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简介

在某些环境中，可能需要将多个串行链路进行捆绑以作为具有聚合带宽的单个链路。本文档介绍如何配置 Cisco 4500 路由器，以使用一个虚拟模板接口对四个串行接口进行链路捆绑。

此配置可用于通过租用线路连接的路由器，或用于具有信道服务单元/数据服务单元 (CSU/DSU) 的路由器。您可以根据需要向此配置中添加其他功能。

先决条件

要求

本文档没有任何特定的要求。

使用的组件

本文档中的信息基于以下软件和硬件版本。

- 实验室环境中带有原始配置的 Cisco 4500 路由器。
- Cisco IOS® 版本 12.2(10b) 在两台路由器上都运行。

本文档中的信息都是基于特定实验室环境中的设备创建的。本文档中使用的所有设备最初均采用原始（默认）配置。如果您是在真实网络上操作，请确保您在使用任何命令前已经了解其潜在影响。

相关产品

此配置也可用于下列硬件和软件版本。

- 任意两台路由器，其中每台服务器带有四个串行接口。

- 可使用 WIC-1T 和 WIC-2T 串行接口。

规则

有关文档规则的详细信息，请参阅 [Cisco 技术提示规则](#)。

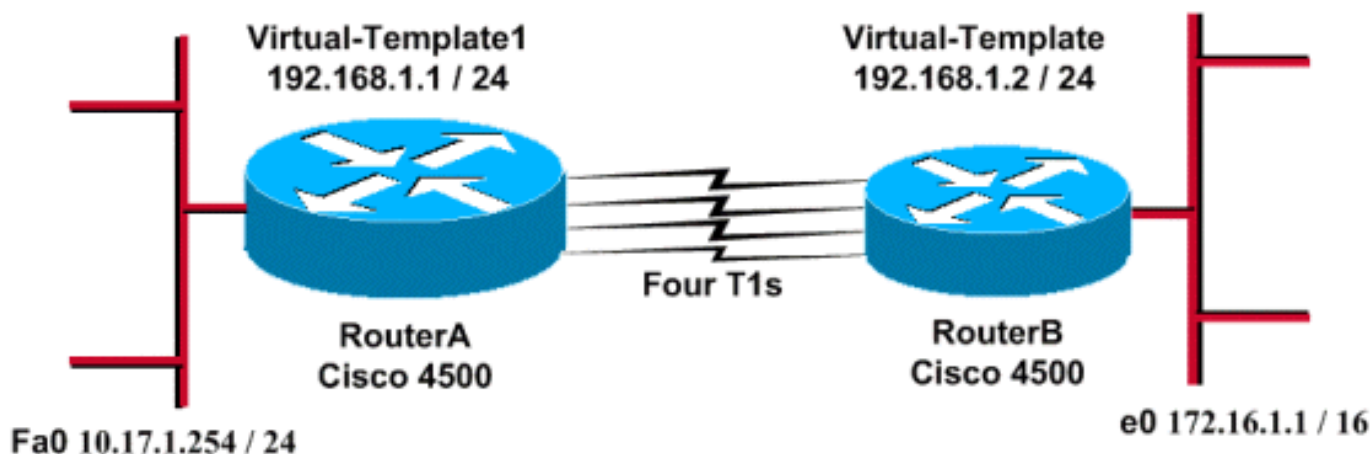
配置

本部分提供有关如何配置本文档所述功能的信息。

注意：要查找本文档所用命令的其他信息，请使用 [命令查找工具](#)（[仅限注册用户](#)）。

网络图

本文档使用下图所示的网络设置。



配置

曾在 4500 系列路由器上使用 Cisco IOS 软件版本 12.2(10b) 对此配置进行过测试。相同的配置概念同样适用于类似的路由器拓扑或其他 Cisco IOS 版本。

