



Configuring IP Multicast over Unidirectional Links

IP multicast requires bidirectional communication, yet some networks include broadcast satellite links, which are unidirectional. Unidirectional link routing (UDLR) provides three mechanisms for a router to emulate a bidirectional link to enable the routing of unicast and multicast packets over a physical unidirectional interface, such as a broadcast satellite link. The mechanisms are a UDLR tunnel, Internet Group Management Protocol (IGMP) UDLR, and IGMP proxy. This document describes a UDLR tunnel and IGMP UDLR. IGMP proxy is described in the “Customizing IGMP” module. The three mechanisms may be used independently or in combination.

- [Prerequisites for UDLR, on page 1](#)
- [Information About UDLR, on page 1](#)
- [How to Route IP Multicast over Unidirectional Links, on page 3](#)
- [Configuration Examples for UDLR, on page 8](#)
- [Additional References, on page 13](#)
- [Feature Information for Configuring IP Multicast over Unidirectional Links, on page 14](#)

Prerequisites for UDLR

- You understand the concepts in the “IP Multicast Technology Overview” module.
- You have IP multicast configured in your network. Refer to the “Configuring Basic IP Multicast” module.

Information About UDLR

UDLR Overview

Both unicast and multicast routing protocols forward data on interfaces from which they have received routing control information. This model requires a bidirectional link. However, some network links are unidirectional. For networks that are unidirectional (such as broadcast satellite links), a method of communication that allows for control information to operate in a unidirectional environment is necessary. (Note that IGMP is not a routing protocol.)

Specifically, in unicast routing, when a router receives an update message on an interface for a prefix, it forwards data for destinations that match that prefix out that same interface. This is the case in distance vector routing protocols. Similarly, in multicast routing, when a router receives a Join message for a multicast group on an interface, it forwards copies of data destined for that group out that same interface. Based on these principles, unicast and multicast routing protocols cannot be supported over UDLs without the use of UDLR. UDLR is designed to enable the operation of routing protocols over UDLs without changing the routing protocols themselves.

UDLR enables a router to emulate the behavior of a bidirectional link for IP operations over UDLs. UDLR has three complementary mechanisms for bidirectional link emulation, which are described in the following sections:

- UDLR Tunnel--A mechanism for routing unicast and multicast traffic.
- Internet Group Management Protocol (IGMP) UDLR--Mechanism for routing multicast traffic. This method scales well for many broadcast satellite links.
- IGMP Proxy--Mechanism for routing multicast traffic.

You can use each mechanism independently or in conjunction with the others. IGMP proxy is described in the “Customizing IGMP” module.

UDLR Tunnel

The UDLR tunnel mechanism enables IP and its associated unicast and multicast routing protocols to treat the unidirectional link (UDL) as being logically bidirectional. A packet that is destined on a receive-only interface is picked up by the UDLR tunnel mechanism and sent to an upstream router using a generic routing encapsulation (GRE) tunnel. The control traffic flows in the opposite direction of the user data flow. When the upstream router receives this packet, the UDLR tunnel mechanism makes it appear that the packet was received on a send-only interface on the UDL.

The purpose of the unidirectional GRE tunnel is to move control packets from a downstream node to an upstream node. The one-way tunnel is mapped to a one-way interface (that goes in the opposite direction). Mapping is performed at the link layer, so the one-way interface appears bidirectional. When the upstream node receives packets over the tunnel, it must make the upper-layer protocols act as if the packets were received on the send-capable UDL.

A UDLR tunnel supports the following functionality:

- Address Resolution Protocol (ARP) and Next Hop Resolution Protocol (NHRP) over a UDL
- Emulation of bidirectional links for all IP traffic (as opposed to only control-only broadcast/multicast traffic)
- Support for IP GRE multipoint at a receive-only tunnel



Note A UDL router can have many routing peers (for example, routers interconnected via a broadcast satellite link). As with bidirectional links, the number of peer routers a router has must be kept relatively small to limit the volume of routing updates that must be processed. For multicast operation, we recommend using the IGMP UDLR mechanism when interconnecting more than 20 routers.

