IDR Working Group
Internet-Draft
Intended status: Standards Track
Expires: March 6, 2017

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September 2, 2016

Wide BGP Communities Attribute
draft-ietf-idr-wide-bgp-communities-03

Abstract

Route tagging plays an important role in external BGP [RFC4271] relations, in communicating various routing policies between peers. It is also a very common best practice among operators to propagate various additional information about routes intra-domain. The most common tool used today to attach various information about routes is through the use of BGP communities [RFC1997].

Such information is important to allow BGP speakers to perform some mutually agreed actions without the need to maintain a separate offline database for each tuple of prefix and associated set of action entries.

This document defines a new encoding which will enhance and simplify what can be accomplished today with the use of BGP communities. The most important addition this specification makes over currently defined BGP communities is the ability to specify, carry as well as use for execution an operator's defined set of parameters. It also provides an extensible platform for any new community encoding needs in the future.

Requirements Language

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 RFC 2119 [RFC2119].

Status of This Memo

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1. Introduction

RFC 1997 [RFC1997] defines the BGP Community Attribute. This attribute is used as a tool to carry additional information in BGP routes which may help to automate peering administration. The BGP Communities Attribute consists of one or more sets of four octet values, where each specifies a different community. Except for two reserved ranges, the encoding of community values mandates that the first two octets are to contain the Autonomous System number, with the next two octets containing some locally defined value.

With the introduction of 4-octet Autonomous System numbers by RFC 4893 [RFC4893] it became obvious that BGP Communities as specified in RFC 1997 will not be able to accommodate new AS encoding. In fact

RFC 4893 explicitly recommends use of four octets AS specific [RFC5668] extended communities [RFC4360] as a way to encode new 4 octet AS numbers.

While the encoding of 4 octet AS numbers is being addressed by [I-D.ietf-idr-as4octet-extcomm-generic-subtype], neither the base BGP communities (standard or extended) nor as4octet-extcomm-generic document define a sufficient level of encoding freedom which could be of practical use. The authors believe that defining a new BGP Path Attribute, with the ability to contain locally defined parameters will enhance the current level of network policies, as well as simplify BGP policy management. The proposed simple encoding will also facilitate the delivery of new network services without a need to define a new BGP extension each time.

When defining any new type of tool there is always a unique opportunity to specify a subset of well recognized behaviors. Lists of the current most commonly used BGP communities, as well as provision for a new registry for future definitions will be contained in a separate document.

2. Protocol Summary

Each Wide BGP Community consists of two main parts - Common Container Header and Community Container type. Implementation of any type is optional. Implementation is considered to comply with this document if at least one community type is supported.

2.1. Common Container Header

Common Container Header is defined in Section 3.1 and contains following encoding:

- Container Types: Types 1,2,3 and 4 are defined in this document.
- Flags: to control common behavior including the transitivness of the community container.
- Length
- Context AS This is the AS number by which community should be interpreted.

2.2. Community Containers

This memo defines four Community Containers with the following encoding

2.2.1. Type 1 Wide Community Container

The Type 1 Wide Community Container is defined in Section 4.

- Community Value: This section defines the action that an operator wishes a router to take.
- Source AS: This is the AS originating the community.
- Target(s): This is an optional list that encodes where the community's action should be taken.
- Exclude Target(s): This is an optional list that encodes where the community's actions should not be taken.
- Parameters: This is an optional list that encodes additional information that the community's action needs to execute properly.
- Community Atoms. These are values and lists of values that are common across community actions. They are defined in Section 8.

2.2.2. Type 2 Wide Community Container

The Type 2 Wide BGP Community 4:4 is defined in Section 5 and contains the following encoding:

- Community Value: Fixed length -> 4 octet : 4 octet community

2.2.3. Type 3 Wide Community Container

The Type 3 Wide BGP Community Nx4 is defined in Section 6 and contains the following encoding:

- Community Value: Variable length -> Nx4 octet community

2.2.4. Type 4 Wide Community Container

The Type 4 Wide BGP Community 16+Nx4 is defined in Section 7 and contains the following encoding:

- Community Value: Variable length -> Fixed 16 octet field followed by N x 4 octet community

3. Wide BGP Community Attribute

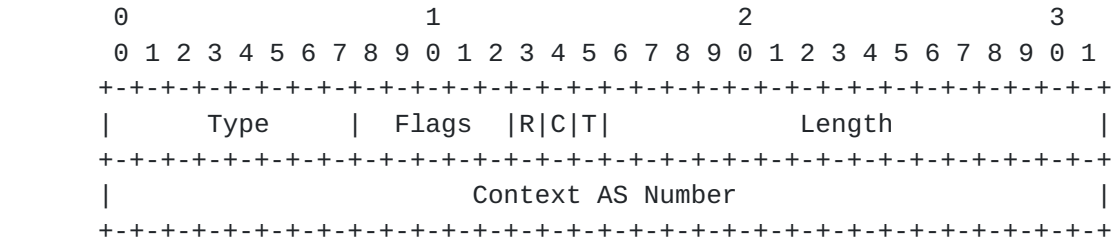
This document defines a new BGP Path Attribute, the Wide BGP Community. The attribute type code is (TBA by IANA).