本文档使用如下所示的配置。

路由器A
路由器B

配置以下内容以实施上面的配置：

- 多链路虚拟模板
- 接口虚拟模板
- 必须进行捆绑的每个串行接口中的 PPP 多链路。
- RIP 作为 IP 路由协议

配置 interface loopback 0 以确保绝不会发生故障，并且 ip unnumbered loopback 0 通过同一 IP 地

址来增强 5 个以上串行接口的捆绑。

当所有串行接口都运行时，将会发送用户流量，多链路 PPP 创建一个虚拟访问接口，并发生 PPP 协商。将从虚拟模板来克隆此虚拟访问接口的配置。在此虚拟访问接口中对正在运行的串行接口进行捆绑，并生成一个聚合带宽。

验证

本部分所提供的信息可用于确认您的配置是否正常工作。

[命令输出解释程序工具](#) ([仅限注册用户](#)) 支持某些 **show** 命令，使用此工具可以查看对 **show** 命令输出的分析。

- **show ip route**
- **show ip rip database**
- **show ppp multilink**
- **show interface virtual-access 1**

```
RouterA#show ip route Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area N1 - OSPF NSSA external type 1,
N2 - OSPF NSSA external type 2 E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area * - candidate
default, U - per-user static route, o - ODR P - periodic downloaded static routeGateway of
last resort is not setR 172.16.0.0/16 [120/1] via 192.168.1.2, 00:00:19, Virtual-Access1
10.0.0.0/24 is subnetted, 1 subnetsC 10.17.1.0 is directly connected, FastEthernet0
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly connected,
Loopback0C 192.168.1.2/32 is directly connected, Virtual-Access1RouterA#show ip route connected
10.0.0.0/24 is subnetted, 1 subnetsC 10.17.1.0 is directly connected, FastEthernet0
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.0/24 is directly
connected, Loopback0C 192.168.1.2/32 is directly connected, Virtual-Access1RouterB#show ip
routeCodes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP D - EIGRP,
EX - EIGRP external, O - OSPF, IA - OSPF inter area N1 - OSPF NSSA external type 1, N2 -
OSPF NSSA external type 2 E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area * - candidate
default, U - per-user static route, o - ODR P - periodic downloaded static routeGateway of
last resort is not setC 172.16.0.0/16 is directly connected, Ethernet0R 10.0.0.0/8 [120/1] via
192.168.1.1, 00:00:18, Virtual-Access1 192.168.1.0/24 is variably subnetted, 2 subnets, 2
masksC 192.168.1.1/32 is directly connected, Virtual-Access1C 192.168.1.0/24 is directly
connected, Loopback0RouterB#show ip route connectedC 172.16.0.0/16 is directly connected,
Ethernet0 192.168.1.0/24 is variably subnetted, 2 subnets, 2 masksC 192.168.1.1/32 is
directly connected, Virtual-Access1C 192.168.1.0/24 is directly connected,
Loopback0RouterA#show ip rip database 10.0.0.0/8 auto-summary10.17.1.0/24 directly
connected, FastEthernet0172.16.0.0/16 auto-summary172.16.0.0/16 [1] via 192.168.1.2,
00:00:34, Virtual-Access1192.168.1.0/24 auto-summary192.168.1.0/24 directly connected,
Loopback0192.168.1.2/32 directly connected, Virtual-Access1RouterB#show ip rip database
10.0.0.0/8 auto-summary10.0.0.0/8 [1] via 192.168.1.1, 00:00:13, Virtual-
Access1172.16.0.0/16 auto-summary172.16.0.0/16 directly connected, Ethernet0192.168.1.0/24
auto-summary192.168.1.0/24 directly connected, Loopback0192.168.1.1/32 directly connected,