IGMP UDLR

In addition to a UDLR tunnel, another mechanism that enables support of multicast routing protocols over UDLs is using IP multicast routing with IGMP, which accommodates UDLR. This mechanism scales well for many broadcast satellite links.

With IGMP UDLR, an upstream router sends periodic queries for members on the UDL. The queries include a unicast address of the router that is not the unicast address of the unidirectional interface. The downstream routers forward IGMP reports received from directly connected members (on interfaces configured to help forward IGMP reports) to the upstream router. The upstream router adds the unidirectional interface to the (*, G) outgoing interface list, thereby enabling multicast packets to be forwarded down the UDL.

In a large enterprise network, it is not possible to be able to receive IP multicast traffic via satellite and forward the traffic throughout the network. This limitation exists because receiving hosts must be directly connected to the downstream router. However, you can use the IGMP proxy mechanism to overcome this limitation. Refer to the “Customizing IGMP” module for more information on this mechanism.

How to Route IP Multicast over Unidirectional Links

This section includes the following procedures. You can do either or both in your network.

Configuring a UDLR Tunnel

To configure a UDLR tunnel, perform the task in this section. The tunnel mode defaults to GRE. You need not assign an IP address to the tunnel (you need not use the **ip address** or **ip unnumbered** commands). You must configure the tunnel endpoint addresses.

You must configure both the upstream and downstream routers to meet the following conditions:

- On the upstream router, where the UDL can only send, you must configure the tunnel to receive. When packets are received over the tunnel, the upper-layer protocols treat the packet as though it is received over the unidirectional, send-only interface.
- On the downstream router, where the UDL can only receive, you must configure the tunnel to send. When packets are sent by upper-layer protocols over the interface, they will be redirected and sent over this GRE tunnel.

Before you begin

Before configuring UDLR tunnel, ensure that all routers on the UDL have the same subnet address. If all routers on the UDL cannot have the same subnet address, the upstream router must be configured with secondary addresses to match all the subnets that the downstream routers are attached to.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **interface tunnel** *number*
5. **tunnel udlr receive-only** *type number*
6. **tunnel source** {ip-address | *type number*}

7. **tunnel destination** {hostname| ip-address}
8. Move to the downstream router.
9. **enable**
10. **configure terminal**
11. **interface** *type number*
12. **interface tunnel** *number*
13. **tunnel udlr send-only** *type number*
14. **tunnel source** {ip-address | *type number*}
15. **tunnel destination** {hostname| ip-address}
16. **tunnel udlr address-resolution**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. • Do this step on the upstream router.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	interface <i>type number</i> Example: <pre>Router(config)# interface gigabitethernet 0/0/0</pre>	Configures the unidirectional send-only interface.
Step 4	interface tunnel <i>number</i> Example: <pre>Router(config-if)# interface tunnel 0</pre>	Configures the receive-only tunnel interface.
Step 5	tunnel udlr receive-only <i>type number</i> Example: <pre>Router(config-if)# tunnel udlr receive-only fastethernet 0/0/0</pre>	Configures the UDLR tunnel. <ul style="list-style-type: none"> • Use the same <i>type</i> and <i>number</i> values as the unidirectional send-only interface <i>type</i> and <i>number</i> values specified with the interface <i>type number</i> command in Step 3.
Step 6	tunnel source {ip-address <i>type number</i> } Example: <pre>Router(config-if)# tunnel source 10.3.4.5</pre>	Configures the tunnel source.
Step 7	tunnel destination {hostname ip-address} Example:	Configures the tunnel destination.