The Wide BGP Community Attribute is an optional, transitive BGP attribute, and may be present only once in the BGP UPDATE message.

The attribute contains a number of typed containers. Any given container type may appear multiple times, unless that container type's definition specifies otherwise.

3.1. Wide BGP Community Attribute Common Container Header

Containers always start with the following common header:



This document defines Types 1,2,3 and 4. See the Section 14 for information on additional type registration policies.

Bit	Value	Meaning
0	0	Transitive across AS boundary
	1	Not Transitive across AS boundary
1	0	Transitive across confederation boundaries
	1	Not transitive across confederation boundaries
2	0	Local community value.
	1	IANA Registered community type or value.
3..7	-	RESERVED - MUST be zero when sent and ignored upon receipt.

Flags are defined globally, to apply to all wide community container types.

Table 1: Flags

Bit 0 (aka T bit) Transitivity bit: Value 0: The communities in the container are transitive across all ASes. Value 1: The communities in the container are transitive across AS boundaries, but not across an administration boundary. An administration in this sense is an arbitrary set of connected ASes, possibly owned by a single administration. How such an administration boundary is determined is out of scope of this document.

Bit 1 (aka C bit) Confederation bit: Is used to manage the propagation scope of a given Wide BGP Community across confederation boundaries. When not set (value of 0) indicates that communities in a given container are transitive across confederation boundary. When set (value 1) communities are not transitive across confederation sub-AS boundary.

Bit 2 (aka R bit) Registered bit: When set (value 1) indicates that the given container carries a Wide BGP Community which is registered with IANA. When not set (value 0) it indicates that community value which follows is locally assigned with a local only meaning and local behaviour.

The Length field represents the total length of a given container in octets.

Context Autonomous System Number: 4 octets

This identifies the AS that is to interpret the community container. For example, an ISP may publish a set of community specifications. A customer of the ISP will use those specifications to formulate the communities. The ISP will read the communities and perform the instructions encoded as per the specifications. The Context ASN is the ASN of the ISP. The ISP is usually directly connected to the customer, but if not, then the intervening network has the opportunity to pass the routes to the Context ASN if it chooses to do so.

4. Container Type 1: Wide Community

The Wide BGP Community Type 1 container is of variable size (but minimum length 8) and is encoded as follows:

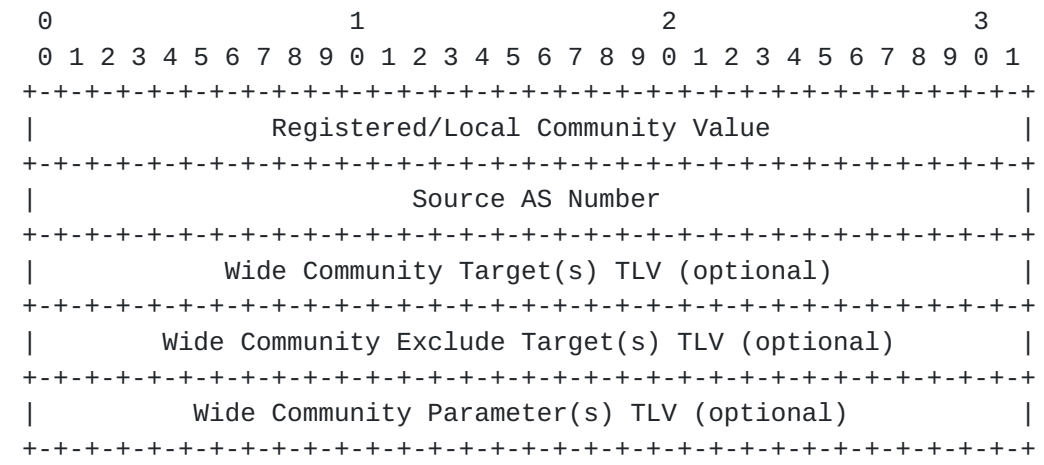


Figure 4: Wide BGP Community Type 1

4.1. Community Value

Community Value: 4 octets

The Wide BGP Community value indicates what set of actions a router is requested to take upon reception of a route containing this community. The semantics of this value depend on whether this is a private/local community or registered.

