

在IOS-XR上的一個BGP鄰居上同時標籤和未標籤

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本檔案將說明在Cisco IOS[®] XR中透過一個BGP作業階段接收和播發未標籤和已標籤路徑的行為。

必要條件

需求

本文件沒有特定需求。

採用元件

本檔案特定於Cisco IOS[®] XR，但並不限於特定軟體版本或硬體。

本文中的資訊是根據特定實驗室環境內的裝置所建立。文中使用到的所有裝置皆從已清除（預設）的組態來啟動。如果您的網路正在作用，請確保您已瞭解任何指令可能造成的影響。

簡介

地址系列識別符號(AFI)表示BGP路由的型別。例如，1表示IPv4,2表示IPv6。

後續地址系列識別符號(SAFI)是路由型別的進一步指示。例如，未標籤路由為1，標籤路由為4。

IPv4的未標籤單播為AFI 1和SAFI 1。

標籤為IPv4的單播為AFI 1和SAFI 4。

IPv6的未標籤單播為AFI 2和SAFI 1。

標籤為IPv6的單播為AFI 2和SAFI 4。

標籤單播(LU)通常稱為RFC 3107「在BGP-4中傳送標籤資訊」。

以後，U是指未標籤的單播，因此SAFI 1和LU是指標籤的單播，因此SAFI 4。

請注意，Cisco IOS® XR需要「allocate-label all| route-policy ...」，否則該路由不會作為SAFI 4發起或傳播到下一個BGP揚聲器。

Cisco IOS® XR不支援一個BGP會話上的IPv4/v6單播和標籤單播。

在Cisco IOS® XR上，一個BGP作業階段上同時啟用未標籤和標籤的支援已在6.2.1中完成。

如果不支援在一個會話上同時運行兩者，則會出現問題，因為上次收到的更新/撤消會覆蓋上一個更新/撤消更新，即使它們是在另一個SAFI上接收到的。

在運行IOS-XR 6.2.1之前的IOS-XR代碼的路由器上，在同一BGP會話上配置SAFI 1和4時，路由器發出以下警告：

```
bgp[1051]: %ROUTING-BGP-4-INCOMPATIBLE_AFI : IPv4 Unicast and IPv4 Labeled-unicast Address families together are not supported under the same neighbor.
```

此警告消息是在IOS-XR 5.3.0和IOS-XR 5.2.2中引入的。

功能交換

BGP對等體之間交換的能力必須匹配。否則，BGP作業階段不會啟動。

以下是BGP Open訊息中為AFI 1/SAFI 1和AFI 1/SAFI 4交換功能的Wireshark擷取：

```

Marker: ffffffffffffffffffffffffffffffffff
Length: 95
Type: OPEN Message (1)
Version: 4
My AS: 65003
Hold Time: 180
BGP Identifier: 10.100.1.4
Optional Parameters Length: 66
v Optional Parameters
  v Optional Parameter: Capability
    Parameter Type: Capability (2)
    Parameter Length: 6
    v Capability: Multiprotocol extensions capability
      Type: Multiprotocol extensions capability (1)
      Length: 4
      AFI: IPv4 (1)
      Reserved: 00
      SAFI: Unicast (1)
  v Optional Parameter: Capability
    Parameter Type: Capability (2)
    Parameter Length: 6
    v Capability: Multiprotocol extensions capability
      Type: Multiprotocol extensions capability (1)
      Length: 4
      AFI: IPv4 (1)
      Reserved: 00
      SAFI: Labeled Unicast (4)
  > Optional Parameter: Capability
  > Optional Parameter: Capability

```

圖1

以下是使用LU配置的IOS-XR的示例，該示例在與使用U配置的IOS的會話中僅配置LU。

IOS-XR:

```

RP/0/0/CPU0:R4#show bgp neighbor 10.100.1.8

BGP neighbor is 10.100.1.8
  Remote AS 65003, local AS 65003, internal link
  Remote router ID 0.0.0.0
  BGP state = Idle
...

Connections established 0; dropped 0
Local host: 10.100.1.4, Local port: 179, IF Handle: 0x00000000
Foreign host: 10.100.1.8, Foreign port: 33396
Last reset 00:00:14, due to BGP Notification sent: unsupported/disjoint capability
Time since last notification sent to neighbor: 00:00:14
Error Code: unsupported/disjoint capability
Notification data sent:

```

None

IOS路由器會為此配置錯誤列印系統日誌消息：

```
*Aug  8 12:40:44.719: %BGP-3-NOTIFICATION: received from neighbor 10.100.1.4 active 2/7  
(unsupported/disjoint capability) 0 by
```

IOS-XR實施細節

配置U或LU

您可以在BGP neighbor命令下配置「address-family ipv4 unicast」，為BGP會話啟用ipv4單播。

您可以在BGP neighbor命令下配置「address-family ipv6 unicast」，為BGP會話啟用ipv6單播。

您可以在BGP neighbor命令下配置「address-family ipv4 labeled-unicast」，為BGP會話啟用標籤為unicast的ipv4。

您可以在BGP neighbor命令下配置「address-family ipv6 labeled-unicast」，為BGP會話啟用標籤為unicast的ipv6。

在IOS-XR中，AFI/SAFI組合是按每BGP對等體配置的。

以下是具有SAFI 1和4的BGP作業階段的範例：

```
router bgp 65003  
  address-family ipv4 unicast  
  redistribute connected  
  allocate-label all unlabeled-path  
  ...  
neighbor 10.100.1.7  
  remote-as 65003  
  update-source Loopback0  
  address-family ipv4 unicast  
  route-reflector-client  
  !  
  address-family ipv4 labeled-unicast  
  route-reflector-client
```

