Export BGP community information in IP Flow Information Export (IPFIX)
draft-ietf-opsawg-ipfix-bgp-community-09

Abstract

   By introducing new Information Elements (IEs), this draft extends the
   existing BGP related IEs to enable IPFIX [RFC7011] to export the BGP
   community information, including the information of BGP standard
   community [RFC1997], BGP extended community [RFC4360], and BGP large
   community [RFC8092]. Network traffic information can then be
   accumulated and analysed at the BGP community granularity, which
   represents the traffic of different kinds of customers, services, or
   geographical regions according to the network operator's BGP
   community planning. Network traffic information at the BGP community
   granularity is useful for network traffic analysis and engineering.

   To clarify, no new BGP community attribute is defined in this
   document and this document has no purpose to replace BGP Monitoring
   Protocol (BMP) defined in RFC7854. The IEs introduced in this
   document are used by IPFIX together with other IEs to facilitate the
   IPFIX Collector analyzing the network traffic at the BGP community
   granularity without running the heavy BGP protocol. When needed, the
   IPFIX Mediator or Collector can use the IEs introduced in this
   document to report the BGP community related traffic flow information
   it gets either from Exporters or through local correlation to other
   IPFIX devices.

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1. Introduction

IP Flow Information Export (IPFIX) [RFC7011] provides network
administrators with traffic flow information using the Information
Elements (IEs) defined in [IANA-IPFIX] registries. Based on the
traffic flow information, network administrators know the amount and
direction of the traffic in their network, then they can optimize
their network when needed. For example, they can shift some flows

from the congested links to the low utilized links through a SDN
controller or PCE [RFC4655].

[IANA-IPFIX] has already defined the following IEs for traffic flow
information exporting in different granularities: sourceIPv4Address,
sourceIPv4Prefix, destinationIPv4Address, destinationIPv4Prefix,
bgpSourceAsNumber, bgpDestinationAsNumber, bgpNextHopIPv4Address,
etc. In some circumstances, however, especially when traffic
engineering and optimization are executed in the Tier 1 or Tier 2
operators' backbone networks, traffic flow information based on these
IEs may not be suitable. Flow information based on IP address or IP
prefix may provide much too fine granularity for a large network. On
the contrary, flow information based on AS number may be too coarse.

BGP community is a BGP path attribute defined in IDR (Inter Domain
Routing) working group. The already defined BGP community attribute
includes the standard community defined in [RFC1997], the extended
community defined in [RFC4360], and the large community defined in
[RFC8092]. BGP community attribute has a variety of use cases, one
practice of which is to use BGP community with planned specific
values to represent the groups of customers, services, geographical
and topological regions, which is used by a lot of operators in their
field networks. Please refer to [RFC4384], [RFC8195] and Section 3
of this document for the detailed examples. To know the traffic
generated by different kinds of customers, from different
geographical or topological regions, by different kinds of customers
in different regions, we need the corresponding community information
related to the traffic flow exported by IPFIX. Network traffic
statistics at the BGP community granularity is useful not only for
the traffic analyzing, but also can then be used by other
applications, such as the traffic optimization applications located
in IPFIX Collector, SDN controller or PCE. [Community-TE] also
states analyzing network traffic information at the BGP community
granularity is prefered for inbound traffic engineering. However,
there is no IE defined for BGP community attribute in [IANA-IPFIX]
yet.

Flow information based on BGP community may be collected by an IPFIX
Mediator defined in [RFC6183]. IPFIX Mediator is responsible for the
correlation between flow information and BGP community. However no
IEs are defined in [RFC6183] for exporting BGP community information
in IPFIX. Furthermore, to correlate the BGP community with the flow
information, the IPFIX Mediator needs to learn BGP routes and perform
lookup in the BGP routing table to get the matching entry for a
specific flow. Neither BGP route learning nor routing table lookup
is trivial for an IPFIX Mediator. The IPFIX Mediator is mainly
introduced to release the performance requirement for the Exporter
[RFC5982]. In fact, to obtain the information for the already

defined BGP related IEs, such as bgpSourceAsNumber,
bgpDestinationAsNumber, and bgpNextHopIPv4Address, etc, the Exporter
has to hold the up-to-date BGP routing table and perform lookup in
the BGP routing table. The Exporter can obtain the BGP community
information in the same procedure, thus the additional load added by
exporting BGP community information is minimal if the Exporter is
already exporting the existing BGP related IEs. It is RECOMMENDED
that the BGP community information be exported by the Exporter
directly using IPFIX.

