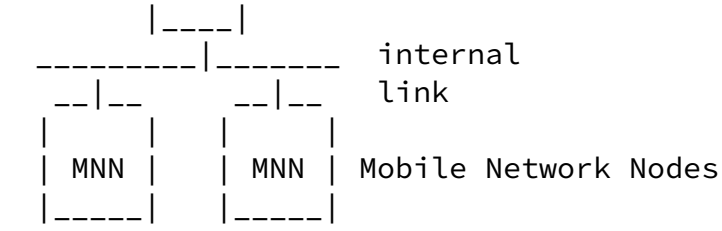


Figure 1: Terminology

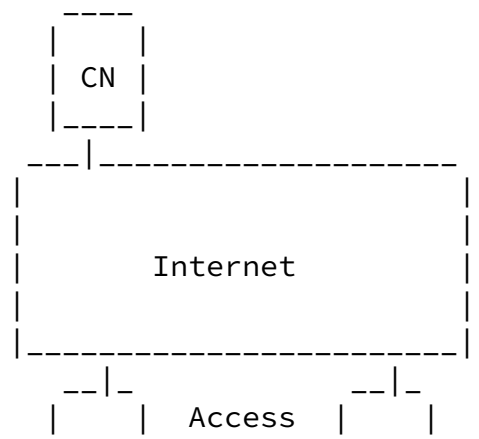
Mobile Router (MR)

A router which changes its point of attachment to the Internet and which acts as a gateway to route packets between the mobile network and the rest of the Internet. The MR is NEMO-enabled and maintains the Internet connectivity for the mobile network. It has at least two interfaces, an egress interface, and an ingress interface. When transmitting a packet to the Internet (i.e. outside), it forwards it through the egress interface; when transmitting it withing the mobile network (i.e. inside), it forwards it through the ingress interface.

Local Fixed Node (LFN)

A standard IPv6 node, either a host (LFH) or a router (LFR), that belongs to the mobile network and which has no mobility support capabilities at all (i.e. it isn't NEMO-enabled nor

MIPv6-enabled).



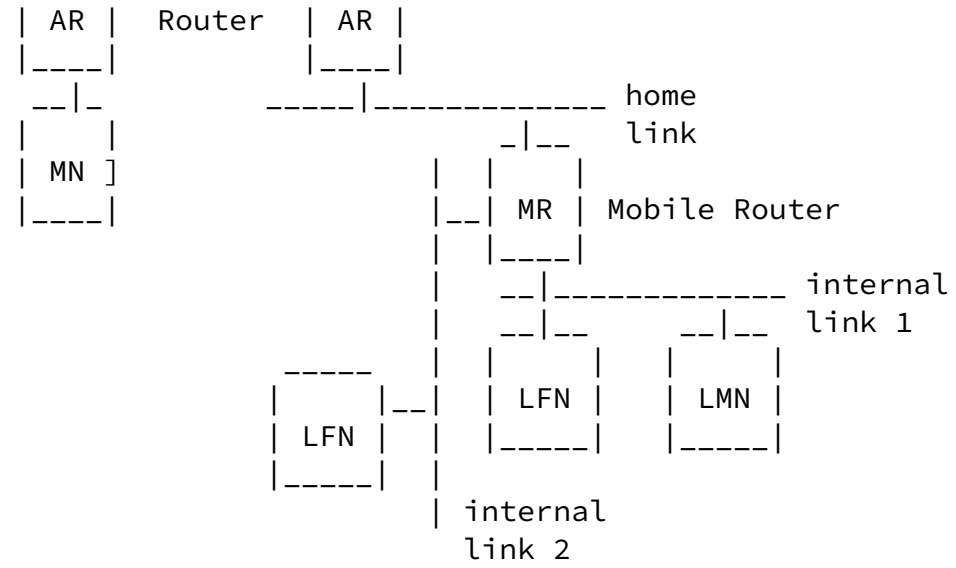


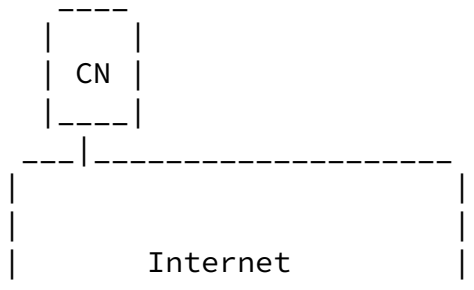
Figure 2: Larger Mobile Network with 2 subnets

Local Mobile Node (LMN)

A mobile node, either a host (LMH) or a router (LMR), that belongs to the mobile network (i.e. its home link is within the mobile network). It is MIPv6-enabled and may be NEMO-enabled.