請注意，路由器BGP下仍然只有「address family unicast」而不是「address-family labeled-unicast」。SAFI 1和4路徑都儲存在這個BGP表中。

BGP表

無論IOS-XR是舊版還是新版6.2.1，只有一個BGP表可以儲存U和LU路由。這一點在路由器bgp下只能配置（啟用）「地址系列ipv4單播」或「地址系列ipv6單播」的事實中顯而易見。不能在路由器bgp下配置「address-family ipv4 labeled-unicast」或「address-family ipv6 labeled-unicast」。

U和LU路徑可以相同。在IOS-XR 6.2.1之前，再次接收相同路徑（這次包含或不包含標籤）會覆蓋先前接收的路徑。在IOS-XR 6.2.1之後，如果兩條相同的路徑僅因標籤的不同而不同，則會視為不同的路徑。路徑新增、刪除或修改由不同的SAFI執行。

以下是具有AFI 1/SAFI 4的BGP表中的路由範例。由於對所有字首啟用了標籤分配，因此此路徑將使用本地標籤儲存。由於只有一個BGP表可儲存U和LU路由，因此字首會顯示為命令「show bgp

ipv4 unicast」和「show bgp ipv4 labeled-unicast」！

```
RP/0/0/CPU0:R4#show bgp ipv4 unicast 10.100.1.1/32
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB  SendTblVer
  Speaker          5         5
  Local Label: 24000
Last Modified: Aug  6 15:03:59.574 for 16:06:13
Paths: (1 available, best #1)
Advertised to update-groups (with more than one peer):
  0.3 0.4
Advertised to peers (in unique update groups):
  10.1.45.5
Path #1: Received by speaker 0
Advertised to update-groups (with more than one peer):
  0.3 0.4
Advertised to peers (in unique update groups):
  10.1.45.5
65002 65001
  10.1.24.2 from 10.1.24.2 (10.100.1.2)
    Received Label 24003
    Origin IGP, localpref 100, valid, external, best, group-best, labeled-unicast
    Received Path ID 0, Local Path ID 0, version 5
    Origin-AS validity: not-found
```

請注意，路徑標有「labeled-unicast」。

```
RP/0/0/CPU0:R4#show bgp ipv4 labeled-unicast 10.100.1.1/32
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB  SendTblVer
  Speaker          5         5
  Local Label: 24000
Last Modified: Aug  6 15:03:59.574 for 16:08:41
Paths: (1 available, best #1)
Advertised to update-groups (with more than one peer):
  0.3 0.4
Advertised to peers (in unique update groups):
  10.1.45.5
Path #1: Received by speaker 0
Advertised to update-groups (with more than one peer):
  0.3 0.4
Advertised to peers (in unique update groups):
  10.1.45.5
65002 65001
  10.1.24.2 from 10.1.24.2 (10.100.1.2)
    Received Label 24003
    Origin IGP, localpref 100, valid, external, best, group-best, labeled-unicast
    Received Path ID 0, Local Path ID 0, version 5
    Origin-AS validity: not-found
```

請注意，路徑標有「labeled-unicast」。

如果路徑同時以U和LU的形式存在，則本地路徑ID會有所不同。

```
RP/0/0/CPU0:R4#show bgp ipv4 labeled-unicast 10.100.1.1/32 detail
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB  SendTblVer
```

```

Speaker                30                30
  Local Label: 24003 (no rewrite);
  Flags: 0x00003028+0x00010000;
Last Modified: Aug 30 10:45:50.502 for 00:01:59
Paths: (2 available, best #1)
Advertised IPv4 Unicast paths to peers (in unique update groups):
  10.100.1.8          10.100.1.9
Advertised IPv4 Labeled-unicast paths to update-groups (with more than one peer):
  0.8
Path #1: Received by speaker 0
Flags: 0x4000000009060205, import: 0x20
Advertised IPv4 Unicast paths to peers (in unique update groups):
  10.100.1.8          10.100.1.9
Advertised IPv4 Labeled-unicast paths to update-groups (with more than one peer):
  0.8
65001, (Received from a RR-client)
  10.100.1.9 (metric 2) from 10.100.1.9 (10.100.1.9)
  Origin IGP, metric 0, localpref 100, valid, internal, best, group-best
  Received Path ID 0, Local Path ID 1, version 29
Path #2: Received by speaker 0
Flags: 0x4080000008020205, import: 0x20
Not advertised to any peer
65001, (Received from a RR-client)
  10.100.1.9 (metric 2) from 10.100.1.9 (10.100.1.9)
  Received Label 24001
  Origin IGP, metric 0, localpref 100, valid, internal, labeled-unicast
  Received Path ID 0, Local Path ID 0, version 0

```

啟用本地標籤分配

您必須配置命令「allocate-label」，以便在BGP中接收的或源路徑具有本地MPLS標籤。如果沒有此命令，路由將沒有本地標籤。

```

RP/0/0/CPU0:R4#conf t
RP/0/0/CPU0:R4(config)#router bgp 65003
RP/0/0/CPU0:R4(config-bgp)# address-family ipv4 unicast
RP/0/0/CPU0:R4(config-bgp-af)#allocate-label ?
all                Allocate labels for all prefixes
route-policy       Use a route policy to select prefixes for label allocation