Through running BGP [RFC4271] or BMP [RFC7854] and performing lookup
in the BGP routing table to get the matching entry for a specific
flow (we call it correlation), IPFIX Collectors and other
applications, such as SDN controller or PCE, can determine the
network traffic at the BGP community granularity. However, neither
running BGP or BMP protocol nor routing table lookup is trivial for
the IPFIX Collectors and other applications. Moreover correlation
between IPFIX flow information and the BGP RIB on the Exporter (such
as router) is more accurate, compared to the correlation on a
Collector, since the BGP routing table may be updated when the IPFIX
Collectors and other applications reveive the IPFIX flow information.
And as stated above, the Exporter can obtain the BGP community
information in the same procedure when it obtains other BGP related
informaiton. So exporting the BGP community information directly by
the Exporter to the Collector is the efficient and accurate way. If
the IPFIX Collectors and other applications only want to determine
the network traffic at the BGP community granularity, they do not
need to run the heavy BGP or BMP protocol when the BGP community
information can be obtained by IPFIX. However, we have to clarify,
the BMP protocol has its own application scenario, the mechanism
introduced in this document has no purpose to replace it.

By introducing new IEs, this draft extends the existing BGP related
IEs to enable IPFIX [RFC7011] to export the BGP community
information, including BGP standard community defined in [RFC1997],
BGP extended community defined in [RFC4360], and BGP large community
defined in [RFC8092]. Flow information, including packetDeltaCount,
octetDeltaCount [RFC7012] etc, can then be accumulated and analysed
by the Collector or other applications, such as SDN controller or PCE
[RFC4655], at the BGP community granularity, which is useful for
knowing the traffic generated by different kinds of customers, from
different geographical or topological regions according to the
operator's BGP community plan, and can then be used by the traffic
engineering or traffic optimization applications, especially in the
backbone network.

The IEs introduced in this document are applicable for both IPv4 and
IPv6 traffic. Both the Exporter and the IPFIX Mediator can use these

IEs to export BGP community information in IPFIX. When needed, the
IPFIX Mediator or Collector can use these IEs to report the BGP
community related traffic flow information it gets either from
Exporters or through local correlation to other IPFIX devices.

To clarify, no new BGP community attribute is defined in this
document, IDR (Inter Domain Routing) working group is the right place
to define new community attributes for the BGP protocol.

Note that this document does not update the IPFIX specification
[RFC7011] and the Information Model [RFC7012] because IANA's IPFIX
registry [IANA-IPFIX] is the ultimate Information Element reference,
per Section 1 of [RFC7012].

Please refer to [IANA-IPFIX] for the whole list of the already
defined BGP related IEs.

Please refer to Appendix A for the encoding example and Section 3 for
a detailed use case.

2. Terminology

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].

IPFIX-specific terminology used in this document is defined in
Section 2 of the IPFIX protocol specification [RFC7011] and Section 2
of [RFC6183]

3. BGP Community based Traffic Collection

[RFC4384] introduces the mechanism of using BGP standard communities
and extended communities to collect the geographical and topological
related information in BGP routing system. [RFC8195] gives some
examples about the application of BGP large communities to represent
the geographical regions. Since the network traffic at the BGP
community granularity represents the traffic generted by different
kinds of customers, from different geographical regions according to
the network operator's BGP community plan, it is useful for the
network operators to analyze and optimize the network traffic among
different customers and regions. This section gives a use case in
which the network operator uses the BGP community based traffic
information to adjust the network paths for different traffic flows.