Virtual-Access1RouterA#show ppp multilink Virtual-Access1, bundle name is RouterB Bundle up for
17:01:59 0 lost fragments, 0 reordered, 0 unassigned 0 discarded, 0 lost received, 1/255 load
0xD3C received sequence, 0x1180 sent sequence Member links: 4 (max not set, min not set)
Serial0, since 17:01:59, last rcvd seq 000D38 Serial11, since 17:01:50, last rcvd seq 000D39
Serial2, since 17:01:46, last rcvd seq 000D3A Serial13, since 17:01:41, last rcvd seq
000D3BRouterB#show ppp multilink Virtual-Access1, bundle name is RouterA Bundle up for 12:47:33
0 lost fragments, 0 reordered, 0 unassigned 0 discarded, 0 lost received, 1/255 load 0x1186
received sequence, 0xD40 sent sequence Member links: 4 (max not set, min not set) Serial0,
since 12:47:33, last rcvd seq 001184 Serial11, since 12:47:27, last rcvd seq 001185
Serial2, since 12:47:23, last rcvd seq 001182 Serial13, since 12:47:20, last rcvd seq
```

```

001183RouterA#show interface virtual-access 1Virtual-Access1 is up, line protocol is up
Hardware is Virtual Access interface Interface is unnumbered. Using address of Loopback0
(192.168.1.1) MTU 1500 bytes, BW 6176 Kbit, DLY 100000 usec, reliability 255/255, txload
1/255, rxload 1/255 Encapsulation PPP, loopback not set Keepalive set (10 sec) DTR is pulsed
for 5 seconds on reset LCP Open, multilink Open Open: IPCP Last input 00:00:00, output never,
output hang never Last clearing of "show interface" counters 17:05:41 Queuing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops 5 minute input rate 0 bits/sec, 0
packets/sec 5 minute output rate 0 bits/sec, 0 packets/sec 1711 packets input, 163898
bytes, 0 no buffer Received 0 broadcasts, 0 runts, 0 giants, 0 throttles 0 input errors,
0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort 2256 packets output, 211897 bytes, 0 underruns
0 output errors, 0 collisions, 0 interface resets 0 output buffer failures, 0 output buffers
swapped out 0 carrier transitionsRouterB#show interface virtual-access 1Virtual-Access1 is
up, line protocol is up Hardware is Virtual Access interface Interface is unnumbered. Using
address of Loopback0 (192.168.1.2) MTU 1500 bytes, BW 6176 Kbit, DLY 100000 usec,
reliability 255/255, txload 1/255, rxload 1/255 Encapsulation PPP, loopback not set Keepalive
set (10 sec) DTR is pulsed for 5 seconds on reset LCP Open, multilink Open Open: IPCP Last
input 00:00:20, output never, output hang never Last clearing of "show interface" counters
12:54:17 Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0 Queuing
strategy: fifo Output queue :0/40 (size/max) 5 minute input rate 0 bits/sec, 0 packets/sec 5
minute output rate 0 bits/sec, 0 packets/sec 2256 packets input, 216460 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles 0 input errors, 0 CRC, 0 frame, 0
overrun, 0 ignored, 0 abort 1714 packets output, 160624 bytes, 0 underruns 0 output
errors, 0 collisions, 0 interface resets 0 output buffer failures, 0 output buffers swapped
out 0 carrier transitions