```

標籤分配針對所有路由或根據配置的路由策略。

IOS-XR上的新實現

在IOS-XR上的舊實現中，當在同一BGP會話上配置U和LU時會出現警告。IOS-XR 5.3.0和5.2.2版引入了警告。IOS-XR 6.2.1版刪除了警告，因為同一BGP會話支援標籤和未標籤。

範例：

```

RP/0/0/CPU0:ios#conf t
RP/0/0/CPU0:ios(config)#router bgp 65001
RP/0/0/CPU0:ios(config-bgp)#add ipv4 unicast
RP/0/0/CPU0:ios(config-bgp-af)#exit
RP/0/0/CPU0:ios(config-bgp)#neighbor 10.0.0.1
RP/0/0/CPU0:ios(config-bgp-nbr)#remote-as 65001
RP/0/0/CPU0:ios(config-bgp-nbr)#exit
RP/0/0/CPU0:ios(config-bgp)#neighbor 10.0.0.1
RP/0/0/CPU0:ios(config-bgp-nbr)#address-family ipv4 unicast

```

```
RP/0/0/CPU0:ios(config-bgp-nbr-af)#exit
RP/0/0/CPU0:ios(config-bgp-nbr)#address-family ipv4 labeled-unicast
RP/0/0/CPU0:ios(config-bgp-nbr-af)#commit
```

```
RP/0/0/CPU0:Aug 21 14:14:22.222 : bgp[1052]: %ROUTING-BGP-4-INCOMPATIBLE_AFI : IPv4 Unicast and IPv4 Labeled-unicast Address families together are not supported under the same neighbor.
```

此錯誤消息的解釋：

此訊息表示使用者已將IPv4單點傳播和IPv4標籤的單點傳播或IPv6單點傳播和IPv6標籤的單點傳播位址系列設定在同一鄰居之下。不支援此特定配置。

建議的操作：配置到路由器的兩個鄰居會話。在第一個鄰居會話下配置單播地址系列，並在第二個鄰居會話下配置標籤單播地址系列。

一對IOS-XR路由器之間的兩個BGP會話的配置示例。為每個BGP會話使用不同的（環回）地址。

```
hostname R1

interface Loopback0
  ipv4 address 10.100.1.1 255.255.255.255
!
interface Loopback1
  ipv4 address 10.100.1.101 255.255.255.255
!
router bgp 65001
  address-family ipv4 unicast
  !
  neighbor 10.100.1.2
  remote-as 65001
  update-source Loopback0
  address-family ipv4 unicast
  !
  !
  neighbor 10.100.1.102
  remote-as 65001
  update-source Loopback1
  address-family ipv4 labeled-unicast
  !
  !
```

```
hostname R2

interface Loopback0
  ipv4 address 10.100.1.2 255.255.255.255
!
interface Loopback1
  ipv4 address 10.100.1.102 255.255.255.255
!
router bgp 65001
  address-family ipv4 unicast
  !
  neighbor 10.100.1.1
  remote-as 65001
  update-source Loopback0
  address-family ipv4 unicast
  !
  !
  neighbor 10.100.1.101
  remote-as 65001
  update-source Loopback1
```

```
address-family ipv4 labeled-unicast
```

```
!
```

在IOS-XR 6.2.1中，在預設VRF上的同一BGP作業階段上支援U和LU!

BGP作業階段是內部還是外部BGP都無關緊要。

任何非預設VRF中的BGP揚聲器都不支援同一會話上的U和LU。

Update-groups

在IOS-XR 6.2.1之前，所有U、LU和U + LU BGP揚聲器都儲存在不同的更新組中。在IOS-XR 6.2.1版之後，情況不再如此。一個更新組中的某些BGP揚聲器只能是U或LU，或者同時是U和LU。

路由傳播

下表顯示了不同方案的通告和撤銷行為。有16種情況。

除非註釋列中另有說明，否則所有選項均適用於IOS-XR 6.2.1版及更高版本。

案例	Bestpath/Add path型別	本地標籤存在？	NHS或NHU	Update-group SAFI	廣告還是撤退？	意見
1	未標籤的路徑，即無rx標籤	是	NHS	SAFI-1	預設通告 退出方式 <i>advertise local-labeled-route(safi-unicast)disable</i> 命令	只能在6.5.1之後進行。
2				SAFI-4	廣告	只能在6.5.1之後進行。 IPv4/v6重新分發路由和6PE:implicit NHS always
3			NHU	SAFI-1	廣告	只能在6.5.1之後進行。
4				SAFI-4	撤消	只能在6.5.1之後進行。 IPv4/v6重新分發路由和6PE:NHU被忽略；implicit NHS always
5		否	NHS	SAFI-1	廣告	
6				SAFI-4	撤消	
7			NHU	SAFI-1	廣告	
8				SAFI-4	撤消	
9	標籤路徑，即帶rx標籤	是	NHS	SAFI-1	預設通告 使用 <i>advertise local-labeled-route(safi-unicast)disable</i> 命令撤消	6.2.1之前：預設行為是Advertise。
10				SAFI-4	廣告	
11			NHU	SAFI-1	撤消	6.2.1之前：行為就是廣告。
12				SAFI-4	廣告	
13		否	NHS	SAFI-1	廣告	
14				SAFI-4	撤消	
15			NHU	SAFI-1	撤消	6.2.1之前：行為就是廣告。