Considering the following scenario, AS C provides transit connection
between AS A and B. By tagging with different BGP communities, the
routes of AS A and B are categorized into several groups respectively

with the operator's plan. For example community A:X and A:Y are used
for the routes originated from different geographical regions in AS
A, and community B:M and B:N are used for the routes representing the
different kinds of customers in AS B, such as B:M is for the mobile
customers and B:N is for the fixed line customers. By default, all
traffic originating from AS A and destined to AS B (we call it
traffic A-B) goes through path C1-C2-C3 (call it Path-1) in AS C.
When the link between C1 and C2 is congested, we cannot simply steer
all the traffic A-B from Path-1 to Path C1-C4-C3 (call it Path-2),
becuse it will cause congestion in Path-2.

```
                             +----------+
                             | PCE/SDN  |
                    +--------|Controller|-------+
                    |        +----------+       |
                    |                           |
                    |            AS C           |
        |           |        +----------+       |        |
        |           |    +---|Router C2 |---+   |        |
        |           |    |   +----------+   |   |        |
    AS A|           |    |100            50|   |        |  AS B
  +--------+  |   +---------+              +---------+  |  +--------+
  |Router A|--|--|Router C1|              |Router C3|--|--|Router B|
  +--------+  |   +---------+              +---------+  |  +--------+
  Community:  |        |100            100|              |  Community:
      A:X     |        |   +----------+   |              |     B:M
      A:Y     |        +---|Router C4 |---+              |     B:N
                             +----------+
```

           Figure 1: BGP Community based Traffic Collection

If the PCE/SDN controller in AS C can obtain the network traffic
information at the BGP community granularity, it can steer some
traffic related to some BGP communities (when we consider only the
source or destination of the traffic), or some BGP community pairs
(when we consider both the source and the destination of the traffic)
from Path-1 to Path-2 according to the utilization of different
paths. For instance, steer the traffic generated by community A:X
from Path-1 to Path-2 by deploying route policy at Router C1, or
steer the traffic from community A:Y to community B:M from Path-1 to
Path-2. Using the IEs defined in this document, IPFIX can export the
BGP community information related to a specific traffic flow together
with other flow information. The traffic information can then be
accumulated at the BGP community granularity and used by the PCE/SDN
controller to steer the appropriate traffic from Path-1 to Path-2.

4. IEs for BGP Standard Community

   [RFC1997] defines the BGP Communities attribute, called BGP Standard
   Community in this document, which describes a group of routes sharing
   some common properties. BGP Standard Communities are treated as 32
   bit values as stated in[RFC1997].

   In order to export BGP standard community information along with
   other flow information defined by IPFIX, three new IEs are
   introduced. One is bgpCommunity, which is used to identify that the
   value in this IE is a BGP standard community. The other two are
   bgpSourceCommunityList and bgpDestinationCommunityList, which are
   both basicList [RFC6313] of bgpCommunity, and are used to export BGP
   standard community information corresponding to a specific flow's
   source and destination IP address respectively.

   The detailed information of the three new IEs are shown in Section 9
   IANA Considerations.

5. IEs for BGP Extended Community

   [RFC4360] defines the BGP Extended Communities attribute, which
   provides a mechanism for labeling the information carried in BGP.
   Each Extended Community is encoded as an 8-octet quantity with the
   format defined in [RFC4360].

   In order to export BGP Extended Community information together with
   other flow information by IPFIX, three new IEs are introduced. The
   first one is bgpExtendedCommunity, which is used to identify that the
   value in this IE is a BGP Extended Community. The other two are
   bgpSourceExtendedCommunityList and
   bgpDestinationExtendedCommunityList, which are both basicList
   [RFC6313] of bgpExtendedCommunity, and are used to export the BGP
   Extended Community information corresponding to a specific flow's
   source and destination IP address respectively.

   The detailed information of the three new IEs are shown in Section 9
   IANA Considerations.

6. IEs for BGP Large Community

   [RFC8092] defines the BGP Large Communities attribute, which is
   suitable for use with all Autonomous System Numbers (ASNs) including
   four-octet ASNs. Each BGP Large Community is encoded as a 12-octet
   quantity with the format defined in [RFC8092].