4.2. Source AS Number

Source Autonomous System Number: 4 octets

The Autonomous System number which indicates the originator of this Wide BGP Community.

When the Autonomous System is a two octet number the first two octets of this 4 octet value MUST be filled with zeros.

4.3. Wide Community Target(s) TLV

The Wide Community Target(s) TLV (Sub-Type 1) contains a list of a Wide Community atoms.

Wide Community Targets define the matching criteria for the community. A given wide community may have a number of targets that it applies to. The semantics of these targets will vary on a per

community basis. Depending on the definition of the community, targets may be optional.

The value field of the Wide Community Target(s) TLV is a series of Wide Community Atom TLVs. The semantics of any given atom TLV MUST be part of the definition of a given Wide Community.

Typically, Wide Community Targets consist of a series of atoms that have "match any" semantics. Thus, if any given target matches per the semantics of that atom for the community, the community is considered to match and the action defined by the community should be executed.

When no Target(s) TLV is specified, it is considered "match all".

If the semantics of a given atom is undefined for the community in question, it MUST be ignored.

When no targets are required by the definition of a given Wide Community, the Wide Community Target(s) TLV SHOULD NOT be encoded in the community. Implementations MUST be prepared to accept a Wide Community Target(s) TLV with an empty value field.

4.4. Wide Community Exclude Target(s) TLV

The Wide Community Exclude Target(s) TLV (Sub-Type 2) contains a list of a Wide Community atoms.

Wide Community Exclude Targets define criteria by which the community is considered to NOT match. Depending on the semantics of the Wide Community, Exclude Target(s) may be optional.

The semantic of the Wide Community Exclude Target(s) is to match all specified Target(s) with the exception of those listed in this TLV.

The value field of the Wide Community Exclude Target(s) TLV is a series of Wide Community Atom TLVs. The semantics of any given atom TLV MUST be part of the definition of a given Wide Community.

If the semantics of a given atom is undefined for the community in question, it MUST be ignored.

If the Wide Community Target(s) TLV and the Wide Community Exclude Target(s) TLV have conflicting semantics, priority MUST be given to the Wide Community Exclude Target(s) TLV.

When no exclude targets are required by the definition of a given Wide Community, the Wide Community Exclude Target(s) TLV SHOULD NOT

be encoded in the community. Implementations MUST be prepared to accept a Wide Community Exclude Target(s) TLV with an empty value field.

4.5. Wide Community Parameter(s) TLV

The Wide Community Parameter(s) TLV (Sub-Type 3) contains a list of a Wide Community atoms.

A given wide community may have parameters which are used as inputs for executing actions defined for that community. These parameters, and any constraints implied by the parameters, MUST be defined by the wide community definition. Parameters consist of an ordered set of atom sub-TLVs. The semantics of any specific positional instance of an atom MUST be defined by the wide community.

If it is the case that a parameter for a given community is of an unexpected type or length, the community MUST be ignored.

If it is the case that there are too many or two few parameters for a given community, the community MUST be ignored.

When no parameters are required by the definition of a given Wide Community, the Wide Community Paramters TLV SHOULD NOT be encoded in the community. Implementations MUST be prepared to accept a Wide Community Parameter TLV with an empty value field.

4.6. Usage

The detailed interpretation of the targets or parameters SHALL be provided when describing given community type in a separate document or when locally defined by an operator.

5. Container Type 2: BGP Wide Community 4:4

The Wide BGP Community Type 2 container is of fixed size (length 8 octets) and is encoded as follows:

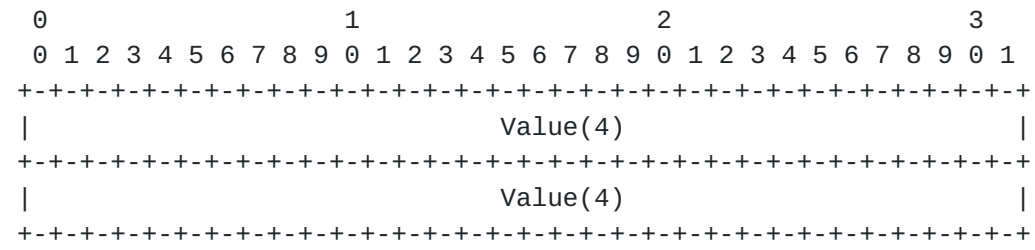


Figure ....: Wide BGP Community Type 2

5.1. Community Value

The BGP Community Container type 2 is a fixed eight octet value (4+4)

A 4:4 Community Container begins with the Common Container Header followed by a number of communities. Each community is 8 octets long. The length field in the header is the length of the header itself plus 8 times the number of communities after the header.

