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S. Jeong (Ed.)
ETRI
C. Vogt (Ed.)
Ericsson
R. Wakikawa
Keio University
M. Liebsch
NEC Network Laboratories
S. Sugimoto
Ericsson
B. Sarikaya
Huawei Technologies USA
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Problem Statement and Requirements for Route Optimization in PMIPv6
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Abstract

This document provides the problem statement for route optimization in Proxy Mobile IPv6 (PMIPv6). It also investigates design goals and requirements for route optimization considering the characteristics of Proxy Mobile IPv6.

Table of Contents

1. Introduction

The Proxy Mobile IPv6 (PMIPv6) base protocol document specifies a network-based local mobility management protocol [1]. The Proxy Mobile IPv6 base protocol describes a mobility management solution without a mobile node's participation in mobility management related signaling process. The Proxy Mobile IPv6 base document considers IPv6 home address mobility over IPv6 transport network. The IPv4 support document [2] extends the Proxy Mobile IPv6 base protocol in order to support IPv4 home address mobility and IPv4 transport network.

The Mobile IPv6 [3] and Enhanced Route Optimization [5] specify route optimization procedures that allow a mobile node (MN) to register its binding information to a corresponding node (CN). After the route optimization procedures, the correspondent node can directly send and receive packets from the mobile node's care-of address.

In Proxy Mobile IPv6, packets originated from or sent to a mobile node are routed through bidirectional tunneling between Mobile Access Gateway (MAG) and Local Mobility Anchor (LMA) by default, so packets from/to the mobile can be delivered through longer path than the optimized route, especially when the mobile node and a correspondent node are in topologically close location and local mobility anchor is away from the mobile node. Hence, route optimization is useful, when Proxy Mobile IPv6 domain spans large area.

2. Terminology

Terminology used in this document is taken directly from [1].

3. Problem Statement

Conventional route optimization mechanisms in Mobile IPv6 [3][5] assume no prior configuration and no trust relationship between route optimization process participants, i.e., mobile node and correspond node [4]. However, Mobile IPv6 route optimization mechanisms may not be directly applicable to Proxy Mobile IPv6 because of the following Proxy Mobile IPv6 characteristics.

- o Since a mobile node is kept completely agnostic on its topological location (i.e., care-of address), basically it is not possible for the mobile node to perform correspondent binding update.

o Unlike Mobile IPv6, a mobile node does not participate in binding management procedures and signaling is contained within the network entities in Proxy Mobile IPv6. Hence, the mobile node cannot perform binding registration to a correspondent node and intermediate nodes in the network should do route optimization procedures on behalf of the mobile node. However, since network entity, such as mobile access gateway, is intermediate entity of MN-CN communication, it does not seem to be easy to trigger Mobile IPv6 route optimization.

o In Mobile IPv6, a correspondent node validates whether a mobile node is reachable through the mobile node's home address and care-of address and sets up trust relationship between the two nodes. However, the correspondent node cannot establish trust relationship with a mobile node in Proxy Mobile IPv6 domain, because the reachability test is not applicable.

4. Application Scenarios for Route Optimization in Proxy Mobile IPv6

Since route optimization requires support on the side of a correspondent node, application scenarios for route optimization can be separated into the following three:

(1) The correspondent node supports (host-based) Mobile IPv6 [3] and handles route optimization itself.

(2) Route optimization support on the correspondent node side is handled by Proxy Mobile IPv6 in the correspondent host's network.

(3) Route optimization in Proxy Mobile IPv6 domain supporting IPv4 and IPv6.

Application scenario (2) can furthermore be subdivided to reflect the relative topological location of mobile and correspondent hosts:

(2a) On the same mobile access gateway

(2b) On different mobile access gateways, but the same local mobility anchor

(2c) On different mobile access gateways and different local mobility anchors from the same Proxy Mobile IPv6 domain

(2d) On different mobile access gateways and different local mobility anchors from different Proxy Mobile IPv6 domains

Application scenario (3) can furthermore be subdivided based on IPv4 support cases:

(3a) The mobile node and the correspondent node support IPv4 home address mobility

(3b) The mobile node and the correspondent node belong to different mobile access gateways and both mobile access gateways support IPv4 transport to the same local mobility anchor

(3c) The mobile node and the correspondent node belong to different mobile access gateways and the mobile access gateways support different IP version transport to the same local mobility anchor

(3d) Two local mobility anchors have either IPv4 or IPv6 when the mobile node and the correspondent node anchored to different local mobility anchor

5. Route Optimization in Proxy Mobile IPv6 Design Goals

This section investigates the fundamental design goals which serve to identify requirements for route optimization solutions in Proxy Mobile IPv6.

The function of route optimization is to enable the mobile node and the correspondent node to communicate through a path that is shorter (in terms of hop count) than the path chosen by base Proxy Mobile IPv6. The benefit of this is a reduction in packet propagation delays, in bandwidth consumption and in congestion at local mobility anchor.

The general design goals for route optimization solutions are to reduce handover latency, to provide security, and to require low signaling overhead [5]. Based on these fundamental route optimization design goals, this section describes special features and goals concerning route optimization design. Route optimization in Proxy Mobile IPv6 have following unique properties to consider.

Route optimization solutions should be designed so that the following design goals can be satisfied.

5.1. Low Protocol Complexity

In the case of Mobile IPv6 route optimization, if route optimization is used, the mobile node and the correspondent node maintain the binding cache about the mobile node's home address and care-of address. However, since mobility related signaling is exchanged between network entities in Proxy Mobile IPv6, it is expected that route optimization is also performed by the network entities. Thus, route optimization will create state on the network. Therefore, route optimization solutions should be secure, lightweight, and scalable. Also, since route optimization participants are network entities, a mobile node and a correspondent node should not be aware of route optimization procedures.