	Command or Action	Purpose
	<code>Router(config-if)# tunnel destination 10.8.2.3</code>	
Step 8	Move to the downstream router.	--
Step 9	enable Example: <code>Router> enable</code>	Enables privileged EXEC mode. • Enter your password if prompted.
Step 10	configure terminal Example: <code>Router# configure terminal</code>	Enters global configuration mode.
Step 11	interface <i>type number</i> Example: <code>Router(config)# interface gigabitethernet 0/0/0</code>	Configures the unidirectional receive-only interface.
Step 12	interface tunnel <i>number</i> Example: <code>Router(config-if)# interface tunnel 0</code>	Configures the send-only tunnel interface.
Step 13	tunnel udldr send-only <i>type number</i> Example: <code>Router(config-if)# tunnel udldr send-only ethernet 0</code>	Configures the UDLR tunnel. • Use the same <i>type</i> and <i>number</i> values as the unidirectional receive-only interface <i>type</i> and <i>number</i> values specified with the interface <i>type number</i> command in Step 3.
Step 14	tunnel source {ip-address <i>type number</i> } Example: <code>Router(config-if)# tunnel source 11.8.2.3</code>	Configures the tunnel source.
Step 15	tunnel destination { <i>hostname</i> ip-address} Example: <code>Router(config-if)# tunnel destination 10.3.4.5</code>	Configures the tunnel destination.
Step 16	tunnel udldr address-resolution Example: <code>Router(config-if)# tunnel udldr address-resolution</code>	Enables the forwarding of ARP and NHRP.

Configuring IGMP UDLR

To configure an IGMP UDL, you must configure both the upstream and downstream routers. You need not specify whether the direction is sending or receiving; IGMP learns the direction by the nature of the physical connection.

When the downstream router receives an IGMP report from a host, the router sends the report to the IGMP querier associated with the UDL interface identified in the **ip igmp helper-address** command.

Before you begin

- All routers on the UDL have the same subnet address. If all routers on the UDL cannot have the same subnet address, the upstream router must be configured with secondary addresses to match all the subnets that the downstream routers are attached to.
- Multicast receivers are directly connected to the downstream routers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip igmp unidirectional-link**
5. Move to the downstream router.
6. **enable**
7. **configure terminal**
8. **ip multicast default-rpf-distance** *distance*
9. **interface** *type number*
10. **ip igmp unidirectional-link**
11. **ip igmp helper-address udl** *type number*
12. **exit**
13. **show ip igmp udldr** [*group-name* | *group-address* | *type number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. • Begin on the upstream router.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface <i>type number</i> Example:	Configures the interface.

	Command or Action	Purpose
	<pre>Router(config)# interface gigabitethernet 0/1/1</pre>	
Step 4	ip igmp unidirectional-link Example: <pre>Router(config-if)# ip igmp unidirectional-link</pre>	Configures IGMP on the interface to be unidirectional.
Step 5	Move to the downstream router.	--
Step 6	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. • Begin on the upstream router.
Step 7	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 8	ip multicast default-rpf-distance <i>distance</i> Example: <pre>Router# ip multicast default-rpf-distance 10</pre>	(Optional) Sets the distance for the default RPF interface. By default, the distance for the default reverse path forwarding (RPF) interface is 15. Any explicit sources learned by routing protocols will take preference if their distance is less than the distance configured by the ip multicast default-rpf-distance command. Use this command on downstream routers if you want some sources to use RPF to reach the UDLR link and others to use the terrestrial paths. <ul style="list-style-type: none"> • If you want IGMP to prefer the UDL, set the distance to be less than the distances of the unicast routing protocols. • If you want IGMP to prefer the non-UDL, set the distance to be greater than the distances of the unicast routing protocols.
Step 9	interface <i>type number</i> Example: <pre>Router(config)# interface gigabitethernet 0/0/0</pre>	Configures the interface.
Step 10	ip igmp unidirectional-link Example: <pre>Router(config-if)# ip igmp unidirectional-link</pre>	Configures IGMP on the interface to be unidirectional.
Step 11	ip igmp helper-address udl <i>type number</i>	Configures the interface to be an IGMP helper.