The Transitivity across AS boundary (T bit) or across confederation boundary (C bit) should be subject to local policy setting with default being set to 0 on both bits indicating full transitivness. The R flag should be set indicating IANA registration.

The same community value SHOULD NOT appear multiple times within the same update message. If it does, then a receiving BGP speaker MAY discard the duplicates.

If a community container has Transitivity 0, transitive across all ASes, then a BGP speaker SHOULD be configured to strip all received transitive communities that have an unexpected Context ASN.

The textual representation of a 4:4 Community is A:B:C, where A is the Context ASN, B is the first 4 octets and C is the final 4 octets of the community. Each ranges from 0 to 4294967295. Each is a decimal non-negative integer without leading zeros. Each number must appear, even if it is 0. For example, "0:1:2" cannot be written as ":1:2".

Even though the Context ASN appears once in the container header, when each community is processed by the routing policy language, each community has the Context ASN individually prepended to it.

6. Container Type 3: BGP Wide Community Nx4

The Wide BGP Community Type 3 container is of variable size (min length 4 octets) and is encoded as follows:

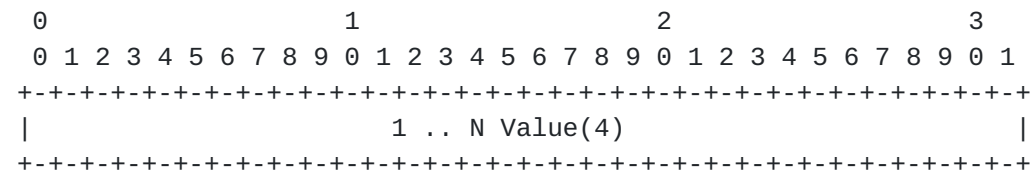


Figure ....: Wide BGP Community Type 3

6.1. Community Value

Value: N times 4 octets

The BGP Community Container type 3 (aka as Nx4) contains a variable length value.

The Community Container begins with the Common Container Header followed by a number of 4 octet values. The length field in the header is the length of the header itself plus total length of 4 octet values.

The Transitivity across AS boundary (T bit) or across confederation boundary (C bit) should be subject to local policy setting with default being set to 1 on both bits indicating no transitivness across administration boundary and confederation boundaries. The R flag should be set indicating IANA registration.

7. Container Type 4: BGP Wide Community 16+Nx4

The Wide BGP Community Type 4 container is of variable size (min length 16 octets) and is encoded as follows:

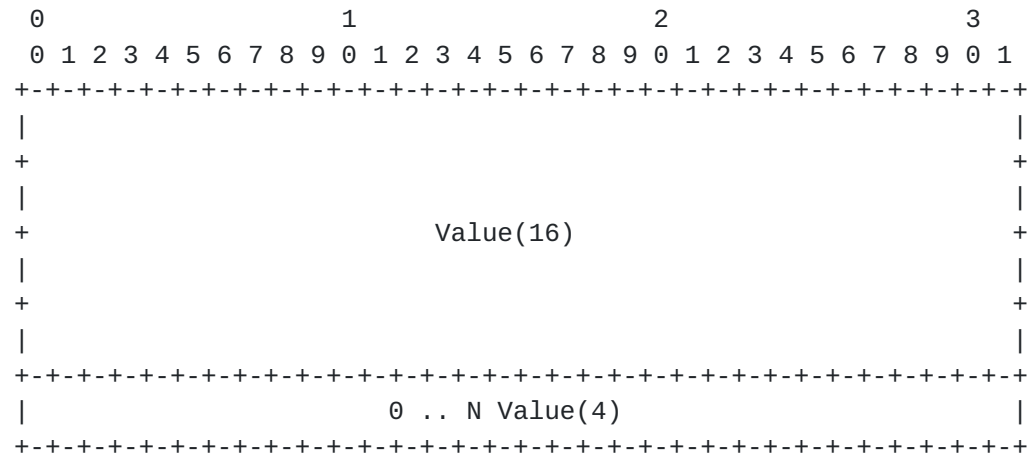


Figure ....: Wide BGP Community Type 4

7.1. Community Value

Value: 16 + N times 4 octets

Value: 16 octets followed by zero to N times 4 octets

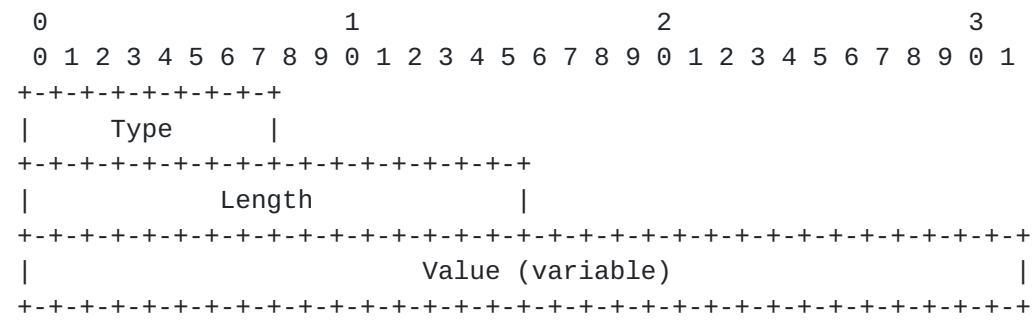
The BGP Community Container type 4 (aka as 16+Nx4) contains a variable length value.

The Community Container begins with the Common Container Header followed by a single 16 octet field then optionally followed by number of 4 octet values. The length field in the header is the length of the header itself plus total length of 4 octet values.

The Transitivity across AS boundary (T bit) or across confederation boundary (C bit) should be subject to local policy setting with default being set to 1 on both bits indicating no transitivness across administration boundary and confederation boundaries. The R flag should be set indicating IANA registration.

8. Wide Community Atoms

Some types of Wide BGP Communities (for example Type 1) will act on and hence need to encode some distinct atoms of data. Use of atoms is solely subject to definition of the specific BGP Container type. Atoms are encoded as TLVs, where each TLV has the following format:



The Type field contains a value of 1-254. The values 0 and 255 are reserved for future use. The TLV types are to be assigned and maintained by IANA registry.

The Length represents the total length of a given TLV's value field in octets.

The Value field contains the TLV value.

Supported format of the TLVs can be:

- Type 1: Autonomous System number list
- Type 2: IPv4 prefix (1 octet prefix length + prefix) list
- Type 3: IPv6 prefix (1 octet prefix length + prefix) list
- Type 4: Integer list
- Type 5: IEEE Floating Point Number list
- Type 6: Neighbor Class list
- Type 7: User-defined Class list
- Type 8: UTF-8 String

The semantics of a given atom will depend upon the context in which it is used, as defined by the containing wide community.

In the following sections defining the different atoms, validation rules for the Length of the atom will be presented. If the Length of the atom does not match the rules for that atom, it SHALL be considered malformed. (See Section 11.)

8.1. The Autonomous System number list atom

This atom represents a list of Autonomous System numbers, each 4 octets in size. The minimum Length of this atom is 4 octets. The Length MUST be a multiple of 4.

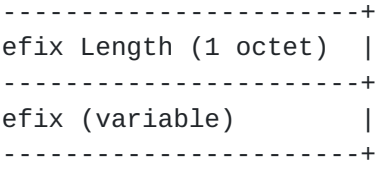
For consistent treatment, all AS numbers MUST be encoded as 4 octet values. When encoding two octet ASes, the first two octets of this four octet value MUST be filled with zeros.

Two special values are reserved for the Autonomous System atoms:

0x00000000 - to indicate "No Autonomous Systems".
0xFFFFFFFF - to indicate "All Autonomous Systems".

8.2. The IPv4 and IPv6 prefix list atoms

This atom represents a list of IPv4 or IPv6 prefix. IPv4 and IPv6 prefix atom values are encoded in the same format used by BGP NLRI in Section 4.3 of [RFC4271].



The Prefix Length for IPv4 prefixes must be in the range of 0..32.

The Prefix Length for IPv6 prefixes must be in the range of 0..128.

The Length field must be able to accommodate the list of prefixes according to the encoding rules. If the Length cannot fully accommodate the required number of octets to encode the Prefix Length and the Prefix, the atom is considered malformed.

8.3. The Integer list atom

This atom represents a list of Integers. Integers are a fixed Length of 4 octets and are stored in network byte order.

The minimum Length of the Integer list atom is 4 octets. The Length MUST be a multiple of 4.

