Internet Engineering Task Force (IETF)
Request for Comments: 7063
Category: Informational
ISSN: 2070-1721

L. Zheng
Huawei Technologies
Z. Zhang
Juniper Networks
R. Parekh
Cisco Systems

December 2013

Survey Report on Protocol Independent Multicast - Sparse Mode (PIM-SM) Implementations and Deployments

Abstract

This document provides supporting documentation to advance the IETF stream's Protocol Independent Multicast - Sparse Mode (PIM-SM) protocol from Proposed Standard to Internet Standard.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are a candidate for any level of Internet Standard; see Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7063.

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1. Motivation

1.1. Overview of PIM-SM

Protocol Independent Multicast - Sparse Mode (PIM-SM) was first published as [RFC2117] in 1997. This version was then obsoleted by [RFC2362] in 1998. The protocol was classified as Experimental in both documents. The protocol specification was then rewritten in whole and advanced to Proposed Standard as [RFC4601] in 2006. Considering its multiple independent implementations developed and sufficient successful operational experience gained, the PIM WG decided to advance the PIM-SM protocol to Internet Standard. The conducted survey and this document are part of the work.

1.2. Requirements of RFCs 2026 and 6410

[RFC2026] defines the stages in the standardization process, the requirements for moving a document between stages, and the types of documents used during this process. Section 4.1.2 of [RFC2026] states that:

> The requirement for at least two independent and interoperable implementations applies to all of the options and features of the specification. In cases in which one or more options or features have not been demonstrated in at least two interoperable implementations, the specification may advance to the Draft Standard level only if those options or features are removed.

[RFC6410] updates the IETF Standards Process defined in [RFC2026]. Primarily, it reduces the Standards Process from three Standards Track maturity levels to two. The second maturity level is a combination of Draft Standard and Standard as specified in [RFC2026]. Section 2.2 of [RFC6410] states that:

> (1) There are at least two independent interoperating implementations with widespread deployment and successful operational experience.
>
> (2)...
>
> (3) There are no unused features in the specification that greatly increase implementation complexity.

Optional features that do not meet the aforesaid criteria have been identified by the PIM Working Group and will be removed. This document provides supporting documentation to advance the IETF stream’s Protocol Independent Multicast - Sparse Mode (PIM-SM) protocol from Proposed Standard to Internet Standard.

2. Survey on Implementations and Deployments

2.1. Methodology

A questionnaire was issued by the PIM WG co-chairs and announced widely to the vendors and operational community to obtain information on PIM-SM implementations and deployments. The survey concluded on 22 Oct 2012. The responses remain confidential and only combined results are published here, while responders chose whether to keep their affiliations confidential. The raw questionnaire is shown in Appendix A, and a compilation of the responses is included in the following section.

2.2. Operator Responses

Nine operators responded to the survey. They are SWITCH, National Research Council Canada, South Dakota School of Mines and Technology, Motorola Solutions, and five anonymous operators.

2.2.1. Description of PIM-SM Deployments

Since 1998, PIM-SM has been deployed for a wide variety of applications: Campus, Enterprise, Research and WAN networks, Broadband ISP, and Digital TV. There are five deployments based on [RFC4601] implementations and two on [RFC2362] implementations. PIM-SM for IPv6 has been deployed by three operators. Out of the nine operators, six have deployed PIM-SM implementations from multiple vendors.

Operators reported minor interoperability issues and these were addressed by the vendors. There was no major interoperability concern reported by the operators.

2.2.2. PIM-SM Deployment with Other Multicast Technologies

Except for one deployment of PIM-SM with Multicast Extensions to OSPF (MOSPF), all other operators have deployed PIM-SM exclusively. No operators acknowledged deployments of either (*,*,RP) or PIM Multicast Border Route (PMBR) for interconnection between PIM-SM and other multicast domains.

2.2.3. PIM-SM Rendezvous Points (RPs) and RP Discovery Mechanisms

The number of PIM-SM RPs deployed by operators ranges from a few (e.g., sixteen) to a massively scaled number (four hundred). Both static configuration and Bootstrap Router (BSR) have been deployed as RP discovery mechanisms.

Anycast-RP has been deployed for RP redundancy. Two operators have deployed Anycast-RP using the Multicast Source Discovery Protocol (MSDP) [RFC3446]. Three operators have deployed Anycast-RP using both MSDP [RFC3446] and PIM [RFC4610] for different scenarios. The best common practice seems to be to use static-RP configuration with Anycast-RP for redundancy.

