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## Configuration option for RFC 8138

### Abstract

This document complements RFC 8138 and dedicates a bit in the RPL configuration option defined in RFC 6550 to indicate whether RFC 8138 compression is used within the RPL Instance.

### Status of This Memo

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### 1. Introduction

The transition of a RPL [[RFC6550](#)] network to activate the compression defined in [[RFC8138](#)] can only be done when all routers in the network support it. A non-capable node acting as a router would drop the compressed packets and black-hole its subDAG. In a mixed case with both RFC8138-capable and non-capable nodes, the compression may be turned on only if all the non-capable nodes act as leaves and their RPL parents handle the compression/decompression on their behalf.

This document complements RFC 8138 and dedicates a flag in the RPL configuration option to indicate whether RFC 8138 compression should be used within the RPL Instance. The setting of new flag is controlled by the Root and propagates as is in the whole network. When the bit is not set, source nodes that support RFC 8138 should refrain from using the compression unless the information is superseded by configuration.

This specification provides scenarios that force a legacy node to become a RPL-Aware-Leaf (RAL). In that case, the 6LR must be aware

by means out of scope that it must uncompress the packets before delivering to the RAL.

## 2. BCP 14

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [[RFC2119](#)][[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

## 3. Updating RFC 6550

This specification defines a new flag "Enable RFC8138 Compression" (T). The "T" flag is set to turn on the use of the compression of RPL artifacts with [[RFC8138](#)] within a RPL Instance. If a RPL Instance has multiple Roots then they must be coordinated to use the same setting.

RPL defines a Configuration Option that is registered to IANA in section 20.14. of [[RFC6550](#)]. The "T" flag is encoded in one of the reserved control bits in the RPL Configuration Option. The bit position of the "T" flag is indicated in [Section 6](#).

Section 6.3.1. of [[RFC6550](#)] defines a 3-bit Mode of Operation (MOP) in the DIO Base Object. The new "T" flag is defined only for MOP value between 0 to 6. For a MOP value of 7 or above, the flag MAY indicate something different and MUST NOT be interpreted as "Enable RFC8138 Compression" unless the specification of the MOP indicates to do so.

## 4. Updating RFC 8138

A node that supports this specification MUST source packets in the compressed form using [[RFC8138](#)] if and only if the "T" flag is set. This behaviour can be overridden by a configuration of the node in order to cope with intermediate implementations of the root that support [[RFC8138](#)] but not this specification and cannot set the "T" flag.

The decision of using [[RFC8138](#)] is made by the originator of the packet depending on its capabilities and its knowledge of the state of the "T" flag. A router that encapsulates a packet is the originator of the resulting packet and decides whether to compress the outer headers as indicated above. An external target [[USEofRPLinfo](#)] is not expected to support [[RFC8138](#)]. An intermediate router MUST forward the packet in the form that the source used, either compressed or uncompressed, unless it is either forwarding to an external target or delivering to a leaf that is not known to support RFC 8138, in which cases it MUST uncompress the packet.

A RPL-Unaware Leaf (RUL) [[UNAWARE-LEAVES](#)] is both a leaf and an external target. A RUL does not participate to RPL and depends on the 6LR to ensure its connectivity. Packets from/to a RUL are tunneled back and forth to the Root regardless of the MOP used in the RPL Instance. A node that supports this specification but does not support [[RFC8138](#)] SHOULD join as a RUL to ensure that the 6LR is aware it needs to uncompress the packets before delivering.

## 5. Transition Scenarios

A node that supports [\[RFC8138\]](#) but not this specification can only be used in a homogeneous network and an upgrade requires a "flag day" where all nodes are updated and then the network is rebooted with implicitly RFC 8138 compression turned on with the "T" flag set on.

A node that supports this specification can work in a network with RFC 8138 compression turned on or off with the "T" flag set accordingly and in a network in transition from off to on or on to off (see [Section 5.1](#)).

A node that does not support [\[RFC8138\]](#) can interoperate with nodes that do in a network with RFC 8138 compression turned off. If the compression is turned on, the node cannot forward compressed packets and therefore it cannot act as a router. It may remain connected to that network as a leaf, in which case it generates uncompressed packets and can receive packets if they are delivered by the parent 6LR in the uncompressed form.

[\[RFC6550\]](#) states that "Nodes other than the DODAG root MUST NOT modify this information when propagating the DODAG Configuration option". Therefore, even a legacy parent propagates the "T" flag as set by the Root whether it supports this specification or not. So when the "T" flag is set, it is transparently flooded to all the nodes in the RPL Instance.

Sections 8.5 and 9.2 of [\[RFC6550\]](#) also suggests that a RPL-aware node may only attach to a DODAG as a leaf node when the node does not support the Mode of Operation of a RPL Instance, the Objective Function (OF) as indicated by the Objective Code Point (OCP) or some other parameters in the configuration option.

Per the above, changing the OCP in a DODAG can be used to force nodes that do not support a particular feature to join as leaf only. This specification reiterates that a node that is configured to operate in a RPL Instance but does not support a value for a known parameter that is mandatory for routing MUST NOT operate as a router but MAY still join as a leaf. Note that a legacy node will not recognize when a reserved field is now used and will not turn to a leaf when the "T" flag is set.