表1 iBGP和eBGP會話的通告行為

NHS =下一跳自己

NHU =下一跳不變。

如果NHU有效，則表示沒有為iBGP會話配置下一跳自身。

請注意，當BGP發言人傳送到eBGP對等體時，NHS總是如此。

對於iBGP揚聲器，可以有NHS或NHU，具體取決於下一跳自身的配置。iBGP對等點的預設行為是NHU。

對於第二列：請注意，僅當最佳路徑或標籤有add-path的路徑之一未標籤或標籤時，才會認為路徑未標籤或標籤。

對於路由傳播，最佳路徑具有哪些特徵非常重要。根據特徵（列2到4），它確定路徑通告為U還是LU，還是同時通告為U。

如果啟用了附加路徑(ADD-PATH)功能，並且路徑標籤為「add-path」，則該路徑的特徵也會對如何通告該路徑產生影響。

"本地標籤存在？：否"表示以下內容：可能收到帶有所接收更新的標籤，但是未安裝該標籤。如果命令「allocate-label」不存在，則不安裝本地標籤。

您可以通過詳細檢視字首來驗證本地標籤是否存在。使用「show bgp <prefix> detail」或「show route <prefix> detail」。

在以下示例中，接收字首時沒有標籤（因此通過SAFI 1對等），並且未分配本地標籤：

```
RP/0/0/CPU0:R2#show bgp ipv4 labeled-unicast 10.100.1.5/32 detail
BGP routing table entry for 10.100.1.5/32
Versions:
  Process          bRIB/RIB   SendTblVer
  Speaker          3          3
  Flags: 0x04001001+0x00000000;
Last Modified: Sep  5 03:44:45.647 for 01:01:27
Paths: (1 available, best #1)
  Advertised to update-groups (with more than one peer):
    0.3
  Path #1: Received by speaker 0
  Flags: 0x4000000001040207, import: 0x00
  Advertised to update-groups (with more than one peer):
    0.3
  Local, (Received from a RR-client)
    10.100.1.1 (metric 2) from 10.100.1.1 (10.100.1.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best, group-best
      Received Path ID 0, Local Path ID 1, version 3

RP/0/0/CPU0:R2#show route 10.100.1.5/32 detail

Routing entry for 10.100.1.5/32
  Known via "bgp 65001", distance 200, metric 0, type internal
  Installed Sep  5 03:44:45.480 for 01:01:37
```

```
Routing Descriptor Blocks
 10.100.1.1, from 10.100.1.1
  Route metric is 0
  Label: None
  Tunnel ID: None
  Extended communities count: 0
  NHID:0x0(Ref:0)
Route version is 0x23 (35)
No local label
IP Precedence: Not Set
QoS Group ID: Not Set
Flow-tag: Not Set
Route Priority: RIB_PRIORITY_RECURSIVE (12) SVD Type RIB_SVD_TYPE_LOCAL
Download Priority 4, Download Version 52
No advertising protos.
```

分配本地標籤

為未標籤的路徑分配標籤

預設情況下，即使設定了「allocate-label」指令，也不會對未標籤的路徑(SAFI 1)進行標籤。

自IOS-XR 6.5.1版起，"allocate-label"命令的關鍵字"unlabeled-path"便可為未標籤的路徑分配標籤。

```
RP/0/0/CPU0:R4#conf t
RP/0/0/CPU0:R4(config)#router bgp 65003
RP/0/0/CPU0:R4(config-bgp)# address-family ipv4 unicast
RP/0/0/CPU0:R4(config-bgp-af)#allocate-label all ?
 unlabeled-path Allocate label for unlabeled paths too
 <cr>
RP/0/0/CPU0:R4(config-bgp-af)#allocate-label all unlabeled-path ?
 <cr>
RP/0/0/CPU0:R4(config-bgp-af)#allocate-label all unlabeled-path
RP/0/0/CPU0:R4(config-bgp-af)#commit
```

該路徑是SAFI 1路徑，因此沒有收到任何標籤。

由於「unlabeled-path」命令，現在有一個本地標籤。

```
RP/0/0/CPU0:R4#show bgp ipv4 labeled-unicast 10.100.1.1/32 detail
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB   SendTblVer
  Speaker          16         16
  Local Label: 24003 (no rewrite);
  Flags: 0x01303028+0x00000000;
Last Modified: Aug 27 19:08:47.502 for 00:00:59
Paths: (1 available, best #1)
  Advertised IPv4 Unicast paths to update-groups (with more than one peer):
    0.3
  Advertised IPv4 Labeled-unicast paths to update-groups (with more than one peer):
    0.7
  Advertised IPv4 Labeled-unicast paths to peers (in unique update groups):
    10.1.45.5
  Path #1: Received by speaker 0
  Flags: 0x4000000009040207, import: 0x20
  Advertised IPv4 Unicast paths to update-groups (with more than one peer):
    0.3
```

```
Advertised IPv4 Labeled-unicast paths to update-groups (with more than one peer):
0.7
Advertised IPv4 Labeled-unicast paths to peers (in unique update groups):
10.1.45.5
65001, (Received from a RR-client)
10.100.1.10 (metric 2) from 10.100.1.10 (10.100.1.10)
Origin IGP, metric 0, localpref 100, valid, internal, best, group-best
Received Path ID 0, Local Path ID 1, version 16
```

```
RP/0/0/CPU0:R4#show route 10.100.1.1/32 detail
```

```
Routing entry for 10.100.1.1/32
Known via "bgp 65003", distance 200, metric 0
...
Route version is 0x4 (4)
Local Label: 0x5dc3 (24003)
IP Precedence: Not Set
...
```

