Network Working Group
Internet-Draft
Intended status: Experimental
Expires: June 5, 2017

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December 2, 2016

Homenet profile of the Babel routing protocol
draft-ietf-homenet-babel-profile-01

Abstract

This document defines the subset of the Babel routing protocol [RFC6126] and its extensions that a Homenet router must implement, as well as the interactions between HNCP and Babel.

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Table of Contents

1. Introduction 2
1.1. Background 2
2. The Homenet profile of Babel 3
2.1. Requirements 3
2.2. Non-requirements 5
3. Interactions between HNCP and Babel 5
3.1. Requirements 6
3.2. Non-requirements 6
4. Acknowledgments 7
5. References 7
5.1. Normative References 7
5.2. Informative References 7
Author's Address 8

1. Introduction

The core of the Homenet protocol suite consists of HNCP [RFC7788], a protocol used for flooding configuration information and assigning prefixes to links, combined with the Babel routing protocol [RFC6126]. Babel is an extensible, flexible and modular protocol: minimal implementations of Babel have been demonstrated that consist of a few hundred of lines of code, while the "large" implementation includes support for a number of extensions and consists of over ten thousand lines of C code.

This document consists of two parts. The first specifies the exact subset of the Babel protocol and its extensions that is required by an implementation of the Homenet protocol suite. The second specifies how HNCP interacts with Babel.

1.1. Background

The Babel routing protocol and its extensions are defined in a number of documents:

- The body of RFC 6126 [RFC6126] defines the core, unextended protocol. It allows Babel's control data to be carried over either link-local IPv6 or IPv4, and in either case allows announcing both IPv4 and IPv6 routes. It leaves link cost estimation, metric computation and route selection to the implementation. Distinct implementations of core RFC 6126 Babel will interoperate and maintain a set of loop-free forwarding paths, but given conflicting metrics or route selection policies may give rise to persistent oscillations.

- The informative Appendix A of RFC 6126 suggests a simple and easy to implement algorithm for cost and metric computation that has been found to work satisfactorily in a wide range of topologies.

- While RFC 6126 does not provide an algorithm for route selection, its Section 3.6 suggests selecting the route with smallest metric with some hysteresis applied. An algorithm that has been found to work well in practice is described in Section III.E of [DELAY-BASED].

- The extension mechanism for Babel is defined in RFC 7557 [RFC7557].

- Four RFCs and Internet-Drafts define optional extensions to Babel: HMAC-based authentication [RFC7298], source-specific routing [BABEL-SS], radio interference aware routing [BABEL-Z], and delay-based routing [BABEL-RTT]. All of these extensions interoperate with the core protocol as well as with each other.

2. The Homenet profile of Babel

2.1. Requirements

REQ1: a Homenet implementation of Babel MUST encapsulate Babel control traffic in IPv6 packets sent to the IANA-assigned port 6696 and either the IANA-assigned multicast group ff02::1:6 or to a link-local unicast address.

> Rationale: since Babel is able to carry both IPv4 and IPv6 routes over either IPv4 or IPv6, choosing the protocol used for carrying control traffic is a matter of preference. Since IPv6 has some features that make implementations somewhat simpler and more reliable (notably link-local addresses), we require carrying control data over IPv6.

REQ2: a Homenet implementation of Babel MUST implement the IPv6 subset of the protocol defined in the body of RFC 6126.

> Rationale: support for IPv6 routing is an essential component of the Homenet architecture.

REQ3: a Homenet implementation of Babel SHOULD implement the IPv4 subset of the protocol defined in the body of RFC 6126. Use of other techniques for acquiring IPv4 connectivity (such as multiple layers of NAT) is strongly discouraged.

> Rationale: support for IPv4 will remain necessary for years to come, and even in pure IPv6 deployments, including code for

supporting IPv4 has very little cost. Since HNCP makes it easy to assign distinct IPv4 prefixes to the links in a network, it is not necessary to resort to multiple layers of NAT, with all of its problems.

REQ4: a Homenet implementation of Babel MUST implement source-specific routing for IPv6, as defined in draft-boutier-babel-source-specific [BABEL-SS]. This implies that it MUST implement the extension mechanism defined in RFC 7557.

Rationale: source-specific routing is an essential component of the Homenet architecture. The extension mechanism is required by source-specific routing. Source-specific routing for IPv4 is not required, since HNCP arranges things so that a single non-specific IPv4 default route is announced (Section 6.5 of [RFC7788]).

REQ5: a Homenet implementation of Babel MUST implement HMAC-based authentication, as defined in RFC 7298, MUST implement the two mandatory-to-implement algorithms defined in RFC 7298, and MUST enable and require authentication when instructed to do so by HNCP.

Rationale: some home networks include "guest" links that can be used by third parties that are not necessarily fully trusted. In such networks, it is essential that either the routing protocol is secured or the guest links are carefully firewalled.

Generic mechanisms such as DTLS and dynamically keyed IPsec are not able to protect multicast traffic, and are therefore difficult to use with Babel. Statically keyed IPsec, perhaps with keys rotated by HNCP, is vulnerable to replay attacks and would therefore require the addition of a nonce mechanism to Babel.

