Unidirectional Link Routing for Unicast and Multicast Environments

Feature Summary

Unidirectional link routing (UDLR) provides a way to forward multicast packets over a physical unidirectional interface (such as a satellite link of high bandwidth) to stub networks that have a back channel.

The Problem

Both unicast and multicast routing protocols forward data on interfaces from which they have received routing control information. That model works only on bidirectional links. The problem is how to accomplish two-way communication over satellite links, which are unidirectional. That is, how can the router perform unidirectional link routing?

To be more specific, in unicast routing, when a router receives an Update 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 for a multicast group on an interface, it forwards data destined for that group out that same interface. Based on these principles, existing unicast and multicast routing protocols cannot be supported over these unidirectional links.

The Solutions

Cisco has two solutions for the unidirectional link problem. If you want to implement a unidirectional link to a satellite, choose one of the following solutions, depending on how many receivers you intend to send to.

UDLR Tunnel

One solution is to create a back channel (another link) so the routing protocols believe the one-way link is bidirectional. The back channel itself is a special, unidirectional, generic route encapsulation (GRE) tunnel through which control traffic flows in the opposite direction of the user data flow. This feature allows IP and its associated unicast and multicast routing protocols to believe the unidirectional link is logically bidirectional.

This solution accommodates all IP unicast and multicast routing protocols without changing them. However, it does not scale as well as Cisco's second UDLR solution if many links to many receivers are involved. We recommend that no more than 20 tunnels feed into the upstream router.

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 think the packets were received on the send-capable unidirectional link.

IGMP Unidirectional Link Routing

Cisco's other UDLR solution is to use IP multicast routing with IGMP, which has been enhanced to accommodate UDLR. This solution scales very well for many satellite links.

Benefits

Unidirectional link routing allows a router to perform routing over a satellite link. A satellite link provides higher bandwidth and is less expensive to use than a terrestrial link. The cost for a receiver attachment is economically attractive.

The following compares the benefits of the two possible ways to achieve UDLR:

- The unidirectional tunnel is a general solution, in that it can handle any unicast IP routing protocol. However, it is not a good solution for thousands of receivers.
- IGMP unidirectional link routing supports IP multicast routing over unidirectional links. It is intended for large-scale multicast routing over unidirectional links.

Restrictions

- The UDLR tunnel should be used with extreme caution, because it does not scale well to a large number of tunnels. This solution is used primarily to deploy a point-to-point link over a satellite network using the link as a router-to-router transit subnet and not as a general purpose, multiaccess transit subnet.
- All routers on the unidirectional link must have the same subnet address. If this cannot be achieved, the upstream router must be configured with secondary addresses to match all the subnets that the downstream routers are attached to.

Related Documentation

For information about tunnel interfaces, refer to the chapter "Configuring Logical Interfaces" in the Cisco IOS Release 12.0 *Cisco IOS Interface Configuration Guide*.

For information about IGMP, refer to the chapter "Configuring IP Multicast Routing" in the Cisco IOS Release 12.0 *Network Protocols Configuration Guide, Part 1*.

Platforms

This feature is supported on any platform that supports Cisco IOS Release 12.0(3)T.

Prerequisites

If you want to configure UDLR, you must decide which solution to implement. Based on how many receivers you expect to have, choose either a UDLR tunnel or IGMP UDLR. Both solutions are provided in this document.

Supported Standards, MIBs and RFCs

MIBs

No new or modified MIBs are supported by this feature.

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB web site on CCO at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

RFCs

None

Standards

None

Terms and Abbreviations

back channel—A link between two routers over which traffic can flow in the opposite direction of the unidirectional link between them. A back channel could be a unidirectional tunnel or a link over any number of routers.

downstream router—A router that receives traffic from a satellite link. It is assumed that this router has only a downstream connection to the satellite with receive-only capabilities.

unidirectional link routing (UDLR)—Routing over a one-way link to or from a satellite link. When used as an adjective to describe a tunnel, a UDLR tunnel is the back channel to complete the two-way communication between routers.

upstream router—A router that forwards data on a unidirectional link such as a satellite link. It is assumed that this router has only an upstream connection to the satellite with send-only capabilities.

Configuration Tasks for a UDLR Tunnel

The unidirectional tunnel does not require an **ip address** or **ip unnumbered** command. That is, you do not assign an IP address to the tunnel, but you must configure the tunnel endpoint addresses.

Use all of the following required commands to configure a UDLR tunnel. The tunnel mode defaults to GRE.