   In order to export BGP Large Community information together with
   other flow information by IPFIX, three new IEs are introduced. The

first one is bgpLargeCommunity, which is used to identify that the
value in this IE is a BGP Large Community. The other two are
bgpSourceLargeCommunityList and bgpDestinationLargeCommunityList,
which are both basicList [RFC6313] of bgpLargeCommunity, and are used
to export the BGP Large Community information corresponding to a
specific flow's source and destination IP address respectively.

The detailed information of the three new IEs are shown in Section 9
IANA Considerations.

7. Operational Considerations

The maximum length of an IPFIX message is 65535 bytes as per
[RFC7011] , and the maximum length of a normal BGP message is 4096
bytes as per [RFC4271]. Since BGP communities, including standard,
extended, and large communities , are BGP path attributes carried in
BGP Update messages, the total length of these attributes can not
exceed the length of a BGP message, i.e. 4096 bytes. So one IPFIX
message with maximum length of 65535 bytes has enough space to fit
all the communities related to a specific flow, relating to both the
source and destination IP addresses.

[I-D.ietf-idr-bgp-extended-messages] extends the maximum size of a
BGP Update message to 65535 bytes. Then theoretically the BGP
community information related to a specific flow may exceed the
length of one IPFIX message. However, according to information about
networks in the field, the number of BGP communities in one BGP route
is usually no more than 10. Nevertheless, BGP speakers that support
the extended message SHOULD be careful to export the BGP communities
in the IPFIX message properly, such as only convey as many
communities as possible in the IPFIX message. The Collector which
receives an IPFIX message with maximum length and BGP communities
contained in its data set SHOULD be aware that the BGP communities
may be truncated due to limited message space. In this case, it is
RECOMMENDED to configure the export policy of BGP communities to
limit the BGP communities by including or excluding specific
communities.

If needed, we may consider to extend the message length of IPFIX
[RFC7011] from 16 bits to 32 bits to solve this problem completely.
The details of increasing IPFIX message length is out of scope of
this document.

To align with the size of BGP extended community and large community,
the size of IE bgpExtendedCommunity and bgpLargeCommunity is 8 octets
and 12 octets respectively. In the event that the
bgpExtendedCommunity or bgpLargeCommunity IE is not of its expected
size, the IPFIX Collector SHOULD ignore it. This is intended to

protect implementations using BGP logic from calling their parsing
routines with invalid lengths.

For the proper processing of the Exporter, when it receives the
template requesting to report the BGP community information (refer to
Appendix A for an example), the Exporter SHOULD obtain the
corresponding BGP community information through BGP lookup using the
corresponding source or destination IP address of the specific
traffic flow. When exporting the IPFIX information to the Collector,
the Exporter SHOULD include the corresponding BGP communities in the
IPFIX message.

8. Security Considerations

This document only defines new IEs for IPFIX. This document itself
does not directly introduce security issues. The same security
considerations as for the IPFIX Protocol Specification [RFC7011] and
Information Model [RFC7012] apply.

As the BGP community information is deducible by other means, there
are no increased privacy concerns, neither.

9. IANA Considerations

This draft specifies the following IPFIX IEs to export BGP community
information along with other flow information.

The Element IDs for these IEs are solicited to be assigned by IANA.
The following table is for IANA's reference to put in each field in
the registry.

ElementID	Name	Data Type	Data Type Semantics
TBA1	bgpCommunity	unsigned32	identifier
TBA2	bgpSourceCommunityList	basicList	list
TBA3	bgpDestinationCommunityList	basicList	list
TBA4	bgpExtendedCommunity	octetArray	default
TBA5	bgpSourceExtended CommunityList	basicList	list
TBA6	bgpDestinationExtended CommunityList	basicList	list

TBA7	bgpLargeCommunity	octetArray	default
TBA8	bgpSourceLargeCommunityList	basicList	list
TBA9	bgpDestinationLarge CommunityList	basicList	list

ElementID	Description	Units
TBA1	BGP community as defined in [RFC1997]	
TBA2	zero or more BGP communities corresponding with source IP address of a specific flow	
TBA3	zero or more BGP communities corresponding with destination IP address of a specific flow	
TBA4	BGP Extended Community as defined in [RFC4360] The size of this IE MUST be 8 octets	
TBA5	zero or more BGP Extended Communities corresponding with source IP address of a specific flow	
TBA6	zero or more BGP Extended communities corresponding with destination IP address of a specific flow	
TBA7	BGP Large Community as defined in [RFC8092] The size of this IE MUST be 12 octets.	
TBA8	zero or more BGP Large Communities corresponding with source IP address of a specific flow	
TBA9	zero or more BGP Large communities corresponding with destination IP address of a specific flow	