REQ6: a Homenet implementation of Babel MUST use metrics that are of a similar magnitude to the values suggested in Appendix A of RFC 6126. In particular, it SHOULD assign costs that are no less than 256 to wireless links, and SHOULD assign costs between 32 and 196 to lossless wired links.

Rationale: if two implementations of Babel choose very different values for link costs, combining routers from different vendors will lead to sub-optimal routing.

REQ7: a Homenet implementation of Babel SHOULD distinguish between wired and wireless links; if it is unable to determine whether a link is wired or wireless, it SHOULD make the worst-case hypothesis that the link is wireless. It SHOULD dynamically probe the quality of wireless links and derive a suitable metric from its quality

estimation. The algorithm described in Appendix A of RFC 6126 MAY be used.

Rationale: support for wireless transit links is a "killer feature" of Homenet, something that is requested by our users and easy to explain to our bosses. In the absence of dynamically computed metrics, the routing protocol attempts to minimise the number of links crossed by a route, and therefore prefers long, lossy links to shorter, lossless ones. In wireless networks, "hop-count routing is worst-path routing".

2.2. Non-requirements

NR1: a Homenet implementation of Babel MAY perform route selection by applying hysteresis to route metrics, as suggested in Section 3.6 of RFC 6126 and described in detail in Section III.E of [BABEL-RTT]. However, it MAY simply pick the route with the smallest metric.

Rationale: hysteresis is only useful in congested and highly dynamic networks. In a typical home network, stable and uncongested, the feedback loop that hysteresis compensates for does not occur.

NR2: a Homenet implementation of Babel MAY include support for other extensions to the protocol, as long as they are known to interoperate with both the core protocol and source-specific routing.

Rationale: delay-based routing is useful in redundant meshes of tunnels, which do not occur in typical home networks (which typically use at most one VPN link). Interference-aware routing, on the other hand, is likely to be useful in home networks, but the extension requires further evaluation before it can be recommended for widespread deployment.

3. Interactions between HNCP and Babel

The Homenet architecture cleanly separates between configuration, which is done by HNCP, and routing, which is done by Babel. While the coupling between the two protocols is deliberately kept to a minimum, some interactions are unavoidable.

All the interactions between HNCP and Babel consist of HNCP causing Babel to perform an announcement on its behalf (in particular, under no circumstances does Babel cause HNCP to perform an action). How this is realised is an implementation detail that is outside the scope of this document: while it could conceivably be done using a private communication channel between HNCP and Babel, existing

implementations have HNCP install a route in the operating system's kernel which is later picked up by Babel.

3.1. Requirements

REQ7: if an HNCP node receives a DHCPv6 prefix delegation for prefix P and publishes an External-Connection TLV containing a Delegated-Prefix TLV with prefix P and no Prefix-Policy TLV, then it MUST announce a source-specific default route with source prefix P over Babel.

Rationale: source-specific routes are the main tool that Homenet uses to enable optimal routing in the presence of multiple IPv6 prefixes. External connections with non-trivial prefix policies are explicitly excluded from this requirement, since their exact behaviour is application-specific.

REQ8: if an HNCP node receives a DHCPv4 lease with an IPv4 address and wins the election for NAT gateway, then it MUST act as a NAT gateway and MUST announce a (non-specific) IPv4 default route over Babel.

Rationale: the Homenet architecture does not use source-specific routing for IPv4; instead, HNCP elects a single NAT gateway and publishes a single default route towards that gateway (RFC 7788 Section 6.5).

REQ9: if an HNCP node assigns a prefix P to an attached link and announces P in an Assigned-Prefix TLV, then it MUST announce a route towards P over Babel.

Rationale: prefixes assigned to links must be routable within the Homenet.

3.2. Non-requirements

NR3: an HNCP node that receives a DHCPv6 prefix delegation MAY announce a non-specific IPv6 default route over Babel in addition to the source-specific default route mandated by requirement REQ7.

Rationale: since the source-specific default route is more specific than the non-specific default route, the former will override the latter if all nodes implement source-specific routing. Announcing an additional non-specific route is allowed, since doing that causes no harm and might simplify operations in some circumstances, e.g. when interoperating with a rougint protocol that does not support source-specific routing.

NR4: an HNCP node that receives a DHCPv4 lease with an IPv4 address and wins the election for NAT gateway SHOULD NOT announce a source-specific IPv4 default route.

Homenet does not require support for IPv4 source-specific routing. Announcing source-specific routes will not cause routing pathologies (blackholes or routing loops), but it might cause packets sourced in different parts of the Homenet to follow different paths, with all the confusion that this entails.

4. Acknowledgments

5. References

5.1. Normative References

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5.2. Informative References

[BABEL-RTT]
Jonglez, B. and J. Chroboczek, "Delay-based Metric Extension for the Babel Routing Protocol", draft-jonglez-babel-rtt-extension-01 (work in progress), May 2015.

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