On the upstream router, where the unidirectional link can only send, configure the tunnel to receive. Use the following commands beginning in global configuration mode. When packets are received over the tunnel, the upper layer protocols think the packet is received over the unidirectional send-only interface.

Command	Purpose
interface *type number*	Configures the unidirectional send-only interface.
interface tunnel *number*	Configures the receive-only tunnel interface.

Command	Purpose
tunnel udlr receive-only *type number*	Configures the UDLR tunnel. Use the same *type* and *number* as the unidirectional SEND-ONLY interface *type* and *number* specified with the **interface** *type number* command.
tunnel source {*ip-address* | *type number*}	Configures the tunnel source.
tunnel destination {*hostname* | *ip-address*}	Configures the tunnel destination.

On the downstream router, where the unidirectional link can only receive, configure the tunnel to send. Use the following commands beginning in global configuration mode. When packets are sent by upper layer protocols over the interface, they will be redirected and sent over this GRE tunnel.

Command	Purpose
interface *type number*	Configures the unidirectional receive-only interface.
interface tunnel *number*	Configures the send-only tunnel interface.
tunnel udlr send-only *type number*	Configures the UDLR tunnel. Use the same *type* and *number* as the unidirectional RECEIVE-ONLY interface *type* and *number* specified with the **interface** *type number* command.
tunnel source {*ip-address* | *type number*}	Configures the tunnel source.
tunnel destination {*hostname* | *ip-address*}	Configures the tunnel destination.

For an example of a UDLR tunnel, see the section “UDLR Tunnel Example.”

Configuration Tasks for IGMP UDLR

Perform the following tasks to configure IGMP UDLR. The first task is required; the remaining task is optional.

- Configure the IGMP Unidirectional Link
- Change the Distance for the Default RPF Interface

Configure the IGMP Unidirectional Link

To configure an IGMP unidirectional link, configure 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.

On the upstream router, use the following command in interface configuration mode:

Command	Purpose
ip igmp unidirectional-link	Configures IGMP on the interface to be unidirectional.

On the downstream router, use the following commands in interface configuration mode. When the router receives an IGMP report from a host, the router helpers that report to the IGMP querier associated with the UDL interface identified in the **ip igmp helper-address** command.

Command	Purpose
ip igmp unidirectional-link	Configures IGMP on the interface to be unidirectional.
ip igmp helper-address udl *type number*	Configures the interface to be an IGMP helper. Use this command on every downstream router, on every interface to a potential multicast receiver. Specify the *type* and *number* that identify the unidirectional link interface.

Change 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.

If you want IGMP to prefer the UDLR link, set the distance to be less than the unicast routing protocols' distances. If you want IGMP to prefer the non-UDLR link, set the distance to be greater than the unicast routing protocols' distances. This task might be required on downstream routers if you want to have some sources RPF to the UDLR link and others through the terrestrial paths.

To configure one of these preferences, use the following command in global configuration mode:

Command	Purpose
ip multicast default-rpf-distance *distance*	Changes the distance for the default RPF interface.

Monitor IGMP Unidirectional Link Routing

To display UDLR information for directly connected groups on interfaces that have a unidirectional link helper address configured, use the following command in EXEC mode:

Command	Purpose
show ip igmp udlr [*groupname-or-address* **|** *interface-unit***]**	Displays UDLR information for directly connected multicast groups on interfaces that have a unidirectional link helper address configured.

Configuration Examples

The following examples each illustrate a different approach to UDLR. The first example is the tunnel approach, and the second example is the IGMP approach.

- UDLR Tunnel Example
- IGMP UDLR Example

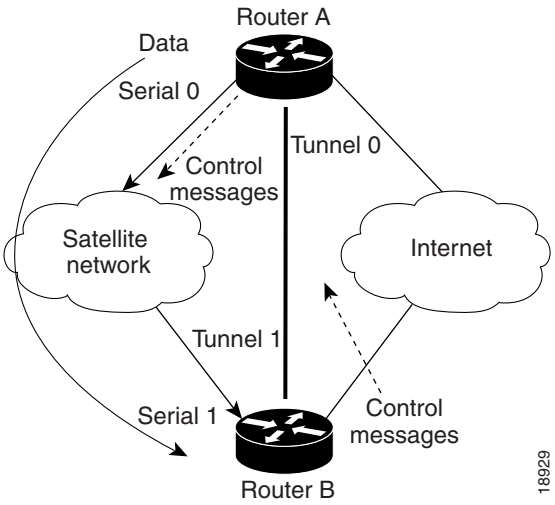
UDLR Tunnel Example

Figure 1 illustrates a UDLR tunnel. In the example, Router A (the upstream router) is configured with Open Shortest Path First (OSPF) and Protocol-Independent Multicast (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 configurations for the two routers follow the figure.