Visiting Mobile Node (VMN)

A mobile node, either a host (VMH) or a router (VMR), that doesn't belong to the mobile network (i.e. its home link is not within the mobile network), and which gets attached to a link within the mobile network and obtains an address on that link. It is MIPv6-enabled and may be NEMO-enabled.



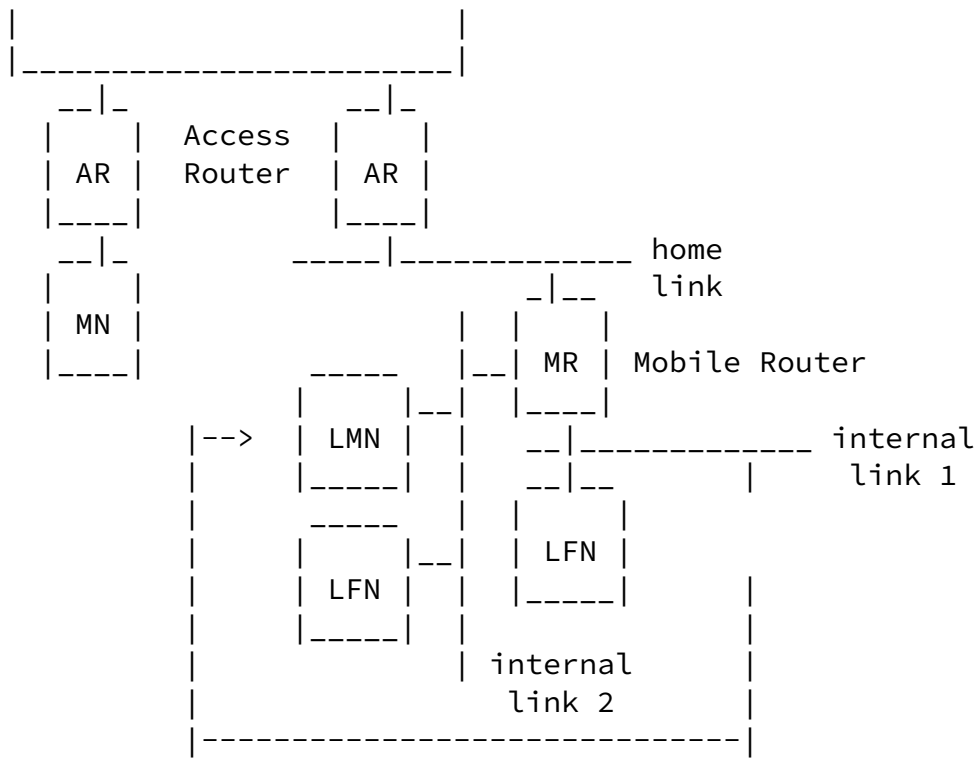


Figure 3: LMN changing subnet

Node behind the MR

Any MNN in a mobile network that is not a MR for this mobile network.

Correspondent Node (CN)

Any node that is communicating with one or more MNNs located in the same mobile network. 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.

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.

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.

The terminology is summarized in fig.1 to 3. Fig.1 shows a single mobile subnetwork. Fig.2. shows a larger mobile network comprising several subnetworks. Fig.3 illustrates a LMN changing its point of attachment within the mobile network.

2.2. Nested Mobility

We speak about nested mobility when there are more than one level of mobility, i.e. when a VMN gets attached to the mobile network. A MNN acts as an Access Router for this VMN.

If the VMN is actually a VMR with nodes behind it, this is a mobile network which gets attached to a larger mobile network. The former is a sub-MONET, and the latter the parent-MONET. It is generally assumed that the sub-MONET and the parent-MONET become a single

aggregated mobile network, i.e. the sub-MONET is indeed a subservient of the larger MONET in terms of getting address space.