ElementID	Range	References	Requester	Revision	date
TBA1		RFC1997	this draft	0	
TBA2		RFC6313,RFC1997	this draft	0	

```
|--------------------------------------------------------------------|
|   TBA3   |          |RFC6313,RFC1997|this draft |    0     |        |
|--------------------------------------------------------------------|
|   TBA4   |          |    RFC4360    |this draft |    0     |        |
|--------------------------------------------------------------------|
|   TBA5   |          |RFC6313,RFC4360|this draft |    0     |        |
|--------------------------------------------------------------------|
|   TBA6   |          |RFC6313,RFC4360|this draft |    0     |        |
|--------------------------------------------------------------------|
|   TBA7   |          |    RFC8092    |this draft |    0     |        |
|--------------------------------------------------------------------|
|   TBA8   |          |RFC6313,RFC8092|this draft |    0     |        |
|--------------------------------------------------------------------|
|   TBA9   |          |RFC6313,RFC8092|this draft |    0     |        |
|--------------------------------------------------------------------|
```

Figure 2: IANA Considerations

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Appendix A. Encoding Example

   In this section, we give an example to show the encoding format for
   the new introduced IEs.

   Flow information including BGP communities is shown in the below
   table. Suppose we want all the fields to be reported by IPFIX.

Source IP	Destination IP	BGP community corresponding with Source IP	BGP community corresponding with Destination IP
1.1.1.1	2.2.2.2	1:1001,1:1002,8:1001	2:1002,8:1001
3.3.3.3	4.4.4.4	3:1001,3:1002,8:1001	4:1001,8:1001

                Figure 3: Flow information including BGP communities

A.1. Template Record

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           SET ID = 2          |          Length = 24          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Template ID = 256      |         Field Count = 4       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0|     SourceIPv4Address = 8    |       Field length = 4        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0| DestinationIPv4Address = 12 |       Field length = 4        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0| bgpSourceCommunityList= TBA2|     Field length = 0xFFFF     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0| bgpDestinationCommunityList |     Field length = 0xFFFF     |
| |         = TBA3             |                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                 Figure 4: Template Record Encoding Format

   In this example, the Template ID is 256, which will be used in the
   Data Record. The field length for bgpSourceCommunityList and
   bgpDestinationCommunityList is 0xFFFF, which means the length of this
   IE is variable, the actual length of this IE is indicated by the list
   length field in the basic list format as per [RFC6313].

A.2. Data Set

   The data set is represented as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          SET ID = 256         |           Length = 92         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   SourceIPv4Address = 1.1.1.1                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              DestinationIPv4Address = 2.2.2.2                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      255      |       List length = 17        |semantic=allof |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      bgpCommunity = TBA1      |          Field Len = 4        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        BGP Source Community Value 1 = 1:1001                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        BGP Source Community Value 2 = 1:1002                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        BGP Source Community Value 3 = 8:1001                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
   |      255       |          List length = 13      |semantic =allof|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        bgpCommunity = TBA1      |          Field Len = 4       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          BGP Destination Community Value 1 = 2:1002           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          BGP Destination Community Value 2 = 8:1001           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                 SourceIPv4Address = 3.3.3.3                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |              DestinationIPv4Address = 4.4.4.4                 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      255       |          List length = 17      |semantic =allof|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        bgpCommunity = TBA1      |          Field Len = 4       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         BGP Source Community Value 1  = 3:1001               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         BGP Source Community Value 2  = 3:1002               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         BGP Source Community Value 3  = 8:1001               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      255       |          List length = 13      |semantic =allof|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        bgpCommunity = TBA1      |          Field Len = 4       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          BGP Destination Community Value 1 = 4:1001           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          BGP Destination Community Value 2 = 8:1001           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                    Figure 5: Data Set Encoding Format

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