這將允許表1中的案例1至4。

要瞭解刪除「allocate-label」命令時為什麼仍分配本地標籤，請運行debug "debug bgp label"。

以下是範例：

```
RP/0/0/CPU0:R4#debug bgp label
```

```
RP/0/0/CPU0:R4#show debug
```

```
#### debug flags set from tty 'con0_0_CPU0' ####
ip-bgp default label flag is ON with value '#####'
```

最好為特定字首或字首組啟用此調試。以下是範例：

```
RP/0/0/CPU0:R4#sh running-config route-policy match-prefix
route-policy match-prefix
if destination in (10.100.1.1/32) then
  pass
else
  drop
endif
end-policy
!
```

```
RP/0/0/CPU0:R4#debug bgp label route-policy match-prefix
```

```
RP/0/0/CPU0:R4#show debug
```

```
#### debug flags set from tty 'con0_0_CPU0' ####

ip-bgp default label flag is ON with value '#####match-prefix####'
```

```
RP/0/0/CPU0:R4#con t
RP/0/0/CPU0:R4(config)#router bgp 65003
RP/0/0/CPU0:R4(config-bgp)# address-family ipv4 unicast
RP/0/0/CPU0:R4(config-bgp-af)#no allocate-label all
RP/0/0/CPU0:R4(config-bgp-af)#commit
```

```
RP/0/0/CPU0:Aug 23 12:43:02.786 : bgp[1048]: [default-lbl] (ip4u): Label computation done:
table=TBL:default (1/1), net=10.100.1.1/32: netfl=0x05043001,
path=0x1073ed5c(10.1.24.2/32,10.1.24.2,0,0x40000000d060001), pathrcvdlab=24002: asbr=1,
```

```
rr=0/1, nhselfcount=1: result="label required"
```

您可以看到此路由器已收到字首10.100.1.1/32的標籤，是ASBR，不是RR，並且具有至少一個BGP會話的下一跳自身。這會導致該字首需要本地標籤。

本地標籤保持不變：

```
RP/0/0/CPU0:R4#show bgp ipv4 unicast 10.100.1.1/32 detail
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB   SendTblVer
  Speaker          13         13
  Local Label: 16002 (no rewrite);
  Flags: 0x05043001+0x00000200;
Last Modified: Aug 23 12:37:11.133 for 00:05:53
Paths: (1 available, best #1)
  Advertised to update-groups (with more than one peer):
    0.6
  Advertised to peers (in unique update groups):
    10.1.46.6      10.100.1.8     10.100.1.7
  Path #1: Received by speaker 0
  Flags: 0x40000000d060001, import: 0x1f
  Advertised to update-groups (with more than one peer):
    0.6
  Advertised to peers (in unique update groups):
    10.1.46.6      10.100.1.8     10.100.1.7
65002 65001
  10.1.24.2 from 10.1.24.2 (10.100.1.2)
    Received Label 24002
    Origin IGP, localpref 100, valid, external, best, group-best, import-candidate
    Received Path ID 0, Local Path ID 1, version 13
    Origin-AS validity: not-found
```

```
RP/0/0/CPU0:R4#show route 10.100.1.1/32 detail
Routing entry for 10.100.1.1/32
  Known via "bgp 65003", distance 20, metric 0, [ei]-bgp, labeled unicast (3107)
  Tag 65002, type external
  Installed Aug 23 12:37:11.440 for 00:06:02
  Routing Descriptor Blocks
    10.1.24.2, from 10.1.24.2, BGP external
      Route metric is 0
      Label: 0x5dc2 (24002)
      Tunnel ID: None
      Extended communities count: 0
      NHID:0x0(Ref:0)
  Route version is 0x4 (4)
Local Label: 0x3e82 (16002)
  IP Precedence: Not Set
  QoS Group ID: Not Set
  Route Priority: RIB_PRIORITY_NON_RECURSIVE_LOW (11) SVD Type RIB_SVD_TYPE_LOCAL
  Download Priority 4, Download Version 28
  No advertising protos.
```

當不需要本地標籤時，調試將顯示以下消息：

```
RP/0/0/CPU0:Aug 23 13:01:15.801 : bgp[1048]: [default-lbl]: Prefix 10.100.1.1/32:() doesn't
require label, releasing
```

```
RP/0/0/CPU0:Aug 23 13:01:15.801 : bgp[1048]: [default-lbl]: bgp_label_release_label: perform
label release onnet 10.100.1.1/32net retain 0 label_retain 0
```

如果字首位於LFIB中，則取決於是否收到帶有標籤的字首，以及allocate-label是否應用於該字首。

接收的標籤用24002以下字首進行標籤。它未安裝在LFIB中，因為BGP沒有allocate-label命令。

```
RP/0/0/CPU0:R4#show bgp ipv4 unicast 10.100.1.1/32
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB  SendTblVer
  Speaker          4         4
  Local Label: 24002
Last Modified: Aug  8 13:52:57.276 for 00:00:36
Paths: (1 available, best #1)
Advertised to update-groups (with more than one peer):
  0.6
Advertised to peers (in unique update groups):
  10.100.1.7
Path #1: Received by speaker 0
Advertised to update-groups (with more than one peer):
  0.6
Advertised to peers (in unique update groups):
  10.100.1.7
65002 65001
10.1.24.2 from 10.1.24.2 (10.100.1.2)
Received Label 24002
Origin IGP, localpref 100, valid, external, best, group-best, labeled-unicast
Received Path ID 0, Local Path ID 0, version 4
Origin-AS validity: not-found
```

```
router bgp 65003
  bgp unsafe-ebgp-policy
  address-family ipv4 unicast
  !
```

```
RP/0/0/CPU0:R4# show mpls forwarding
```