```

故障排除

本部分提供的信息可用于对配置进行故障排除。

故障排除命令

[命令输出解释程序工具](#) ([仅限注册用户](#)) 支持某些 **show** 命令，使用此工具可以查看对 **show** 命令输出的分析。

注意： 在发出 **debug** 命令之前，请参阅[有关 Debug 命令的重要信息](#)。

- **debug ppp negotiation** - 用于查看客户端是否正在传递 PPP 协商；此命令用于检查地址协商。
- **debug ppp authentication** - 看见客户端是否可以是否通过认证。如果您使用的是 11.2 之前的 Cisco IOS 软件版本，请改用 **debug ppp chap** 命令。
- **debug ppp error** - 显示和 PPP 连接协商与操作相关的协议错误以及统计错误。
- **debug vtemplate** - 用于显示虚拟模板克隆以形成虚拟访问接口。
- **debug ppp multilink events** - 用于查看 PPP 多链路事件调试。显示与影响多链路组的事件有关的信息。
- **show ppp multilink** - 用于查看多链路捆绑的成员。

以下输出是从 Cisco 4500 路由器获得的。这些输出显示路由器正在建立多链路 PPP 连接。

```

RouterA#debug vtemplate Virtual Template debugging is on*Dec 1 17:24:16.519: Vi1 VTEMPLATE:
Reuse Vi1, recycle queue size 0*Dec 1 17:24:16.519: Vi1 VTEMPLATE: Set default settings with ip
unnumbered*Dec 1 17:24:16.539: Vi1 VTEMPLATE: Hardware address 00d0.bbfa.f579*Dec 1
17:24:16.543: Vi1 VTEMPLATE: Has a new cloneblk vtemplate, now it has vtemplate*Dec 1
17:24:16.543: Vi1 VTEMPLATE: ***** CLONE VACCESS1 *****Dec 1 17:24:16.543: Vi1
VTEMPLATE: Clone from Virtual-Template1interface Virtual-Access1default ip addressno ip
addressencap pppip unnumbered loopback0end *Dec 1 17:24:16.595: %LINK-3-UPDOWN: Interface
Virtual-Access1, changed state to up*Dec 1 17:24:17.515: %LINEPROTO-5-UPDOWN: Line protocol on
Interface Serial0, changed state to up*Dec 1 17:24:17.595: %LINEPROTO-5-UPDOWN: Line protocol on
Interface Virtual-Access1, changed state to upRouterA#debug ppp negotiation PPP protocol
negotiation debugging is onDec 11 19:39:14.523: %LINK-5-CHANGED: Interface Serial0, changed