8.4. The IEEE Floating Point Number list atom

This atom represents a list of floating point numbers. Floating point numbers are a fixed Length of 4 octets and are stored in [IEEE.754.1985] format.

This atom represents a list of floating point numbers.

The minimum Length of the Floating Point Number list atom is 4 octets. The Length MUST be a multiple of 4.

8.5. The Neighbor Class list atom

The Neighbor Class list atom represents a classification of a BGP peering session, each 4 octets in size. This class currently can contain three values:

1 - Peer: This class is typically applied to sessions where a transit-free relationship exists between two providers.
2 - Customer: This class is typically applied to sessions where the remote end of the session is operated by a customer.
3 - Upstream: This class is typically applied to sessions where the remote end of the session is operated by a network from which you receive transit routes.

The Neighbor Class list atom represents a classification of a BGP peering session.

The minimum Length of the Neighbor Class list atom is 4 octets. The Length MUST be a multiple of 4.

8.6. The User-defined Class list atom

Similar to the Neighbor Class atom, the User-defined Class list atom represents a classification of a network property. The exact property definition is up to the semantics of the defining Autonomous System. The semantics governing a given User-defined Class list are defined by the Context AS Number.

Examples of User-defined Class properties include geography (East, West), continent (North America, Asia, Europe), etc. Similar to the [RFC1997] BGP Communities, it is necessary that the Context AS provide a registry of the value and the semantics of a given community.

The minimum Length of the User-defined Class list atom is 4 octets. The Length of this atom MUST be a multiple of 4.

8.7. The UTF-8 String atom

The UTF-8 String atom represents an arbitrary Unicode string in UTF-8 [RFC3629] format. The Length is required to be of sufficient size to carry the UTF-8 string in the Value field.

Implementations MUST be prepared for truncated/improperly formed UTF-8 strings. When detecting such a string, the implementation should remove trailing octets of a multi-octet sequence in order to have a well-formed string.

Implementations MUST be prepared to receive empty (zero-Length) UTF-8 String atoms as they may be used as Parameters.

9. Well Known Standard BGP Communities

According to RFC 1997, as well as IANA's Well-Known BGP Communities registry, the following BGP communities are defined to have global significance:

0xFFFF0000	planned-shut	[draft-francois-bgp-gshut]
0xFFFFFF01	NO_EXPORT	[RFC1997]
0xFFFFFF02	NO_ADVERTISE	[RFC1997]
0xFFFFFF03	NO_EXPORT_SUBCONFED	[RFC1997]
0xFFFFFF04	NOPEER	[RFC3765]

This document recommends for simplicity as well as for avoidance of backward compatibility issues the continued use of BGP Standard Community Attribute type 8 as defined in RFC 1997 to distribute non Autonomous System specific Well-Known BGP Communities.

For the same reason, this document does not intended to obsolete the currently defined and deployed BGP Extended Communities.

10. Operational Considerations

Having two different ways to propagate locally assigned BGP communities, one via the use of Standard BGP Communities and the other one via the use of Wide BGP Communities, may seem to

potentially cause problems when considering propagation of conflicting actions. However, even at present, an operator may append Standard BGP Communities with conflicting information. It is therefore recommended that any implementation, in supporting both standard and Wide BGP communities, allow for their easy inbound and outbound processing. The actual execution of all communities should be treated as a union and, if supported by an implementation, their execution permissions are to be a local configuration matter.

11. Error Handling

If a length field overshoots the attribute as determined by the attribute length, then the attribute is malformed. If the length of any BGP Community Container would indicate a fractional number of communities, i.e. it is not divisible by 8 after subtracting the length of the header, then the attribute is malformed. In each case, the update message should be treated as withdrawn. Further procedures are described in [RFC7606]

If any atom in a Wide Community container's Exclude Targets TLV is unrecognized, no actions should be taken for that Wide Community. While the Targets TLV is meant to be inclusive, the Exclude Targets TLV is meant to be proscriptive of applying the action.

If any Wide Community container or atoms contained therein are determined to be malformed, the Wide Community Path attribute must be considered malformed. BGP implementations should use "treat-as-withdraw" semantics as defined in [I-D.ietf-idr-error-handling].

12. Example

12.1. Example Type 1 Wide Community Definition

An operator of an AS 64496, wishes to locally define a Wide Community with the semantics of permitting AS_PATH prepending with targets that include AS numbers of peer ASes and peers who have been marked with a set of enumerated city locations.

AS 64496 has established a registered set of values to use for its User-defined Class:

100 - Amsterdam
101 - New York
102 - San Francisco
103 - Tokyo
104 - Moscow

Target semantics:

The Autonomous System Number list atom refers to the target peer AS Numbers.