Local Label	Outgoing Label	Prefix or ID	Outgoing Interface	Next Hop	Bytes Switched
24000	Aggregate	10.1.24.0/24	default		0
24001	Aggregate	10.1.45.0/24	default		0

如果存在allocate-label命令，則本地標籤存在於LFIB中：

```
router bgp 65003
  bgp unsafe-ebgp-policy
  address-family ipv4 unicast
  allocate-label all
  !
```

```
RP/0/0/CPU0:R4#show mpls forwarding
```

Local Label	Outgoing Label	Prefix or ID	Outgoing Interface	Next Hop	Bytes Switched
24000	Aggregate	10.1.24.0/24	default		0
24001	Aggregate	10.1.45.0/24	default		0
24002	24002	10.100.1.1/32		10.1.24.2	0

即使BGP字首是通過LU會話接收的，但未分配本地標籤，如果完成NHS，則不會通過其他LU會話通告路由。這是表1中的案例14。如果傳出BGP會話是eBGP，則會發生這種情況。

範例：

```
RP/0/0/CPU0:R2#show bgp ipv4 unicast 10.100.1.1/32 detail
```

```
BGP routing table entry for 10.100.1.1/32
```

```
Versions:
```

```
Process          bRIB/RIB  SendTblVer
Speaker          3         3
```

```
Flags: 0x00001001+0x00000000;
```

```
Last Modified: Aug 22 09:00:20.646 for 00:10:56
```

```
Paths: (1 available, best #1)
```

```
Not advertised to any peer
```

```
Path #1: Received by speaker 0
```

```
Flags: 0x4080000001060001, import: 0x20
```

```
Not advertised to any peer
```

```
65001
```

```
10.1.12.1 from 10.1.12.1 (10.100.1.1)
```

```
Received Label 3
```

```
Origin IGP, metric 0, localpref 100, valid, external, best, group-best, labeled-unicast
```

```
Received Path ID 0, Local Path ID 0, version 3
```

```
Origin-AS validity: not-found
```

```
RP/0/0/CPU0:R2#show route 10.100.1.1/32 detail
```

```
Routing entry for 10.100.1.1/32
```

```
Known via "bgp 65002", distance 20, metric 0, labeled unicast (3107)
```

```
Tag 65001, type external
```

```
Installed Aug 22 09:00:20.416 for 00:10:59
```

```
Routing Descriptor Blocks
```

```
10.1.12.1, from 10.1.12.1, BGP external
```

```
Route metric is 0
```

```
Label: 0x100004 (1048580)
```

```
Tunnel ID: None
```

```
Binding Label: None
```

```
Extended communities count: 0
```

```
NHID:0x0(Ref:0)
```

```
Route version is 0x1 (1)
```

```
No local label
```

```
IP Precedence: Not Set
```

```
...
```

這可能是因為路由器BGP下沒有地址系列單播的命令「allocate-label」。

刪除「allocate-label」命令時，您需要重新啟動進程BGP，以便路由器刪除BGP路由的本地標籤。

表1中的新advertise local-labeled-route命令是一個新命令，它指示帶有本地標籤的路由不應通過SAFI-1通告為未標籤的路由。

此命令如下：

通告local-labeled-route [disable]

此命令在neighbor address-family下配置。此命令的作用是指示是否應該通過IPv4/v6單播(SAFI 1)將具有本地標籤的IPv4/v6路由通告給BGP鄰居。

預設行為是使用本地標籤通告路由。

新命令還可配置為：

通告local-labeled-route safi-unicast [disable]

此命令在BGP部分的af-group下配置。其功能與上述功能相同，適用於所有BGP鄰居。

預設行為是使用本地標籤通告路由。

地址系列IPv4 Unicast下的命令「show bgp neighbor」上存在行「Advertise routes with local-label via Unicast SAFI」或「Do not advertise routes with local-label via Unicast SAFI」，指示BGP揚聲器允許通告帶有或不帶有本地標籤的路由。

預設行為示例：

```
RP/0/0/CPU0:R4#show bgp neighbor 10.1.45.5
...
For Address Family: IPv4 Unicast
  BGP neighbor version 5
  Update group: 0.1 Filter-group: 0.5 No Refresh request being processed
    Extended Nexthop Encoding: advertised and received
  Route refresh request: received 0, sent 0
  0 accepted prefixes, 0 are bestpaths
  Exact no. of prefixes denied : 0.
  Cumulative no. of prefixes denied: 0.
  Prefix advertised 2, suppressed 0, withdrawn 0
  Maximum prefixes allowed 1048576
  Threshold for warning message 75%, restart interval 0 min
  An EoR was not received during read-only mode
  Last ack version 5, Last synced ack version 0
  Outstanding version objects: current 0, max 1, refresh 0
  Additional-paths operation: None
  Advertise routes with local-label via Unicast SAFI
```