	Command or Action	Purpose
	Example: <pre>Router(config-if)# ip igmp helper-address udl ethernet 0</pre>	<ul style="list-style-type: none"> Use this command on every downstream router, on every interface to specify the <i>type</i> and <i>number</i> values that identify the UDL interface.
Step 12	exit Example: <pre>Router(config-if)# exit</pre>	Exits configuration mode and returns to EXEC mode.
Step 13	show ip igmp udlr [<i>group-name</i> <i>group-address</i> <i>type number</i>] Example: <pre>Router(config)# show ip igmp udlr</pre>	(Optional) Displays UDLR information for directly connected multicast groups on interfaces that have a UDL helper address configured.

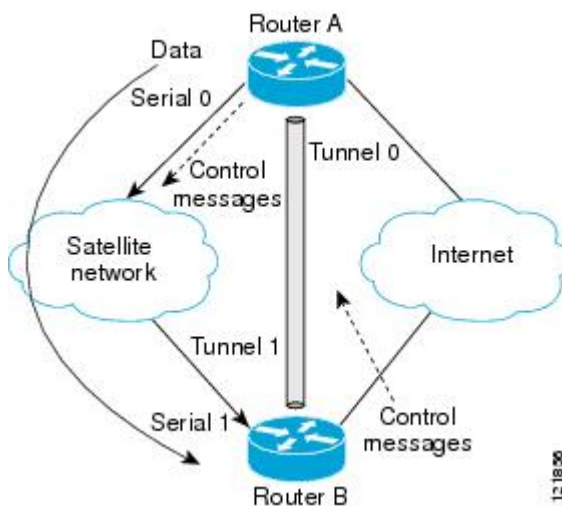
Configuration Examples for UDLR

UDLR Tunnel Example

The following example shows how to configure a UDLR tunnel. In the example, Router A (the upstream router) is configured with Open Shortest Path First (OSPF) and PIM. Serial interface 0 has send-only capability. Therefore, the UDLR tunnel is configured as receive only, and points to serial 0.

Router B (the downstream router) is configured with OSPF and PIM. Serial interface 1 has receive-only capability. Therefore, the UDLR tunnel is configured as send-only, and points to serial 1. The forwarding of ARP and NHRP is enabled. The figure below illustrates the example.

Figure 1: UDLR Tunnel Example



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Router A Configuration

```
ip multicast-routing
!
! Serial0/0/0 has send-only capability
!
interface serial 0/0/0
 encapsulation hdlc
 ip address 10.1.0.1 255.255.0.0
 ip pim sparse-dense-mode
!
! Configure tunnel as receive-only UDLR tunnel.
!
interface tunnel 0
 tunnel source 10.20.0.1
 tunnel destination 10.41.0.2
 tunnel udlr receive-only serial 0/0/0
!
! Configure OSPF.
!
router ospf
 network 10.0.0.0 0.255.255.255 area 0
```

Router B Configuration

```
ip multicast-routing
!
! Serial1 has receive-only capability
!
interface serial 1/0/0
 encapsulation hdlc
 ip address 10.1.0.2 255.255.0.0
 ip pim sparse-dense-mode
!
! Configure tunnel as send-only UDLR tunnel.
!
interface tunnel 0
 tunnel source 10.41.0.2
 tunnel destination 10.20.0.1
 tunnel udlr send-only serial 1/0/0
 tunnel udlr address-resolution
!
! Configure OSPF.
!
router ospf
 network 10.0.0.0 0.255.255.255 area 0
```

IGMP UDLR Example

The following example shows how to configure IGMP UDLR. In this example, uplink-rtr is the local upstream router and downlink-rtr is the downstream router.