The MR(s) used to directly connect the aggregated mobile network to the fixed Internet is referred to as the Top-Level Mobile Router (TLMR) The terms upstream-MONET, downstream-MONET, and root-MONET have also been introduced.

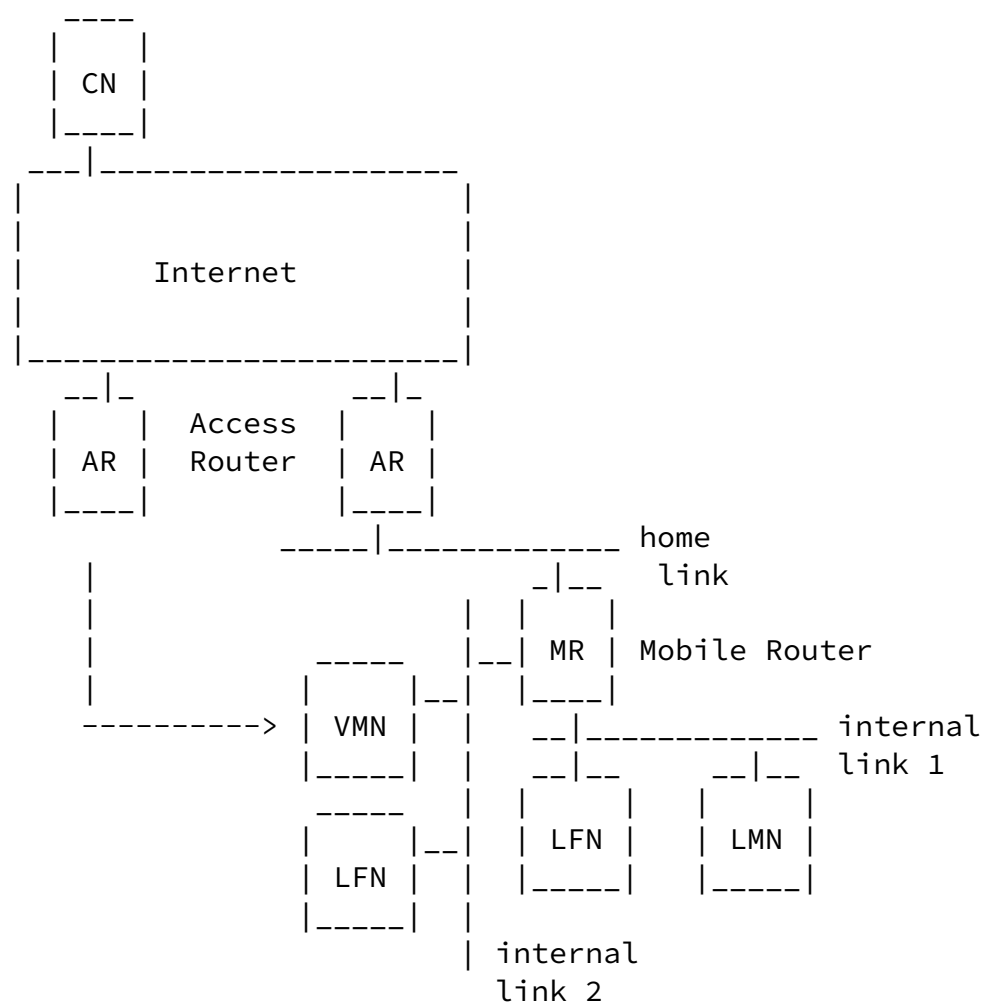


Figure 4: Nested Mobility: single VMN that attaches to a mobile network

As for an instance of nested mobility, when a passenger carrying a mobile phone (VMN) or a PAN (sub-MONET) gets Internet access from the public access network deployed in the bus (parent-MONET). Fig.4 and 5. illustrate nested mobility. In fig.4, a single VMN gets attached to the mobile network. In fig 5, a VMR carrying an entire network, thus a sub-MONET.