The intent for this specification is to perform a migration once and for all without the need for a flag day. In particular it is not the intention to undo the setting of the "T" flag, and though it is possible to roll back (see [Section 5.4](#)), adding nodes that do not support [\[RFC8138\]](#) after a roll back may be problematic if the roll back is not fully complete (see caveats in [Section 5.2](#)).

### 5.1. Inconsistent State While Migrating

When the "T" flag is turned on in the configuration option by the root, the information slowly percolates through the DODAG as the DIO gets propagated. Some nodes will see the flag and start sourcing packets in the compressed form while other nodes in the same RPL Instance are still not aware of it. Conversely, in non-storing mode, the root will start using RFC 8138 with a SRH-6LoRH that routes all

the way to the last router or possibly to the leaf, if the leaf supports RFC 8138.

This is why it is required that all the routers in the RPL Instance support [\[RFC8138\]](#) at the time of the switch, and all nodes that do not support [\[RFC8138\]](#) only operate as leaves.

Setting the "T" flag is ultimately the responsibility of the network administrator. In a case of upgrading a network to turn the compression on, the network SHOULD be operated with the "T" flag reset until all targeted nodes are upgraded to support this specification. [Section 5.2](#) and [Section 5.3](#) provide possible transition scenarios where this can be enforced.

## 5.2. Single RPL Instance Scenario

In a Single RPL Instance Scenario, nodes that support RFC 8138 are configured with a new OCP, that may use the same OF operation or a variation of it. The root sets the "T" flag at the time it migrates to the new OCP. As a result, nodes that do not support RFC 8138 join as leaves and do not forward packets anymore. The leaves generate packets without compression. The parents - which supports RFC 8138 - may encapsulate the packets using RFC 8138 if needed. The other way around, the root encapsulates packets to the leaves all the way to the parent, which decapsulates and distribute the uncompressed inner packet to the leaf.

This scenario presents a number of caveats:

- \*The method consumes an extra OCP. It also requires a means to signal the capabilities of the leaf, e.g., using ["RPL Mode of Operation extension"](#) [\[MOP-EXT\]](#).
- \*If an implementation does not move to a leaf mode when the OCP is changed to an unknown one, then the node may be stalled.
- \*If the only possible parents of a node are nodes that do not support RFC 8138, then that node will loose all its parent at the time of the migration and it will be stalled until a parent is deployed with the new capability.
- \*Nodes that only support RFC8138 for forwarding may not parse the RPI in native form. If such nodes are present, the parent needs to encapsulate with RFC8138.

## 5.3. Double RPL Instances Scenario

An alternate to the Single RPL Instance Scenario is to deploy an additional RPL Instance for the nodes that support [\[RFC8138\]](#). The two RPL Instances operate independently as specified in [\[RFC6550\]](#). The preexisting RPL Instance that does not use [\[RFC8138\]](#), whereas the new RPL Instance does. This is signaled by the "T" flag which is only set in the configuration option in DIO messages in the new RPL Instance.

Nodes that support RFC 8138 participate to both Instances but favor the new RPL Instance for the traffic that they source. On the other hand, nodes that only support the uncompressed format would either not be configured for the new RPL Instance, or would be configured to join it as leaves only.

This method eliminates the risks of nodes being stalled that are described in [Section 5.2](#) but requires implementations to support at least two RPL Instances and demands management capabilities to introduce new RPL Instances and deprecate old ones.

#### 5.4. Rolling Back

After downgrading a network to turn the [\[RFC8138\]](#) compression off, the administrator SHOULD make sure that all nodes have converged to the "T" flag reset before allowing nodes that do not support the compression in the network (see caveats in [Section 5.2](#)).

It is RECOMMENDED to only deploy nodes that support [\[RFC8138\]](#) in a network where the compression is turned on. A node that does not support [\[RFC8138\]](#) MUST only be used as a leaf.

#### 6. IANA Considerations

This specification updates the Registry for the "DODAG Configuration Option Flags" that was created for [\[RFC6550\]](#) as follows:

Bit Number	Capability Description	Reference
2	Turn on RFC8138 Compression (T)	THIS RFC

Table 1: New DODAG Configuration Option Flag

#### 7. Security Considerations

Setting the "T" flag before some routers are upgraded may cause a loss of packets. The new bit is protected as the rest of the configuration so this is just one of the many attacks that can happen if an attacker manages to inject a corrupted configuration.

Setting and resetting the "T" flag may create inconsistencies in the network but as long as all nodes are upgraded to RFC 8138 support they will be able to forward both forms. The draft insists that the source is responsible for selecting whether the packet is compressed or not, and all routers must use the format that the source selected. So the result of an inconsistency is merely that both forms will be present in the network, at an additional cost of bandwidth for packets in the uncompressed form.

#### 8. Acknowledgments

The authors wish to thank Rahul Jadhav for his in-depth review and constructive suggestions.

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