The User-defined Class for AS 64496 has been defined elsewhere and the values 100..104 may be used for this locally defined Wide Community.

The Targets TLV MUST contain at least one entry.

The Exclude Targets TLV MAY contain entries of the above supported atoms.

The semantics of all other atoms are undefined for this community.

Parameter semantics:

The parameter TLV shall consist of exactly one Integer atom value that is constrained to have a value of 2..8.

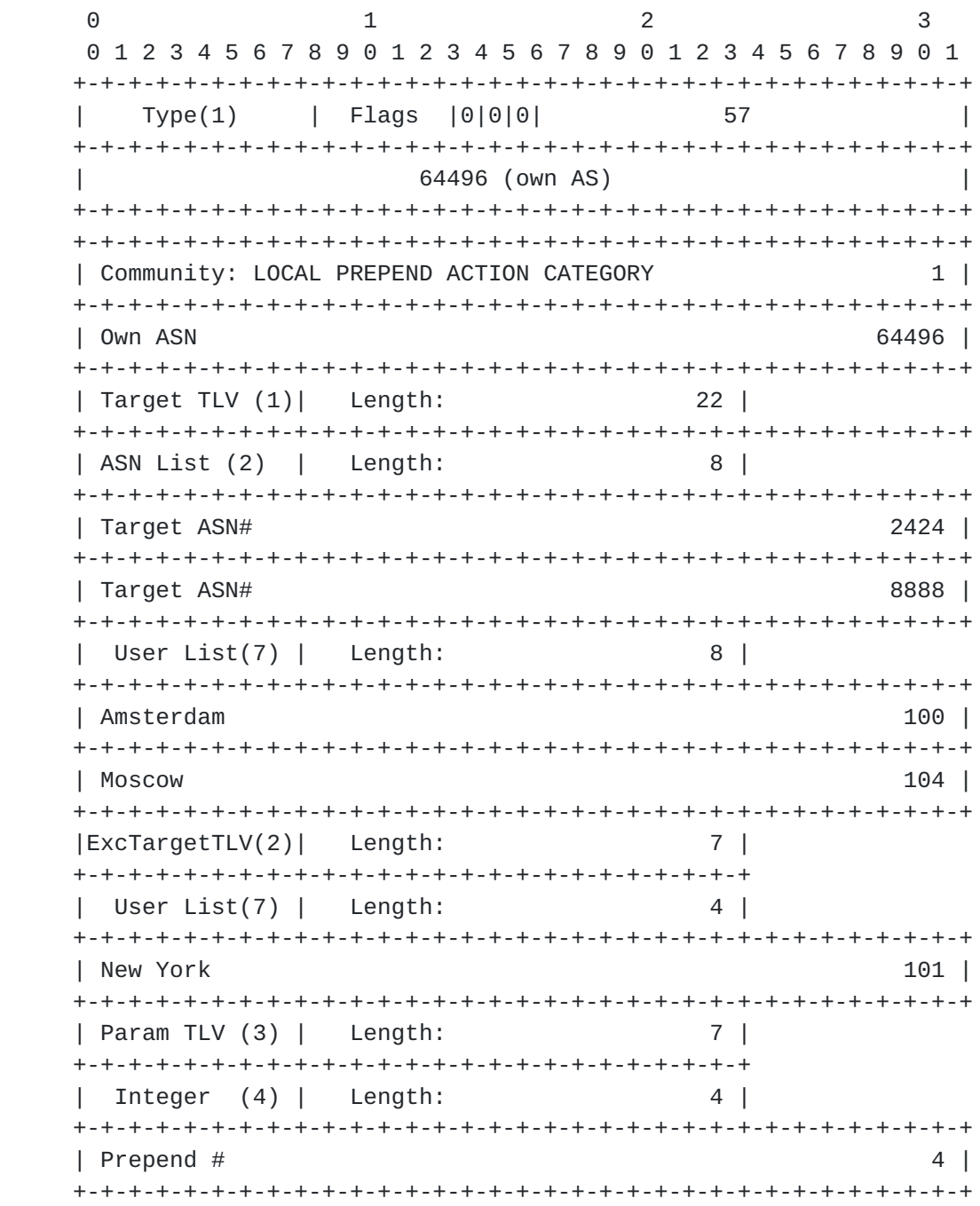
12.2. Example Type 1 Wide BGP Community Encoding

AS_PATH prepend 4 TIMES TO AS 2424, AS 8888, to peers marked as Amsterdam (100) or to peers marked Moscow (104), but not to peers in New York (101).