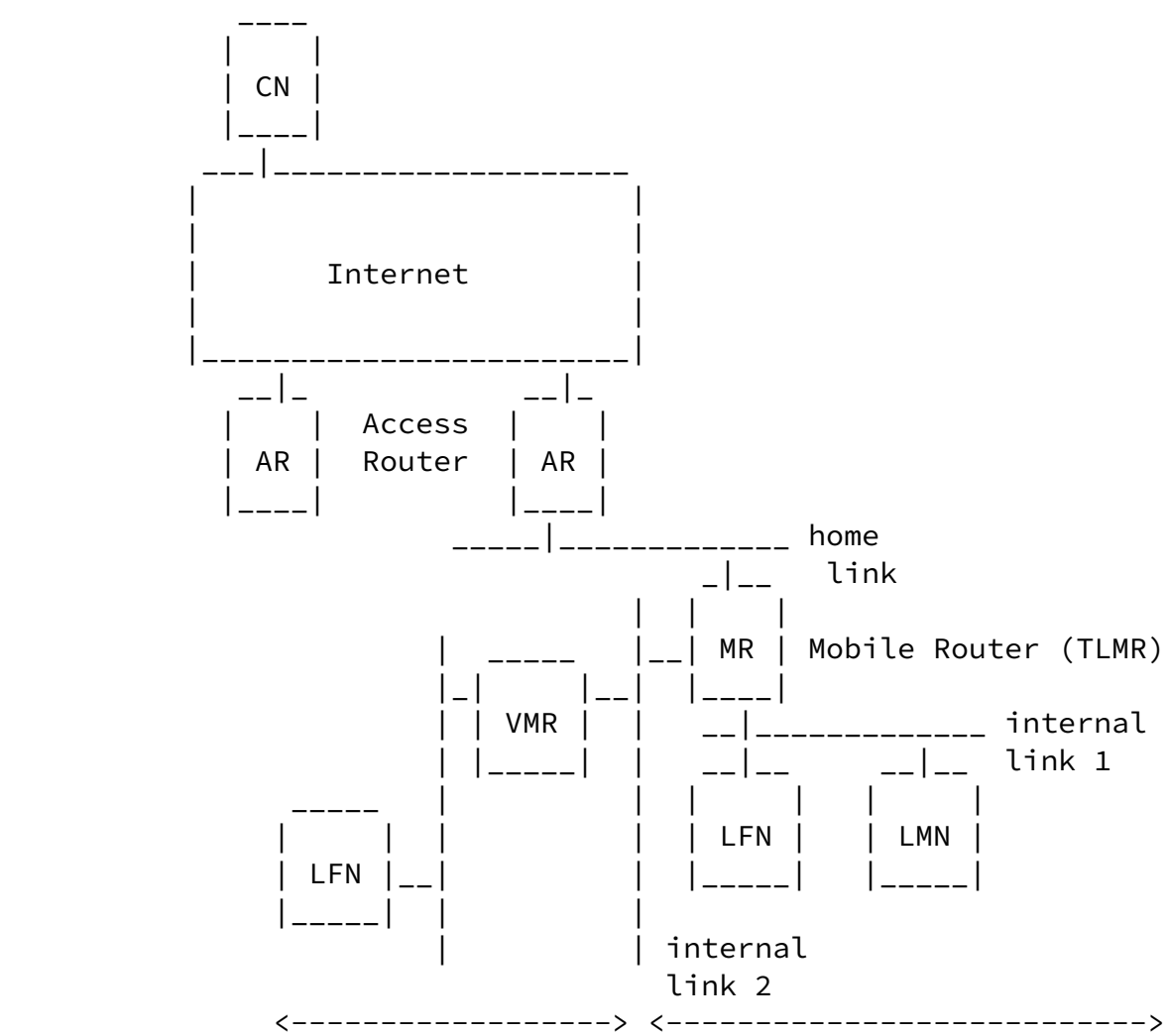


Figure 5: Nested Mobility: sub-MONET that attaches to a larger mobile network

2.3. Miscellaneous Terms

NEMO-enabled node

a node that has been extended with NEtwork MObility support capabilities and may take special actions based on that. (Details of the capabilities are not known yet, but it will be based on enhancements to Mobile IPv6 [MIPv6] and may be implementing some sort of Route Optimization).

MIPv6-enabled node

A mobile node that implements the "MN Operation" of Mobile IPv6

[MIPv6]. I.e. A node that only implements the "CN Operation" of Mobile IPv6 is NOT considered MIPv6-enabled.