或

```
RP/0/0/CPU0:R4# conf t
RP/0/0/CPU0:R4(config)#router bgp 65003
RP/0/0/CPU0:R4(config-bgp)# neighbor 10.1.45.5
RP/0/0/CPU0:R4(config-bgp-nbr)# address-family ipv4 unicast
RP/0/0/CPU0:R4(config-bgp-nbr-af)#advertise local-labeled-route disable
RP/0/0/CPU0:R4(config-bgp-nbr-af)#commit
```

```
RP/0/0/CPU0:R4#show bgp neighbor 10.1.45.5

BGP neighbor is 10.1.45.5
...
For Address Family: IPv4 Unicast
  BGP neighbor version 5
  Update group: 0.1 Filter-group: 0.5 (Update-group Change
  pending)
  No Refresh request being processed
    Extended Nexthop Encoding: advertised and received
  Route refresh request: received 0, sent 0
  0 accepted prefixes, 0 are bestpaths
  Exact no. of prefixes denied : 0.
  Cumulative no. of prefixes denied: 0.
  Prefix advertised 2, suppressed 0, withdrawn 0
  Maximum prefixes allowed 1048576
  Threshold for warning message 75%, restart interval 0 min
  An EoR was not received during read-only mode
  Last ack version 5, Last synced ack version 0
  Outstanding version objects: current 0, max 1, refresh 0
  Additional-paths operation: None
  Do not advertise routes with local-label via Unicast SAFI
```

最佳路徑計算

最佳路徑計算流程沒有變化。如果路徑是SAFI 1或SAFI 4，或者路徑是否有標籤，則最佳路徑計算流程不會有任何不同。因此，SAFI 1或SAFI 4路徑之間沒有優先順序。無論同一BGP作業階段或不同作業階段上是否存在SAFI 1/SAFI 4，都會發生這種情況。因此，如果一個BGP作業階段是SAFI 1和4，且兩個位址系列上都收到首碼，則最佳路徑計算會選取一個作為最佳路徑，因為所有屬性都相同。如果U路徑和LU路徑之間的所有BGP屬性相同，則最後接收的路徑將成為最佳路徑。

如果從不同的BGP對等點收到SAFI 1和SAFI 4路徑，則通向BGP的路徑總是會有所不同，從兩個路徑中選取相同的最佳路徑。即使在這種情況下，所有屬性都相同，鄰居地址也會不同。檢視[BGP最佳路徑選取演算法](#)，會選取來自具有最低鄰居位址的鄰居的路徑（最後步驟13）作為最佳路徑。

使用命令「show bgp <AFI> <SAFI> <prefix> bestpath-compare」驗證最佳路徑最佳的原因。

此首選項可由使用者使用RPL建立。

下面是這樣的RPL示例。

```
RP/0/0/CPU0:R7#show bgp ipv4 un 10.100.1.1/32 detail
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB   SendTblVer
  Speaker          682       682
  Flags: 0x00003001+0x00010000;
Last Modified: Aug 28 13:16:26.826 for 00:00:10
Paths: (2 available, best #2)
  Not advertised to any peer
  Path #1: Received by speaker 0
  Flags: 0x4000000000020005, import: 0x20
  Not advertised to any peer
  65001
    10.100.1.4 (metric 2) from 10.100.1.4 (10.100.1.10)
      Origin IGP, metric 0, localpref 100, valid, internal
      Received Path ID 1, Local Path ID 0, version 0
      Originator: 10.100.1.10, Cluster list: 10.100.1.4
  Path #2: Received by speaker 0
  Flags: 0x4080000001060005, import: 0x20
  Not advertised to any peer
  65001
    10.100.1.4 (metric 2) from 10.100.1.4 (10.100.1.10)
      Received Label 24003
      Origin IGP, metric 0, localpref 100, valid, internal, best, group-best, labeled-unicast
      Received Path ID 1, Local Path ID 0, version 682
      Originator: 10.100.1.10, Cluster list: 10.100.1.4
```

LU路徑是最佳路徑。

帶權重的RPL用於優先使用U路徑。

```
route-policy weight
  if destination in (10.100.1.1/32) then
    set weight 60000
  endif
end-policy
```

```
router bgp 65003
  address-family ipv4 unicast
```



```

additional-paths receive
additional-paths send
!
neighbor 10.100.1.4
remote-as 65003
update-source Loopback0
address-family ipv4 unicast
    route-policy weight in
!
address-family ipv4 labeled-unicast
!
!

```

```
RP/0/0/CPU0:R7#show bgp ipv4 un 10.100.1.1/32 bestpath-compare
```

```
BGP routing table entry for 10.100.1.1/32
```

```
Versions:
```

```

Process          bRIB/RIB   SendTblVer
Speaker          726        726

```

```
Last Modified: Aug 28 13:39:27.826 for 00:04:54
```

```
Paths: (2 available, best #1)
```

```
Not advertised to any peer
```

```
Path #1: Received by speaker 0
```

```
Not advertised to any peer
```

```
65001
```

```
10.100.1.4 (metric 2) from 10.100.1.4 (10.100.1.10)
```

```
Origin IGP, metric 0, localpref 100, weight 60000, valid, internal, best, group-best
```

```
Received Path ID 1, Local Path ID 0, version 726
```

```
Originator: 10.100.1.10, Cluster list: 10.100.1.4
```

```
best of AS 65001, Overall best
```

```
Path #2: Received by speaker 0
```

```
Not advertised to any peer
```

```
65001
```

```
10.100.1.4 (metric 2) from 10.100.1.4 (10.100.1.10)
```

```
Received Label 24003
```

```
Origin IGP, metric 0, localpref 100, valid, internal, labeled-unicast
```

```
Received Path ID 1, Local Path ID 0, version 0
```

```
Originator: 10.100.1.10, Cluster list: 10.100.1.4
```

```
Lower weight than best path (path #1)
```