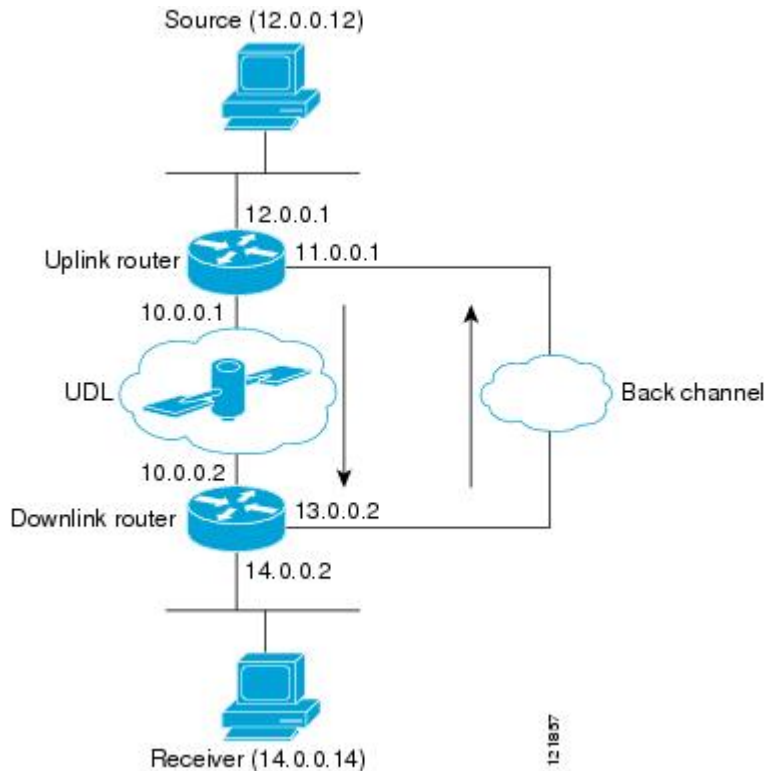
Both routers are also connected to each other by a back channel connection. Both routers have two IP addresses: one on the UDL and one on the interface that leads to the back channel. The back channel is any return route and can have any number of routers.



Note Configuring PIM on the back channel interfaces on the uplink router and downlink router is optional.

All routers on a UDL must have the same subnet address. If all routers on a UDL cannot have the same subnet address, the upstream router must be configured with secondary addresses to match all the subnets that the downstream routers are attached to.

Figure 2: IGMP Unidirectional Link Routing Example



Uplink Router (uplink-rtr) Configuration

```
ip multicast-routing
!
! Interface that source is attached to
!
interface gigabitethernet 0/0/0
description Typical IP multicast enabled interface
ip address 12.0.0.1 255.0.0.0
ip pim sparse-dense-mode
!
! Back channel
!
interface gigabitethernet 1/0/0
description Back channel which has connectivity to downlink-rtr
ip address 11.0.0.1 255.0.0.0
ip pim sparse-dense-mode
!
! Unidirectional link
!
```

```

interface serial 0/0/0
  description Unidirectional to downlink-rtr
  ip address 10.0.0.1 255.0.0.0
  ip pim sparse-dense-mode
  ip igmp unidirectional-link
  no keepalive

```

Downlink Router (downlink-rtr) Configuration

```

ip multicast-routing
!
! Interface that receiver is attached to, configure for IGMP reports to be
! helped for the unidirectional interface.
!
interface gigabitethernet 0/0/0
  description Typical IP multicast-enabled interface
  ip address 14.0.0.2 255.0.0.0
  ip pim sparse-dense-mode
  ip igmp helper-address udl serial 0/0/0
!
! Back channel
!
interface gigabitethernet 1/0/0
  description Back channel that has connectivity to downlink-rtr
  ip address 13.0.0.2 255.0.0.0
  ip pim sparse-dense-mode
!
! Unidirectional link
!
interface serial 0/0/0
  description Unidirectional to uplink-rtr
  ip address 10.0.0.2 255.0.0.0
  ip pim sparse-dense-mode
  ip igmp unidirectional-link
  no keepalive

```

Integrated UDLR Tunnel IGMP UDLR and IGMP Proxy Example

The following example shows how to configure UDLR tunnels, IGMP UDLR, and IGMP proxy on both the upstream and downstream routers sharing a UDL.

