Internet Engineering Task Force (IETF)
Request for Comments: 7772
BCP: 202
Category: Best Current Practice
ISSN: 2070-1721

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February 2016

Reducing Energy Consumption of Router Advertisements

Abstract

Frequent Router Advertisement messages can severely impact host power consumption. This document recommends operational practices to avoid such impact.

Status of This Memo

This memo documents an Internet Best Current Practice.

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). Further information on BCPs is available in 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/rfc7772.

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1. Introduction

Routing information is communicated to IPv6 hosts by Router Advertisement (RA) messages [RFC4861]. If these messages are sent too frequently, they can severely impact power consumption on battery-powered hosts.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2. Problem Scenarios

2.1. Solicited Multicast RAs on Large Networks

On links with a large number of battery-powered devices, sending solicited multicast Router Advertisements can severely impact host power consumption. This is because every time a device joins the network, all devices on the network receive a multicast Router Advertisement. In the worst case, if devices are continually joining and leaving the network, and the network is large enough, then all devices on the network will receive solicited Router Advertisements at the maximum rate specified by Section 6.2.6 of [RFC4861], which is one every 3 seconds.

2.2. Frequent Periodic Router Advertisements

Some networks send periodic multicast Router Advertisements very frequently (e.g., once every few seconds). This may be due to a desire to minimize customer impact of network renumbering events, which in some large residential networks occur relatively frequently. In the presence of hosts that ignore RAs or even all IPv6 packets when in sleep mode, such networks may see a need to send RAs frequently in order to avoid leaving devices with non-functional IPv6 configurations for extended periods of time. Unfortunately, this has severe impact on battery life.

3. Consequences

Observed effects of frequently sending Router Advertisement messages to battery-powered devices include:

- Some hosts simply experience bad battery life on these networks and otherwise operate normally. This is frustrating for users of these networks.

- Some hosts react by dropping all Router Advertisement messages when in power-saving mode on any network, e.g., <https://code.google.com/p/android/issues/detail?id=32662>. This causes devices to lose connectivity when in power-saving mode, potentially disrupting background network communications, because the device is no longer able to send packets or acknowledge received traffic.

- Some hosts react by dropping *all* IPv6 packets when in power-saving mode, <http://www.gossamer-threads.com/lists/nsp/ipv6/54641>. This disrupts network communications.

Compounding the problem, when dealing with devices that drop Router Advertisements when in power saving mode, some network administrators work around the problem by sending RAs even more frequently. This causes devices to engage in even more aggressive filtering.

4. Router Advertisement Frequency

The appropriate frequency of periodic RAs depends on how constrained the network devices are.

- Laptop-class devices will likely experience no noticeable battery-life impact, even if RAs are sent every few seconds.

- Tablets, phones, and watches experience it more noticeably. At the time of writing, current-generation devices might consume on the order of 5 mA when the main processor is asleep. Upon receiving a packet, they might consume on the order of 200 mA for 250 ms, as the packet causes the main processor to wake up, process the RA, attend to other pending tasks, and then go back to sleep. Thus, on such devices, the cost of receiving one RA will be approximately 0.014 mAh.

  In order to limit the amount of power used to receive Router Advertisements to, say, 2% of idle power (i.e., to impact idle battery life by no more than 2%), the average power budget for receiving RAs must be no more than 0.1 mA, or approximately 7 RAs per hour. Due to background multicast loss and the tendency of current devices to rate-limit multicast when asleep, many of these RAs might not reach the device. Thus, the minimum lifetimes for RA configuration parameters such as default router lifetime might reasonably be 5-10 times the RA period, or roughly 45-90 minutes.

  An impact of 2% relative to measured idle current is negligible, since on this sort of device average power consumption is typically much higher than idle power consumption.

- Specialized devices in non-general-purpose networks such as sensor networks might have tighter requirements. In these environments, even longer RA intervals might be appropriate.

5. Recommendations

5.1. Network-Side Recommendations

1. Router manufacturers SHOULD allow network administrators to configure the routers to respond to Router Solicitations with unicast Router Advertisements if:

   * The Router Solicitation’s source address is not the unspecified address, and:

   * The solicitation contains a valid Source Link-Layer Address option.

2. Administrators of networks that serve large numbers (tens or hundreds) of battery-powered devices SHOULD enable this behavior.

3. Networks that serve battery-powered devices SHOULD NOT send multicast RAs too frequently (see Section 4) unless the information in the RA packet has substantially changed. If there is a desire to ensure that hosts pick up configuration changes

quickly, those networks MAY send frequent Router Advertisements for a limited period of time (e.g., not more than one minute) immediately after a configuration change.

No protocol changes are required. Responding to Router Solicitations with unicast Router Advertisements is already allowed by Section 6.2.6 of [RFC4861], and Router Advertisement intervals are already configurable by the administrator to a wide range of values.

5.2. Device-Side Recommendations

1. Maintaining IPv6 connectivity requires that hosts be able to receive periodic multicast RAs [RFC4861]. Therefore, hosts that process unicast packets sent while they are asleep MUST also process multicast RAs sent while they are asleep. Battery-powered hosts MAY rate-limit identical RAs if they are sent too frequently.

2. Battery-powered devices that do not intend to maintain IPv6 connectivity while asleep SHOULD either disconnect from the network, abandoning all IPv6 configuration on that network, or perform Detecting Network Attachment in IPv6 (DNAv6) procedures [RFC6059] when waking up.

6. Security Considerations

Misconfigured or malicious hosts sending rogue Router Advertisements [RFC6104] can also severely impact power consumption on battery-powered hosts if they send a significant number of such messages. Any IPv6 network where there is potential for misconfigured or malicious hosts should take appropriate countermeasures to mitigate the problem.

7. References

7.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

[RFC4861] Narten, T., Nordmark, E., Simpson, W., and H. Soliman, "Neighbor Discovery for IP version 6 (IPv6)", RFC 4861, DOI 10.17487/RFC4861, September 2007, <http://www.rfc-editor.org/info/rfc4861>.

[RFC6059] Krishnan, S. and G. Daley, "Simple Procedures for Detecting Network Attachment in IPv6", RFC 6059, DOI 10.17487/RFC6059, November 2010, <http://www.rfc-editor.org/info/rfc6059>.

7.2. Informative References

[RFC6104] Chown, T. and S. Venaas, "Rogue IPv6 Router Advertisement Problem Statement", RFC 6104, DOI 10.17487/RFC6104, February 2011, <http://www.rfc-editor.org/info/rfc6104>.

Acknowledgements

The authors wish to thank Steven Barth, Frank Bulk, David Farmer, Igor Gashinsky, Ray Hunter, Erik Kline, Erik Nordmark, Alexandru Petrescu, Libor Polcak, Mark Smith, Jinmei Tatuya, and James Woodyatt for feedback and helpful suggestions.

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