Multihoming

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

What is meant by a multihomed-MONET is not clear and is left for open discussion. It depends on the possible configurations covered by the revised problem scope. Future discussion will assess if a MR may fall in all the above described cases and if multiple MRs may be used to connect the mobile network to the Internet.

Local-Area Mobility

Mobility within a single administrative domain, i.e. between subnetworks topologically close in the IP hierarchy. In the

literature, and depending on the definition of ``closeness'', this is also termed intra-site mobility, intra-domain mobility, local mobility or micro-mobility. As an instance of Local-Area Mobility, 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.

Wide-Area Mobility

Mobility across domain boundaries, i.e. between subnetworks topologically distant in the IP hierarchy. In the literature, and depending on the definition of ``remoteness'', this is also termed inter-site mobility, inter-domain mobility, or global mobility, or macro-mobility. 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.

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 as idle from the point of view of the 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.

3. Observations

Structure of the mobile network

A MR changing its point of attachment does not cause the MNNs behind the MR to change their own physical point of attachment. Thus, the internal structure of a mobile network is not modified as a result of the mobile network changing its point of attachment. MNNs may or may not notice such a displacement, but they must not be required to be NEMO-enabled. However, MNNs MAY appear to move from the point of view of an observer in the Internet. In addition, the internal structure of the mobile network is assumed to be relatively stable (no dynamic change of the topology).

Mobile Router is a transit point

All packets sent from a CN to a MNN necessarily transit through a

MR.

Size of the mobile network

A mobile network may comprise one or more subnets. Its size could scale from a sole subnet with a few IP devices, such as in the case of a PAN, to a collection of subnets with hundreds of IP devices, such as in a train.

Large number of CNs

A mobile network may have a very large number of CNs. For instance, each passenger in a train may be considered a MNN. Each of them may be communicating with a few CNs. As a result, the total number of CNs could be several times as large as the number of MNNs and scale up to a few thousands.

Sparseness of the CNs

CNs are typically sparsely distributed in the Internet and belong to distinct administrative domains.

Handoff frequency

Mobile networks may not move with the same speed and frequency. For instance, a PAN connected to the Internet via a 802.11b WLAN (e.g. user in a shopping mall) is likely to change its point of attachment very frequently, while an aircraft or a boat may be connected to the Internet via the same satellite link for a couple of hours. Obviously, mobile networks may not move at all for a

large amount of time.

Dog-leg Routing

As a result of mobility, routing between a CN in the global Internet and a mobile node may not be optimal. Packets usually transit via the home link of the mobile node if no routing optimization is explicitly performed. In network mobility, multiple dog-leg routing may be introduced by nested mobility. In this case, packets intended to a VMN may first transit by the VMN's home link, then being rerouted to the MR's home link.

Ad-Hoc Network

An Ad-hoc network as defined in the IETF MANET Working Group is not to be confused with a mobile network. An ad-hoc network is an autonomous system made of mobile nodes (i.e. routers) connected by wireless links. The routers are free to move randomly and to organize themselves arbitrary. Topologies are highly dynamic. In a mobile network, some routers may effectively move arbitrary, but this not a common case. However, an Ad-hoc network connected to the Internet and that changes its point of attachment may be considered as a special instance of a mobile network.

Network mobility support (NEMO) and Mobile Ad-hoc Networking (MANET) have not the same objectives. Network mobility support aims at providing Internet reachability to nodes in the mobile network and at maintaining session continuity after the mobile network has changed its point of attachment in the topology. On the other hand, MANET aims at maintaining routes between highly dynamic nodes.

Routers in the Mobile Network

All routers in the Internet are considered to run a number of protocols such as a routing protocol, Neighbor Discovery, ICMP, and others. This also applies to routers in the mobile network, including the MR.

4. Changes from previous draft

- updated definition of LFN, LMN, VMN, mobile network, mobile network prefix, CN

- added terms NEMO-enabled and MIPv6-enabled.

- added a section (2.2) for terminology specific to nested mobility: root-MONET, parent-MONET, sub-MONET, upstream, downstream.

- added a paragraph about multihoming

- removed mobile IP-subnet.

- added comments about Ad-Hoc network in section 3

- added comments about multiple dog-leg routing in section 3

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