Upstream Configuration

```

ip multicast-routing
!
interface Tunnel0
  ip address 9.1.89.97 255.255.255.252
  no ip directed-broadcast
  tunnel source 9.1.89.97
  tunnel mode gre multipoint
  tunnel key 5
  tunnel udlr receive-only GigabitEthernet2/3/0
!
interface GigabitEthernet2/0/0
  no ip address
  shutdown
!
! user network
interface GigabitEthernet2/1/0

```

```

    ip address 9.1.89.1 255.255.255.240
    no ip directed-broadcast
    ip pim dense-mode
    ip cgm
    fair-queue 64 256 128
    no cdp enable
    ip rsvp bandwidth 1000 100
    !
interface GigabitEthernet2/2/0
    ip address 9.1.95.1 255.255.255.240
    no ip directed-broadcast
    !
! physical send-only interface
interface GigabitEthernet2/3/0
    ip address 9.1.92.100 255.255.255.240
    no ip directed-broadcast
    ip pim dense-mode
    ip nhrp network-id 5
    ip nhrp server-only
    ip igmp unidirectional-link
    fair-queue 64 256 31
    ip rsvp bandwidth 1000 100
    !
router ospf 1
    network 9.1.92.96 0.0.0.15 area 1
    !
ip classless
ip route 9.1.90.0 255.255.255.0 9.1.92.99

```

Downstream Configuration

```

ip multicast-routing
!
interface Loopback0
    ip address 9.1.90.161 255.255.255.252
    ip pim sparse-mode
    ip igmp helper-address udl GigabitEthernet2/3/0
    ip igmp proxy-service
!
interface Tunnel0
    ip address 9.1.90.97 255.255.255.252
    ip access-group 120 out
    no ip directed-broadcast
    no ip mroute-cache
    tunnel source 9.1.90.97
    tunnel destination 9.1.89.97
    tunnel key 5
    tunnel udlr send-only GigabitEthernet2/3/0
    tunnel udlr address-resolution
!
interface GigabitEthernet2/0/0
    no ip address
    no ip directed-broadcast
    shutdown
    no cdp enable
!
! user network
interface GigabitEthernet2/1/0
    ip address 9.1.90.1 255.255.255.240
    no ip directed-broadcast
    ip pim sparse-mode
    ip igmp mroute-proxy Loopback0
    no cdp enable

```

```

!
! Backchannel
interface GigabitEthernet2/2/0
 ip address 9.1.95.3 255.255.255.240
 no ip directed-broadcast
 no cdp enable
!
! physical receive-only interface
interface GigabitEthernet2/3/0
 ip address 9.1.92.99 255.255.255.240
 no ip directed-broadcast
 ip pim sparse-mode
 ip igmp unidirectional-link
 no keepalive
 no cdp enable
!
router ospf 1
 network 9.1.90.0 0.0.0.255 area 1
 network 9.1.92.96 0.0.0.15 area 1
!
ip classless
ip route 0.0.0.0 0.0.0.0 9.1.95.1
! set rpf to be the physical receive-only interface
ip mroute 0.0.0.0 0.0.0.0 9.1.92.96
ip pim rp-address 9.1.90.1
!
! permit ospf, ping and rsvp, deny others
access-list 120 permit icmp any any
access-list 120 permit 46 any any
access-list 120 permit ospf any any

```

Additional References

Related Documents

Related Topic	Document Title
IP multicast commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	<i>Cisco IOS IP Multicast Command Reference</i>
Tunnel interfaces	“Implementing Tunnels” module
IGMP and IGMP Proxy	“Customizing IGMP” module

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS XE releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/techsupport

Feature Information for Configuring IP Multicast over Unidirectional Links

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for Configuring IP Multicast over Unidirectional Links

Feature Name	Releases	Feature Configuration Information
UDLR Tunnel ARP and IGMP Proxy	12.2(8)T	This feature enables arp over a unidirectional link and overcomes the existing limitation of requiring downstream multicast receivers to be directly connected to the unidirectional link downstream router.
Uni-Directional Link Routing (UDLR)	12.2(2)T 12.2(17d)SXB1	Unidirectional link routing is used to allow routing protocols to function in environments where routers are connected through unidirectional links. Unidirectional link routing enables layer 3 connectivity by tunneling routing information to the router on the upstream side of a unidirectional link.