Use Hop Count 0 to request the receiving router to not propagate this wide community.

Locally community value (flag bit 0 = 0).
Do not decrement Hop Count field across confederation boundaries (0)

Local community 1 for sample AS 64496.



13. Security considerations

Transitive communities could unintentionally spread far from their origin. If a router receives many routes from multiple sources on the Internet with different communities, it could cause significant memory usage. To prevent excessive memory usage, routers should be configured to strip unexpected communities from received routes.

All the security considerations for BGP Communities as well as for BGP RFCs apply here.

Given the flexibility and power offered by Wide BGP communities, it is important to consider the additional possibilities allowed by their definition. In particular, for locally defined Wide BGP Communities, it may be wise to restrict the range of parameters. For registred Wide BGP Communities, the security considerations of the document defining them MUST address issues specific to those newly defined Wide Communities.

Security considerations specific to Wide BGP Communities will be discussed in a later revision of this draft.

14. IANA Considerations

This document defines a new BGP Path Attribute called Wide BGP Community Attribute. For this new type IANA is to allocate a new value in the corresponding registry:

Registry Name: BGP Path Attributes

This document makes the following assignments for the optional, transitive Wide BGP Communities Attribute:

Name	Type Value
Wide BGP Community Attribute	TBA

This document requests IANA to define and maintain a new registry named: "Wide BGP Communities Attribute Container Types".

The pool of: 0x0000-0xFFFF has been defined for its allocations. The allocation policy is on a first come, first served basis.

This document makes the following assignments for the Wide BGP Communities Container Types values:

Name	Type Value
Reserved	0x00
Type 1, Wide BGP Community	0x01
Type 2, BGP Community 4:4	0x02
Type 3, BGP Community Nx4	0x03
Type 4, BGP Community 16+Nx4	0x04
Types 5-100 to be allocated using IETF Consensus	
Types 101-200 to be allocated first come, first served	
Types 201-254 are reserved for experimental use	
Reserved	0xFF

This document requests IANA to define and maintain a new registry named: "Wide BGP Communities Atom Types". The pool of 0x0000-0xFFFF has been defined for its allocations.

This document makes the following assignments for the Wide BGP Communities Atom Type values:

Name	Type Value
Reserved	0x00
Autonomous System Number List	0x01
IPv4 Prefix list	0x02
IPv6 Prefix list	0x03
Integer list	0x04
IEEE Floating Point Number list	0x05
Neighbor Class list	0x06
User-defined Class list	0x07
UTF-8 string	0x08
Reserved	0xFF

This document requests IANA to define and maintain a new registry named: "Registered Wide BGP Communities". The pool of 0x00000000-0FFFFFFF has ben defined for its allocation.

This document makes the following assignments for the Registered Wide BGP Communities:

Name	Type Value
Reserved	0x00
AS-4 List Generic Wide BGP Community	0x01
Reserved	0xFFFFFFFF

Values 2-1023 are to be allocated using IETF Consensus. Values 64512-65534 are reserved for experimental use. All other values are available on a first-come, first served basis.

15. Change History

Changes from -03 via -04 to -05:

Update the Introduction.

Substantial re-work of atom types removing proposed Group container and moving atoms to be lists.

Added the Exclude Targets TLV to the Wide Community container.

Added a section on error handling.

Updated the example.

Changes from -02 to -03:

Removed C and R named bit fields originally from -00.

Rename Target AS field to Context AS.

Make Integer Atom a fixed 4 octets in length.

Add Neighbor Class Atom

Rename TTL to Hop Count

Changes from -01 to -02:

The Type field has been expanded to 2 octets.

The Length field has been moved to the common header.

Changed format to use TLVs.

Added atom TLV to define well defined syntactic items.

Added TLVs to distinguish targets from parameters.

Various editorial changes to language.

16. Outstanding Issues

The following are known issues that have yet to be resolved in this draft:

- The interaction of the Container TTL field with VPN peers.

- The name Wide Communities is overloaded in this document. The scope of this feature has evolved since the initial -00 of the draft. The general feature of a containerized BGP Community extension and the Type 1 container, the Wide community, currently share names. "There are only two hard things in Computer Science: cache invalidation and naming things."

17. Contributors

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18. Acknowledgments

This document owes draft-lange-flexible-bgp-communities a debt for the inspiration of many features contained herein.

The authors would like to thank Enke Chen, Pedro Marques, Alton Lo, Igor Gashinsky and Job Snijders for their valuable input.

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