Applicability Statement: The use of RPL in Building and Home Environments
draft-brandt-roll-rpl-applicability-home-building-01

Abstract

The purpose of this document is to to provide guidance in the use of
RPL to provide the features required in building or home
environments, two application spaces which share a substantial number
of requirements. Note that this document refers to a specific
revision of the RPL draft, and thus, a new revision of the RPL draft
will likely necessitate a new revision of this document.

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1. Introduction

The purpose of this document is to to provide guidance in the use of
RPL [RPL-15] to provide the features required both by [HOME-REQ] and
by [BUILDING-REQ] , as these two application spaces share a
substantial number of requirements. Note that this document refers
to a specific revision of the RPL draft, and thus, a new revision of
the RPL draft will likely necessitate a new revision of this
document. RPL provides multipoint-to-point (MP2P) paths from sensors
to a sink, along a DAG; an advanced tree structure for organising
network nodes in a loop-free topology with backup routes and
potential support for policy-based routing. The root of the DAG is
the sink, and sensors discover and maintain the DAG via the
dissemination of DIO signaling, initiated by the root. Conversely,
RPL provides point-to-multippoint (P2MP) paths from the root to nodes
along the same DAG. RPL also provide point-to-point (P2P) paths from
node to node, through the first ancestor along the DAG, that is
common to both source and destination nodes. Such paths are
discovered and maintained via DAO signaling, initiated by the
destination node.

2. Problem Statement

Several features required by [HOME-REQ] and by [BUILDING-REQ]
challenge the P2P paths provided by RPL [RPL-15]. This section
reviews these challenges. In some cases, a sensor may need to
spontaneously initiate the discovery and mainten of a path towards a
desired destination that is neither the root of a DAG, nor a
destination originating DAO signaling. This feature is absent from
the RPL for now. Furthermore, provided P2P paths are not
satisfactory in some cases because they involve too many intermediate
sensors before reaching destination, which may be an issue in terms
of energy or delay constraints. RPL does not provide a mechanism for
discovering and maintaining more efficient alternative P2P paths when
they are available. These deficiencies call for the specification,
within RPL, of complementary mechanisms which will help alleviate the
challenges described below.

2.1. Risk of undesired long P2P routes

The DAG, being a tree structure is formed from a root. If nodes
residing in different branches have a need for communicating
internally, DAG mechanisms provided in RPL [RPL-15] will propagate
traffic towards the root, potentially all the way to the root, and
down along another branch. In a typical example two nodes could
reach each other via just two router nodes but in unfortunate cases,
RPL [RPL-15] may send traffic three hops up and three hops down

again. This leads to several undesired phenomena described in the
following sections

2.1.1. Traffic concentration at the root

If many P2P data flows have to move up towards the root to get down
again in another branch there is an increased risk of congestion the
nearer to the root of the DAG the data flows. Due to the broadcast
nature of RF systems any child node of the root is not just directing
RF power downwards its subtree but just as much upwards towards the
root; potentially jamming other MP2P traffic leaving the tree or
preventing the root of the DAG from sending P2MP traffic into the DAG
because the listen-before-talk link-layer protection kicks in.

2.1.2. Excessive battery consumption in source nodes

Battery-powered nodes originating P2P traffic depend on the route
length. Long routes cause source nodes to stay awake for longer
periods before returning to sleep. Thus, a longer route translates
proportionally (more or less) into higher battery consumption.

2.2. Risk of delayed route repair

The RPL DAG mechanism uses DIO and DAO messages to monitor the health
of the DAG. In rare occasions, changed radio conditions may render
routes unusable just after a destination node has returned a DAO
indicating that the destination is reachable. Given enough time, the
next Trickle timer-controlled DIODAO update will eventually repair
the broken routes. In a worst-case event this is however too late.
In an apparently stable DAG, Trickle-timer dynamics may reduce the
update rate to a few times every hour. If a user issues an actuator
command, e.g. light on in the time interval between the last DAO
message was issued the destination module and the time one of the
parents sends the next DIO, the destination cannot be reached.
Nothing in RPL [RPL-15] kicks in to restore connectivity in a
reactive fashion. The consequence is a broken service in home and
building applications.

2.2.1. Broken service

Experience from the telecom industry shows that if the voice delay
exceeds 250ms users start getting confused, frustrated andor annoyed.
In the same way, if the light does not turn on within the same period
of time, a home control user will activate the controls again,
causing a sequence of commands such as Light{on,off,off,on,off,..} or
Volume{up,up,up,up,up,...} Whether the outcome is nothing or some
unintended response this is unacceptable. A controlling system must
be able to restore connectivity to recover from the error situation.

Waiting for an unknown period of time is not an option. While this issue was identified during the P2P analysis it applies just as well to application scenarios where an IP application outside the LLN controls actuators, lights, etc.

3. IANA Considerations

This document has no actions for IANA.

4. Security Considerations

This document does not have to any security considerations.

5. Informative References

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          Brandt, A., Buron, J., and G. Porcu, "Home Automation
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[BUILDING-REQ]
          Martocci, J., De Mil, P., Vermeylen, W., and N. Riou,
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[RPL-15] Winter, T. and P. Thubert, "RPL: IPv6 Routing Protocol for
          Low power and Lossy Networks", draft-ietf-roll-rpl-15 ,
          2010.

Appendix A. Acknowledgements

This document reflects discussions and remarks from several individuals including (in alphabetical order): Mukul Goyal, Jerry Martocci, Charles Perkins, and Zach Shelby.

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