5.2. Trust Relationship

In Mobile IPv6 route optimization, it is assumed that the mobile node and the correspondent node do not have any trust relationship [4], whereas in Proxy Mobile IPv6, network entities that perform route optimization are managed objects by the network and owned by the same administrative domain. Thus, different approaches are possible to establish trust relationship.

When route optimization support on the correspondent node side is handled by Proxy Mobile IPv6, route optimization solutions need to benefit from a trust relationship between network entities in Proxy Mobile IPv6. However, we may not assume trust relationship between network entities located in Proxy Mobile IPv6 domain.

When the correspondent node supports Mobile IPv6 and handles route optimization itself, route optimization solutions cannot assume trust relationship between network entities and the correspondent node.

5.3. Security Aspect

Security threats and limitations to route optimization in Mobile IPv6 are investigated in [4]. Return routability procedures [3] and enhanced route optimization [5] address the threats without public-key infrastructure or a preexisting relationship between the mobile node and the correspondent node. Thus, route optimization solutions in Proxy Mobile IPv6 also need to mitigate or to provide sufficient defense against those security threats. When Proxy Mobile IPv6 route optimization participants are administered within the same domain, infrastructure-based authorization mechanisms, such as IPsec, also may be usable.

5.4. Common Solution for IPv4 and IPv6

Proxy Mobile IPv6 base protocol specification and extension document enable a Proxy Mobile IPv6 domain to support both IPv6 and IPv4. As defined in the IPv4 extension document in Proxy Mobile IPv6 [2], the mobile node and the correspondent node can be provided IPv4 home address mobility in the Proxy Mobile IPv6 domain. Furthermore, the transport network between mobile access gateway and local mobility anchor can provide IPv4 transport and NAT may reside inside the network. Thus, route optimization solutions should provide home address mobility and transport support for both IPv6 and IPv4. Also, in the case of IPv4 transport support, NAT traversal mechanism may need to be in place.

5.5. Policy Control and Charging

In general, network operators that provide IP mobility service to the mobile nodes want to monitor the user traffic for the purposes of policy control and charging. Therefore, it is desirable to ensure that route optimization solutions are designed so that network operators can figure out where to place enforcement point of policy control and charging.

6. Requirements

This section lists the requirements on route optimization for Proxy Mobile IPv6.

R1: The route optimization solutions MUST NOT conflict with design goals and requirements for network-based localized mobility management as they are described in [6].

R2: The route optimization solutions SHOULD have no negative impact on the scalability of a network-based localized mobility management domain.

R3: Route optimization solutions SHOULD be scalable in Proxy Mobile IPv6 domains.

R4: Route optimization solutions MAY use preconfigured or pre-established information for authenticating/authorizing route optimization participants and any signaling message for route optimization.

R5: Any signaling message for route optimization SHOULD be exchanged securely during route optimization procedures.

R6: Route optimization solutions SHOULD mitigate or provide sufficient defense against possible security threats investigated in [4].

R7: Route optimization solutions SHOULD maintain route optimization states efficiently when mobile nodes handover in Proxy Mobile IPv6 domain(s).

R8: Route optimization solutions SHOULD operate over IPv6 and IPv4 transport networks.

R9: Route optimization solutions MAY consider support both IPv6, IPv4 and dual stack mobile nodes.

R10: Route optimization solutions MAY provide NAT traversal mechanism for IPv4 private transport network.

R11: Route optimization solutions MUST NOT conflict with an operator's policy to protect its network.

7. IANA Considerations

No action is required by IANA for this document.

8. Security Considerations

Security issues are handled in Section 5.3.

9. Contributors

This contribution is a joint effort of several people. The contributors can be reached at (in alphabetical order):

Sangjin Jeong
sjjeong@etri.re.kr

Long Le
Long.Le@nw.neclab.eu

Jaehwoon Lee

jaehwoon@dongguk.edu

Marco Liebsch
liebsch@netlab.nec.de

Alice Qinxia
alice.Q@huawei.com

Behcet Sarikaya
bsarikaya@huawei.com

Shinta Sugimoto
shinta@sfc.wide.ad.jp

Christian Vogt
christian.vogt@ericsson.com

Ryuji Wakikawa
ryuji@sfc.wide.ad.jp

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Authors' Addresses

Sangjin Jeong
Electronics and Telecommunications Research Institute
138 Gajeongno, Yuseong
Daejeon,   305-700
Korea

Email: sjjeong@etri.re.kr

Christian Vogt
Ericsson Research, NomadicLab
Hirsalantie 11
02420 Jorvas,
Finland

Email: christian.vogt@ericsson.com

Ryuji Wakikawa
Keio University
5322 Endo
Fujisawa, Kanagawa 252-8520
Japan

Email: ryuji@sfc.wide.ad.jp

Marco Liebsch
NEC Network Laboratories
Kurfuersten-Anlage 36
69115 Heidelberg,
Germany

Email: liebsch@netlab.nec.de

Shinta Sugimoto
Nippon Ericsson K.K.
Koraku Mori Building
1-4-14, Koraku, Bunkyo-ku
Tokyo,   112-0004
Japan

Email: shinta.sugimoto@ericsson.com

Behcet Sarikaya
Huawei Technologies USA
1700 Alma Dr. Suite 500
Plano, TX 75075
USA

Email: sarikaya@ieee.org

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