現在U路徑是最好的。

沒有新命令可優先使用標籤路徑而非未標籤路徑。您只需在BGP鄰居的address-family unicast或labeled-unicast下配置RPL。

檢驗BGP中的行為

要在IOS-XR中調試BGP更新傳播，可以開啟以下debug命令：`debug bgp update <BGP neighbor> in` 退出。

這將顯示來自或發往該BGP發言者的傳入或傳出BGP更新。對於未標籤的IPv4非廣播(AFI 1/SAFI 1)，位址系列顯示為(ip4u)，對於標籤的IPv4單點傳播(AFI 1/SAFI 4)，顯示為(ipv4lu)。對於IPv6，會出現相同的情況。

有一個新欄位「labeled-unicast」，表示路徑是透過SAFI 4得知的。

範例：

```
RP/0/0/CPU0:R1#show bgp ipv4 unicast 10.100.1.7/32
```

BGP routing table entry for 10.100.1.7/32

Versions:

```
Process          bRIB/RIB  SendTblVer
Speaker          26        26
```

Last Modified: Sep 4 10:45:44.551 for 00:29:11

Paths: (1 available, best #1)

Not advertised to any peer

Path #1: Received by speaker 0

Not advertised to any peer

Local

10.100.1.4 (metric 3) from 10.100.1.102 (10.100.1.4)

Received Label 24000

Origin incomplete, metric 0, localpref 100, valid, internal, best, group-best, **labeled-**

unicast

Received Path ID 0, Local Path ID 1, version 26

Originator: 10.100.1.4, Cluster list: 10.100.1.2

若要驗證是否已通告字首，可以在結尾使用關鍵字「advertised-routes」的「show bgp ... neighbors」命令。

範例：

R4兩次向鄰居10.100.1.7通告10.100.1.1/32，因為已啟用新增路徑（兩個路徑不同）。

```
RP/0/0/CPU0:R4#show bgp ipv4 labeled-unicast neighbors 10.100.1.7 advertised-routes
```

Network	Next Hop	From	AS Path
10.1.24.0/24	10.100.1.4	Local	?
10.1.34.0/24	10.100.1.4	Local	?
10.1.45.0/24	10.100.1.4	Local	?
10.1.46.0/24	10.100.1.4	Local	?
10.1.47.0/24	10.100.1.4	Local	?
10.1.48.0/24	10.100.1.4	Local	?
10.1.49.0/24	10.100.1.4	Local	?
10.1.104.0/24	10.100.1.4	Local	?
10.1.114.0/24	10.100.1.4	Local	?
10.100.1.1/32	10.100.1.4	10.100.1.9	65001i
		10.100.1.10	65001i
10.100.1.4/32	10.100.1.4	Local	?

Processed 11 prefixes, 12 paths

iBGP和下一躍點自我 — 整合MPLS

表1中的規則適用。使用統一MPLS或無縫MPLS，區域邊界路由器(ABR)充當路由反射器，但也是iBGP路由的下一跳。ABR位於標籤流量的轉發路徑中。ABR必須具有下一跳自身的顯式配置。

因應措施

- 如果一個BGP會話不支援U和LU，則解決方法是在一對路由器之間具有兩個BGP會話。每台路由器上必須使用兩個（環回）介面。

IOS-XR的配置示例。

```
interface Loopback0
  ipv4 address 10.100.1.7 255.255.255.255
!
```

```

interface Loopback1
  ipv4 address 10.100.1.107 255.255.255.255
!
router bgp 65003
  address-family ipv4 unicast
!
  neighbor 10.100.1.4  -> towards loopback0 on peer
  remote-as 65003
  update-source Loopback0
  address-family ipv4 unicast
!
!
  neighbor 10.100.1.104  -> towards loopback1 on peer
  remote-as 65003
  update-source Loopback1
  address-family ipv4 labeled-unicast
!

```

U和LU路徑通過兩個不同的BGP會話傳送/接收。

```

RP/0/0/CPU0:R7#show bgp ipv4 unicast 10.100.1.1/32 detail
BGP routing table entry for 10.100.1.1/32
Versions:
  Process          bRIB/RIB  SendTblVer
  Speaker          753      753
  Flags: 0x00001001+0x00010000;
Last Modified: Aug 28 14:06:40.826 for 00:22:10
Paths: (2 available, best #1)
  Not advertised to any peer
  Path #1: Received by speaker 0
  Flags: 0x4000000001060005, import: 0x20
  Not advertised to any peer
  65001
    10.100.1.4 (metric 2) from 10.100.1.4 (10.100.1.10)
      Origin IGP, metric 0, localpref 100, valid, internal, best, group-best
      Received Path ID 1, Local Path ID 0, version 753
      Originator: 10.100.1.10, Cluster list: 10.100.1.4
  Path #2: Received by speaker 0
  Flags: 0x4080000000020005, import: 0x20
  Not advertised to any peer
  65001
    10.100.1.104 (metric 2) from 10.100.1.104 (10.100.1.10)
      Received Label 24003
      Origin IGP, metric 0, localpref 100, valid, internal, labeled-unicast
      Received Path ID 1, Local Path ID 0, version 0
      Originator: 10.100.1.10, Cluster list: 10.100.1.4

```