2.3. Vendor Responses

Eight vendors reported PIM-SM implementations. They are XORP, Huawei Technologies, Cisco Systems, Motorola Solutions, Juniper Networks, and three other anonymous vendors.

2.3.1. Implementations Based on RFCs 4601 and 2362

Four vendors reported PIM-SM implementations based on [RFC4601] and two reported PIM-SM implementations based on [RFC2362]. Two other reported implementations are hybrids.

Minor interoperability issues have been addressed by the vendors over the years and no concerns were reported by any vendor.

2.3.2. Lack of (*,*,RP) and PMBR Implementations

Most vendors have not implemented (*,*,RP) state as specified in [RFC4601] either due to lack of deployment requirements or due to security concerns. Similarly, most vendors have also not implemented PMBR due to lack of deployment requirements or because it was considered too complex and non-scalable.

Only one vendor, XORP, reported (*,*,RP) and PMBR implementation and they were implemented just because these were part of the [RFC4601] specification.

2.3.3. Implementations of Other Features of RFC 4601

Most vendors have implemented all of the following from the [RFC4601] specification:

- Source-Specific Multicast (SSM)
- Join suppression
- Explicit tracking
- Register mechanism
- Shortest Path Tree (SPT) switchover at last-hop router

- Assert mechanism
- Hashing of group to RP mappings

Some vendors do not implement explicit tracking and SSM.

2.4. Key Findings

PIM-SM has been widely implemented and deployed for different applications. The protocol is sufficiently well specified in [RFC4601] resulting in interoperable implementation deployed by operators.

There are no deployments and only one known implementation of (*,*,RP) and PMBR as specified in [RFC4601]. Hence, it is necessary to remove these features from the specification as required by [RFC2026] and [RFC6410].

3. Security Considerations

The PIM WG is aware of at least three (and believes there are more) PIM-SM implementations that support the use of IPsec to protect PIM messages. For at least one of them, IPsec is not part of the PIM implementation itself -- one just configures IPsec with Security Policy Databases (SPDs) where interface, the ALL_PIM_ROUTERS multicast address, etc., can be used as selectors, according to [RFC5796].

4. Acknowledgements

The authors would like to thank Tim Chown and Bill Atwood, who helped to collect and anonymize the responses as the neutral third party. Special thanks are also given to Alexander Gall, William F. Maton Sotomayor, Steve Bauer, Sonum Mathur, Pavlin Radoslavov, Shuxue Fan, Sameer Gulrajani, and to the anonymous responders.

5. References

5.1. Normative References

[RFC2026] Bradner, S., "The Internet Standards Process -- Revision 3", BCP 9, RFC 2026, October 1996.

[RFC6410] Housley, R., Crocker, D., and E. Burger, "Reducing the Standards Track to Two Maturity Levels", BCP 9, RFC 6410, October 2011.

5.2. Informative References

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[RFC2362] Estrin, D., Farinacci, D., Helmy, A., Thaler, D., Deering, S., Handley, M., and V. Jacobson, "Protocol Independent Multicast-Sparse Mode (PIM-SM): Protocol Specification", RFC 2362, June 1998.

[RFC3446] Kim, D., Meyer, D., Kilmer, H., and D. Farinacci, "Anycast Rendevous Point (RP) mechanism using Protocol Independent Multicast (PIM) and Multicast Source Discovery Protocol (MSDP)", RFC 3446, January 2003.

[RFC4601] Fenner, B., Handley, M., Holbrook, H., and I. Kouvelas, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", RFC 4601, August 2006.

[RFC4610] Farinacci, D. and Y. Cai, "Anycast-RP Using Protocol Independent Multicast (PIM)", RFC 4610, August 2006.

[RFC5796] Atwood, W., Islam, S., and M. Siami, "Authentication and Confidentiality in Protocol Independent Multicast Sparse Mode (PIM-SM) Link-Local Messages", RFC 5796, March 2010.

Appendix A. Questionnaire

This section provides copies of the questionnaires exactly as distributed to operators and implementors.

A.1. PIM Survey for Operators

Introduction:

PIM-SM was first published as RFC2117 in 1997 and then again as RFC2362 in 1998. The protocol was classified as Experimental in both of these documents. The PIM-SM protocol specification was then rewritten in whole and advanced to Proposed Standard as RFC4601 in 2006. Considering the multiple independent implementations developed and the successful operational experience gained, the IETF has decided to advance the PIM-SM routing protocol to Draft Standard. This survey intends to provide supporting documentation to advance the Protocol Independent Multicast - Sparse Mode (PIM-SM) routing protocol from IETF Proposed Standard to Draft Standard. (Due to RFC6410, now the intention is to progress it to Internet Standard. Draft Standard is no longer used.)