Figure 1 UDLR Tunnel Example



Router A

```
ip multicast-routing
!
! Serial0 has send-only capability
!
interface serial 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 11.0.0.1
 tunnel destination 11.0.0.2
 tunnel udlr receive-only serial 0
!
! Configure OSPF.
!
router ospf <pid>
 network 10.0.0.0 0.255.255.255 area 0
```

Router B

```
ip multicast-routing
!
! Serial1 has receive-only capability
!
interface serial 1
 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 11.0.0.2
 tunnel destination 11.0.0.1
 tunnel udlr send-only serial 1
!
! Configure OSPF.
!
router ospf <pid>
 network 10.0.0.0 0.255.255.255 area 0
```

IGMP UDLR Example

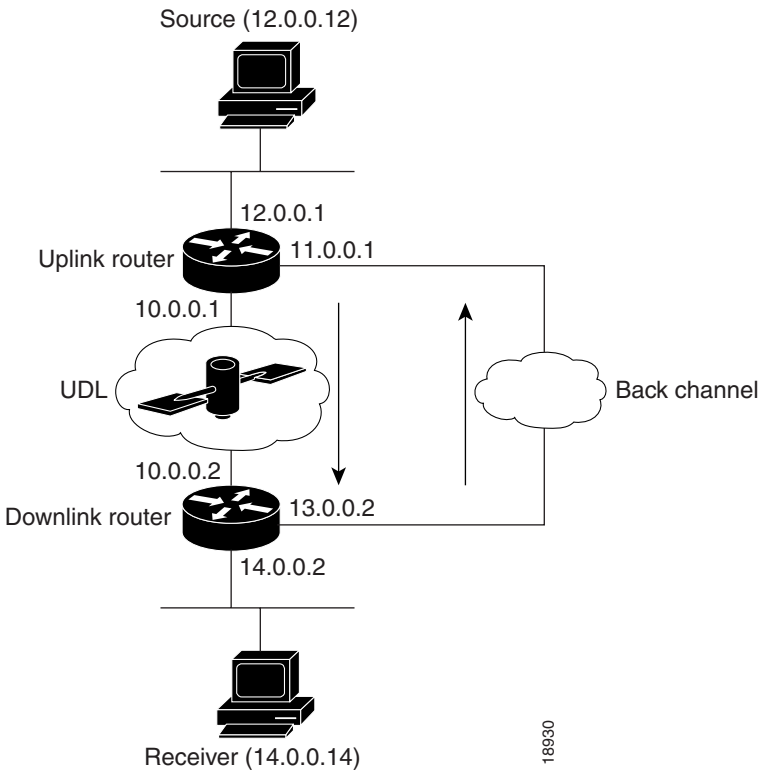
In the following example, uplink-rtr is the local upstream router and downlink-rtr is the downstream router. Figure 2 illustrates the example, and the configurations of the two routers follow.

Both routers are also connected to each other by a back channel connection. Both routers have two IP addresses: one on the unidirectional link 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 unidirectional link must have the same subnet address. If this cannot be achieved, 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)

```
ip multicast-routing
!
! Interface that source is attached to
!
interface ethernet 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 ethernet 1
 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
 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)

```
ip multicast-routing
!
! Interface that receiver is attached to, configure for IGMP reports to be
! helpered for the unidirectional interface.
!
interface ethernet 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
!
! Back channel
!
interface ethernet 1
 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
 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
```

Command Reference

This section documents the following new commands. All other commands used with this feature are documented in the Cisco IOS Release12.0 command references

- **ip igmp helper-address**
- **ip igmp unidirectional-link**
- **ip multicast default-rpf-distance**
- **show ip igmp udlr**
- **tunnel udlr receive-only**
- **tunnel udlr send-only**

ip igmp helper-address

To configure IGMP helpering as required for IGMP unidirectional link routing (UDLR), use the **ip igmp helper-address** interface configuration command. To disable such report forwarding, use the **no** form of this command.

ip igmp helper-address udl *type number*
no ip igmp helper-address

Syntax Description

udl *type number*	Interface type and number of unidirectional interface.

Default

No forwarding occurs.

Command Mode

Interface configuration

Usage Guidelines

This command was revised in Cisco IOS Release 12.0(3)T with the addition of the **udl** keyword.

This command is required on a downstream router on each interface connected to a potential multicast receiver. The command allows the downstream router to helper IGMP reports received from hosts to an upstream router connected to a unidirectional link associated with the configured *type* and *number*.

Example

The following example configures a helper address on a downstream router:

```
ip multicast-routing
!
! Interface that receiver is attached to, configure for IGMP reports to be
! helpered for the unidirectional interface.
!
interface ethernet 0
 description Forward IGMP reports from this interface to UDL querier
 ip address 14.0.0.2 255.0.0.0
 ip pim sparse-dense-mode
 ip igmp helper-address udl serial 0
```

Related Command

ip igmp unidirectional-link

ip igmp unidirectional-link

To configure an interface to be unidirectional and enable it for IGMP unidirectional link routing (UDLR), use the **ip igmp unidirectional-link** interface configuration command. To disable the unidirectional link, use the **no** form of this command.

ip igmp unidirectional-link
no ip igmp unidirectional-link

Syntax Description

This command has no arguments or keywords.

Default

No unidirectional link routing occurs.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 12.0(3)T.

One example of when you might configure this command is if you have traffic traveling via a satellite.

If you have a small number of receivers, another way to achieve UDLR is to configure a UDLR tunnel. See the **tunnel udlr receive-only** and **tunnel udlr send-only** commands.

Example

The following example configures an upstream router with UDLR on serial interface 0:

```
ip multicast-routing
!
! Unidirectional link
!
interface serial 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
```

Related Commands

ip igmp helper-address
ip multicast default-rpf-distance
show ip igmp udlr
tunnel udlr receive-only
tunnel udlr send-only

ip multicast default-rpf-distance

When configuring IGMP unidirectional link routing, to change the distance given to the default Reverse Path Forwarding (RPF) interface, use the **ip multicast default-rpf-distance** global configuration command. To restore the default value, use the **no** form of this command.

ip multicast default-rpf-distance *distance*
no ip multicast default-rpf-distance

Syntax Description

distance	Distance given to the default RPF interface. The default value is 15.

Default

15

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 12.0(3)T.

This command is optional. If you want to receive all multicast traffic from all sources on the unidirectional link, as long as 15 is the lowest distance, you need not change the value of 15.

The default RPF interface is selected when an IGMP Query is received on a unidirectional link and indicates to the router all sources will RPF to the unidirectional link interface.

Any explicit sources learned by routing protocols will take preference as long as their distance is less than the *distance* configured with the **ip multicast default-rpf-distance** command.

You might consider changing the default value for one of the following reasons:

- To make IGMP prefer the unidirectional link, configure a value less than existing routing protocols.
- If you want to receive multicast packets from sources on interfaces other than the UDL interface, configure a value greater than existing routing protocols' distances to make IGMP prefer the non-unidirectional link.

Examples

The following example configures a distance of 20:

```
ip multicast default-rpf-distance 20
```

Related Command

ip igmp unidirectional-link

show ip igmp udlr

To display unidirectional link routing (UDLR) information for directly connected multicast groups on interfaces that have a unidirectional link helper address configured, use the **show ip igmp udlr** EXEC command.

show ip igmp udlr [*group-name-or-address* | *type number*]

Syntax Description

group-name-or-address	(Optional) Name or address of the multicast group for which to show UDLR information.
type number	(Optional) Interface type and number for which to show UDLR information.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 12.0(3)T.

This command displays which groups are being forwarded and received over the unidirectional link.

On the upstream router, this command shows which interface is a UDL interface and which IP multicast groups are being forwarded out that interface. The UDL Reporter is the IP address of the downstream interface on the receiving router. If there is more than one downstream router, this field shows which downstream router forwarded the IGMP host report to the upstream router over the ground-based network. This report is forwarded over the unidirectional link so that all downstream routers know which groups have already have been requested by other downstream routers, so that additional IGMP host reports are suppressed.

On the downstream router, this command (the Interface field) shows which local interface an IGMP host report (from a directly connected host for a specific group) was received on. The UDL Reporter is the IP address of the router that had forwarded the IGMP host report to the upstream router over the ground-based network. The UDL Interfaces column shows the interface on which IP multicast packets are being received.

Examples

The following is sample output of the **show ip igmp udlr** command on an upstream router:

```
upstream-rtr# show ip igmp udlr

IGMP UDLR Status, UDL Interfaces: Serial0
Group Address    Interface            UDL Reporter     Reporter Expires
224.2.127.254    Serial0              10.0.0.2         00:02:12
224.0.1.40       Serial0              10.0.0.2         00:02:11
225.7.7.7        Serial0              10.0.0.2         00:02:15
```

The following is sample output of the **show ip igmp udlr** command on a downstream router:

```
downstream-rtr# show ip igmp udlr

IGMP UDLR Status, UDL Interfaces: Serial0
Group Address    Interface            UDL Reporter     Reporter Expires
224.2.127.254    Serial0              10.0.0.2         00:02:49
224.0.1.40       Serial0              10.0.0.2         00:02:48
225.7.7.7        Serial0              10.0.0.2         00:02:52
```

Table 1 describes the significant fields in the first display.

Table 1 show ip igmp udlr Field Descriptions

Field	Description
Group Address	All groups helpered by the reporter on the interface.
Interface	Interface type and number to which the group is connected.
UDL Reporter	IP address of the router on the UDL network that is IGMP helpering for the group.
Reporter Expires	How soon the reporter will become inactive, in hours:minutes:seconds. This can occur under the following conditions: • The reporter has gone down. • The link or network to the reporter has gone down. • The group member attached to the reporter has left the group.

tunnel udlr receive-only

To configure a unidirectional, GRE tunnel to act as a back channel that can receive messages, when another interface is configured for unidirectional link routing (UDLR) to send messages, use the **tunnel udlr receive-only** interface configuration command. To remove the tunnel, use the **no** form of this command.

tunnel udlr receive-only *type number*
no tunnel udlr receive-only *type number*

Syntax Description

type number	Interface type and number. Make this *type* and *number* match the unidirectional send-only interface type and number specified by the **interface** command. Thus, when packets are received over the tunnel, the upper layer protocols will believe the packets are received over the unidirectional send-only interface.

Default

No UDLR tunnel is configured.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 12.0(3)T.

Use this command to configure a router that has a unidirectional interface with send-only capabilities. One example of when you might configure this command is if you have traffic traveling via a satellite.

The *type* and *number* must match the send-only interface type and number specified by the **interface** command.

You must configure the **tunnel udlr send-only** command at the opposite end of the tunnel.

If you have a large number of receivers, you should configure UDLR by an alternative means: IGMP UDLR. See the **ip igmp unidirectional-link** command.

Example

In the following example, Router A (the upstream router) is configured with 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 A

```
ip multicast-routing
!
! Serial0 has send-only capability
!
```

```
interface serial 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 ethernet 0
 tunnel destination <downstream-router>
 tunnel udlr receive-only serial 0
!
! Configure OSPF.
!
router ospf <pid>
 network 10.0.0.0 0.255.255.255 area 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.

Router B

```
ip multicast-routing
!
! Serial1 has receive-only capability
!
interface serial 1
 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 ethernet 0
 tunnel destination <upstream-router>
 tunnel udlr send-only serial 1
!
! Configure OSPF.
!
router ospf <pid>
 network 10.0.0.0 0.255.255.255 area 0
```

Related Commands

interface
interface tunnel
ip igmp unidirectional-link
tunnel udlr send-only

tunnel udlr send-only

To configure a unidirectional, GRE tunnel to act as a back channel that can send messages, when another interface is configured for unidirectional link routing (UDLR) to receive messages, use the **tunnel udlr send-only** interface configuration command. To remove the tunnel, use the **no** form of this command.

tunnel udlr send-only *type number*
no tunnel udlr send-only *type number*

Syntax Description

type number	Interface type and number. Make this *type* and *number* match the unidirectional receive-only interface type and number specified by the **interface** command. Thus, when packets are sent by upper layer protocols over the interface, they will be redirected and sent over this GRE tunnel.

Default

No UDLR tunnel is configured.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 12.0(3)T.

Use this command to configure a router that has a unidirectional interface with receive-only capabilities. The UDLR tunnel will act as a back channel. One example of when you might configure this command is if you have traffic traveling via a satellite.

The *type* and *number* must match the receive-only interface type and number specified by the **interface** command.

You must configure the **tunnel udlr receive-only** command at the opposite end of the tunnel.

Example

In the following example, Router A (the upstream router) is configured with 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 A

```
ip multicast-routing
!
! Serial0 has send-only capability
!
interface serial 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 ethernet 0
 tunnel destination <downstream-router>
 tunnel udlr receive-only 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.

Router B

```
ip multicast-routing
!
! Serial1 has receive-only capability
!
interface serial 1
 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 ethernet 0
 tunnel destination <upstream-router>
 tunnel udlr send-only serial 1
```

Related Commands

interface
interface tunnel
ip igmp unidirectional-link
tunnel udlr receive-only