```

state to resetDec 11 19:39:14.523: Se0 LCP: State is ClosedDec 11 19:39:14.627: %SYS-5-CONFIG_I: Configured from console by consoleDec 11 19:39:16.523: %LINK-3-UPDOWN: Interface Serial0, changed state to upDec 11 19:39:16.523: Se0 PPP: Treating connection as a dedicated lineDec 11 19:39:16.523: Se0 PPP: Phase is ESTABLISHING, Active Open [0 sess, 1 load]Dec 11 19:39:16.523: **Se0 LCP: O CONFREQ [Closed] id 25 len 24**Dec 11 19:39:16.523: Se0 LCP: MagicNumber 0xD4CBA693 (0x0506D4CBA693)Dec 11 19:39:16.523: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:39:16.523: Se0 LCP: EndpointDisc 1 RouterA (0x130A01506F6D65726F6C)Dec 11 19:39:16.535: **Se0 LCP: I CONFREQ [REQsent] id 33 len 25**Dec 11 19:39:16.535: Se0 LCP: MagicNumber 0x03200E36 (0x050603200E36)Dec 11 19:39:16.535: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:39:16.539: Se0 LCP: EndpointDisc 1 RouterB (0x130B0150756C6C69676E79)Dec 11 19:39:16.539: **Se0 LCP: O CONFACK [REQsent] id 33 len 25**Dec 11 19:39:16.539: Se0 LCP: MagicNumber 0x03200E36 (0x050603200E36)Dec 11 19:39:16.539: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:39:16.539: Se0 LCP: EndpointDisc 1 RouterB (0x130B0150756C6C69676E79)Dec 11 19:39:16.539: **Se0 LCP: I CONFACK [ACKsent] id 25 len 24**Dec 11 19:39:16.539: Se0 LCP: MagicNumber 0xD4CBA693 (0x0506D4CBA693)Dec 11 19:39:16.539: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:39:16.543: Se0 LCP: EndpointDisc 1 RouterA (0x130A01506F6D65726F6C)Dec 11 19:39:16.543: **Se0 LCP: State is Open**Dec 11 19:39:16.543: **Se0 PPP: Phase is VIRTUALIZED [0 sess, 1 load]**Dec 11 19:39:16.555: Vi1 PPP: Phase is DOWN, Setup [0 sess, 1 load]Dec 11 19:39:16.587: %LINK-3-UPDOWN: Interface **Virtual-Access1, changed state to up**Dec 11 19:39:16.587: Vi1 PPP: Treating connection as a dedicated lineDec 11 19:39:16.587: **Vi1 PPP: Phase is ESTABLISHING, Active Open [0 sess, 1 load]**Dec 11 19:39:16.587: Vi1 LCP: O CONFREQ [Closed] id 1 len 29Dec 11 19:39:16.587: Vi1 LCP: AuthProto CHAP (0x0305C22305)Dec 11 19:39:16.587: Vi1 LCP: MagicNumber 0xD4CBA6D4 (0x0506D4CBA6D4)Dec 11 19:39:16.587: Vi1 LCP: MRRU 1524 (0x110405F4)Dec 11 19:39:16.587: Vi1 LCP: EndpointDisc 1 RouterA (0x130A01506F6D65726F6C)Dec 11 19:39:16.587: **Vi1 PPP: Phase is UP [0 sess, 1 load]**Dec 11 19:39:16.591: Vi1 IPCP: O CONFREQ [Closed] id 1 len 10Dec 11 19:39:16.591: Vi1 IPCP: Address 192.168.1.1 (0x0306C0A80101)Dec 11 19:39:16.591: **Vi1 MLP: Added first link Se0 to bundle RouterB**Dec 11 19:39:16.623: Vi1 IPCP: I CONFREQ [REQsent] id 1 len 10Dec 11 19:39:16.623: Vi1 IPCP: Address 192.168.1.2 (0x0306C0A80102)Dec 11 19:39:16.623: Vi1 IPCP: O CONFACK [REQsent] id 1 len 10Dec 11 19:39:16.623: Vi1 IPCP: Address 192.168.1.2 (0x0306C0A80102)Dec 11 19:39:16.623: Vi1 IPCP: I CONFACK [ACKsent] id 1 len 10Dec 11 19:39:16.627: Vi1 IPCP: Address 192.168.1.1 (0x0306C0A80101)Dec 11 19:39:16.627: **Vi1 IPCP: State is Open**Dec 11 19:39:16.627: **Vi1 IPCP: Install route to 192.168.1.2**Dec 11 19:39:17.543: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed state to upDec 11 19:39:17.587: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access1, changed state to upRouterB#debug ppp negotiation PPP protocol negotiation debugging is onDec 11 19:38:08.975: **Se0 LCP: I CONFREQ [Closed] id 25 len 24**Dec 11 19:38:08.975: Se0 LCP: MagicNumber 0xD4CBA693 (0x0506D4CBA693)Dec 11 19:38:08.975: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:38:08.975: Se0 LCP: EndpointDisc 1 RouterA (0x130A01506F6D65726F6C)Dec 11 19:38:08.975: Se0 LCP: Lower layer not up, Fast StartingDec 11 19:38:08.975: Se0 PPP: Treating connection as a dedicated lineDec 11 19:38:08.979: **Se0 PPP: Phase is ESTABLISHING, Active Open [0 sess, 1 load]**Dec 11 19:38:08.979: **Se0 LCP: O CONFREQ [Closed] id 33 len 25**Dec 11 19:38:08.979: Se0 LCP: MagicNumber 0x03200E36 (0x050603200E36)Dec 11 19:38:08.979: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:38:08.979: Se0 LCP: EndpointDisc 1 RouterB (0x130B0150756C6C69676E79)Dec 11 19:38:08.979: **Se0 LCP: O CONFACK [REQsent] id 25 len 24**Dec 11 19:38:08.979: Se0 LCP: MagicNumber 0xD4CBA693 (0x0506D4CBA693)Dec 11 19:38:08.979: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:38:08.979: Se0 LCP: EndpointDisc 1 RouterA (0x130A01506F6D65726F6C)Dec 11 19:38:08.979: %LINK-3-UPDOWN: **Interface Serial0, changed state to up**Dec 11 19:38:08.987: **Se0 LCP: I CONFACK [ACKsent] id 33 len 25**Dec 11 19:38:08.987: Se0 LCP: MagicNumber 0x03200E36 (0x050603200E36)Dec 11 19:38:08.987: Se0 LCP: MRRU 1524 (0x110405F4)Dec 11 19:38:08.987: Se0 LCP: EndpointDisc 1 RouterB (0x130B0150756C6C69676E79)Dec 11 19:38:08.987: **Se0 LCP: State is Open**Dec 11 19:38:08.987: Se0 PPP: Phase is VIRTUALIZED [0 sess, 1 load]Dec 11 19:38:08.999: Vi1 PPP: Phase is DOWN, Setup [0 sess, 1 load]Dec 11 19:38:09.039: Se0 IPCP: Packet buffered while building MLP bundle interfaceDec 11 19:38:09.043: %LINK-3-UPDOWN: **Interface Virtual-Access1, changed state to up**Dec 11 19:38:09.043: Vi1 PPP: Treating connection as a dedicated lineDec 11 19:38:09.043: Vi1 PPP: Phase is ESTABLISHING, Active Open [0 sess, 1 load]Dec 11 19:38:09.043: Vi1 LCP: O CONFREQ [Closed] id 1 len 30Dec 11 19:38:09.043: Vi1 LCP: AuthProto CHAP (0x0305C22305)Dec 11 19:38:09.043: Vi1 LCP: MagicNumber 0x03200E78 (0x050603200E78)Dec 11 19:38:09.043: Vi1 LCP: MRRU 1524 (0x110405F4)Dec 11 19:38:09.043: Vi1 LCP: EndpointDisc 1 RouterB (0x130B0150756C6C69676E79)Dec 11 19:38:09.043: **Vi1 PPP: Phase is UP [0 sess, 1 load]**Dec 11 19:38:09.043: Vi1 IPCP: O CONFREQ [Closed] id 1 len 10Dec 11 19:38:09.043: Vi1 IPCP: Address 192.168.1.2 (0x0306C0A80102)Dec 11 19:38:09.047: **Vi1 MLP: Added first link Se0 to bundle RouterA**Dec 11 19:38:09.047: Vi1 PPP: Pending ncpQ size is 1Dec 11 19:38:09.047: Se0 IPCP: Redirect packet to Vi1Dec 11 19:38:09.047: Vi1 IPCP: I CONFREQ [REQsent] id 1 len 10Dec 11 19:38:09.047: Vi1 IPCP: Address 192.168.1.1 (0x0306C0A80101)Dec 11 19:38:09.047: Vi1 IPCP: O

```
CONFACK [REQsent] id 1 len 10Dec 11 19:38:09.047: Vi1 IPCP: Address 192.168.1.1
(0x0306C0A80101)Dec 11 19:38:09.051: Vi1 IPCP: I CONFACK [ACKsent] id 1 len 10Dec 11
19:38:09.051: Vi1 IPCP: Address 192.168.1.2 (0x0306C0A80102)Dec 11 19:38:09.051: Vi1 IPCP:
State is OpenDec 11 19:38:09.051: Vi1 IPCP: Install route to 192.168.1.1Dec 11 19:38:09.987:
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed state to upDec 11 19:38:10.043:
%LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access1, changed state to
upRouterB#debug ppp multilink eventsMultilink events debugging is onDec 11 19:41:30.239: %LINK-
3-UPDOWN: Interface Serial0, changed state to upDec 11 19:41:30.243: Se0 MLP: Request add link
to bundleDec 11 19:41:30.243: Se0 MLP: Adding link to bundleDec 11 19:41:30.255: Vi1 MLP: VP:
Clone from Vtemplate 1 block=1Dec 11 19:41:30.299: %LINK-3-UPDOWN: Interface Virtual-Access1,
changed state to upDec 11 19:41:30.299: Vi1 MLP: Added first link Se0 to bundle RouterADec 11
19:41:31.243: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed state to upDec 11
19:41:31.243: Se0 MLP: cdp packet forwarded to wrong interfaceDec 11 19:41:31.299: %LINEPROTO-5-
UPDOWN: Line protocol on Interface Virtual-Access1, changed state to up
```

相关信息

- [显示呼叫方统计信息](#)
- [多链路 PPP RFC 1717](#) 
- [配置带有拨号配置文件的点到点DDR](#)
- [WAN 技术支持页](#)
- [技术支持 - Cisco Systems](#)