This survey is issued on behalf of the IETF PIM Working Group.

The responses will be collected by a neutral third-party and kept strictly confidential if requested in the response; only the final combined results will be published. Tim Chown and Bill Atwood have agreed to anonymize the response to this Questionnaire. They have a long experience with multicast but have no direct financial interest in this matter, nor ties to any of the vendors involved. Tim is working at University of Southampton, UK, and he has been active in the IETF for many years, including the mboned working group, and he is a co-chair of the 6renum working group. Bill is at Concordia University, Montreal, Canada, and he has been an active participant in the IETF pim working group for over ten years, especially in the area of security.

Please send questionnaire responses addressed to them both. The addresses are tjc@ecs.soton.ac.uk and william.atwood@concordia.ca. Please include the string "RFC4601 bis Questionnaire" in the subject field.

Before answering the questions, please complete the following background information.

Name of the Respondent:

Affiliation/Organization:

Contact Email:

Provide description of PIM deployment:

Do you wish to keep the information provided confidential:

Questions:

1 Have you deployed PIM-SM in your network?

2 How long have you had PIM-SM deployed in your network? Do you know if your deployment is based on the most recent RFC4601?

3 Have you deployed PIM-SM for IPv6 in your network?

4 Are you using equipment with different (multi-vendor) PIM-SM implementations for your deployment?

5 Have you encountered any inter-operability or backward-compatibility issues amongst differing implementations? If yes, what are your concerns about these issues?

6 Have you deployed both dense mode and sparse mode in your network? If yes, do you route between these modes using features such as *,*,RP or PMBR?

7 To what extent have you deployed PIM functionality, like BSR, SSM, and Explicit Tracking?

8 Which RP mapping mechanism do you use: Static, AutoRP, or BSR?

9 How many RPs have you deployed in your network?

10 If you use Anycast-RP, is it Anycast-RP using MSDP (RFC 3446) or Anycast-RP using PIM (RFC4610)?

11 Do you have any other comments on PIM-SM deployment in your network?

A.2. PIM Survey for Implementors

Introduction:

PIM-SM was first published as RFC2117 in 1997 and then again as RFC2362 in 1998. The protocol was classified as Experimental in both of these documents. The PIM-SM protocol specification was then rewritten in whole and advanced to Proposed Standard as RFC4601 in 2006. Considering the multiple independent implementations developed and the successful operational experience gained, the IETF has decided to advance the PIM-SM routing protocol to Draft Standard. This survey intends to provide supporting documentation to advance the Protocol Independent Multicast - Sparse Mode (PIM-SM) routing protocol from IETF Proposed Standard to Draft Standard. (Due to RFC6410, now the intention is to progress it to Internet Standard. Draft Standard is no longer used.)

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Please send questionnaire responses addressed to them both. The addresses are tjc@ecs.soton.ac.uk and william.atwood@concordia.ca. Please include the string "RFC 4601 bis Questionnaire" in the subject field.

Before answering the questions, please complete the following background information.

Name of the Respondent:

Affiliation/Organization:

Contact Email:

Provide description of PIM implementation:

Do you wish to keep the information provided confidential:

Questions:

1 Have you implemented PIM-SM?

2 Is the PIM-SM implementation based on RFC2362 or RFC4601?

3 Have you implemented (*,*, RP) state of RFC4601? What is the rationale behind implementing or omitting (*,*,RP)?

4 Have you implemented the PMBR as specified in RFC4601 and RFC2715? What is the rationale behind implementing or omitting PMBR?

5 Have you implemented other features and functions of RFC4601:

- SSM

- Join Suppression

- Explicit tracking

- Register mechanism

- SPT switchover at last-hop router

- Assert mechanism

- Hashing of group to RP mappings

6 Does your PIM-SM implementation support IPv6?

7 Have you encountered any inter-operability issues with other PIM implementations in trials or in the field?

8 Do you have any other comments or concerns about PIM-SM as specified in RFC4601?

Authors' Addresses

Lianshu Zheng
Huawei Technologies
China

EMail: vero.zheng@huawei.com

Zhaohui Zhang
Juniper Networks
USA

EMail: zzhang@juniper.net

Rishabh Parekh
Cisco Systems
USA

EMail: riparekh@cisco.com