对帧中继配置与故障排除的全面的指南

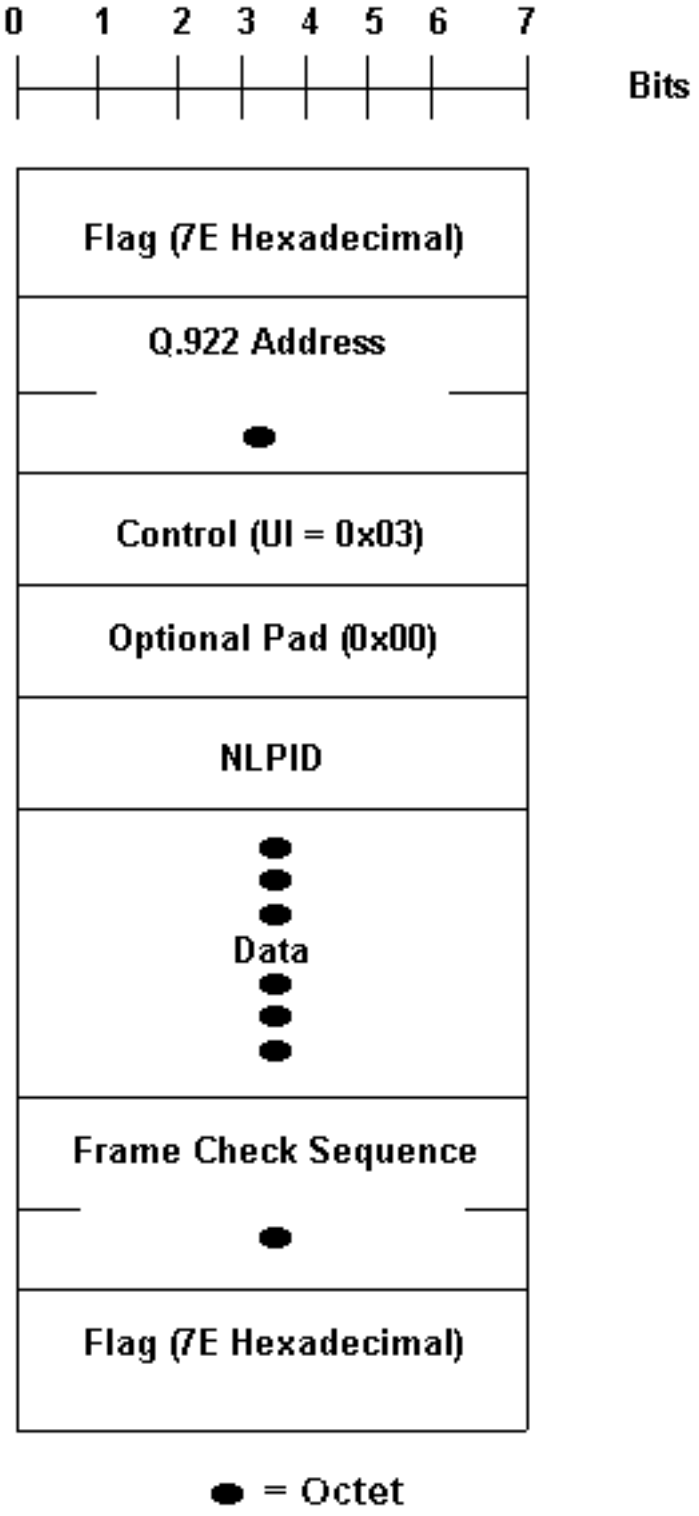
目录

简介
开始使用前
规则
先决条件
使用的组件
背景理论
配置基本的帧中继
网络图
配置
debug 和 show 命令
配置星形帧中继
网络图
配置
显示命令
分支间连接
配置
显示命令
配置帧中继子接口
点到点子接口
显示命令
星型连接子接口
显示命令
配置多点子接口的动态和静态映射
网络图
配置
debug 和 show 命令
配置 IP 无编号帧中继
网络图
配置
显示命令
配置帧中继备份
ISDN 上的帧中继备份
配置每个 DCLI 备份
带有拨号程序配置文件的星型网
配置帧中继交换
网络图
配置

显示命令
配置帧中继 DLCI 优先级
实施注意事项
网络图
配置
debug 和 show 命令
帧中继广播队列
流量整形
流量整形参数
一般流量整形
帧中继流量整形
常用帧中继命令
show frame-relay pvc
show frame-relay map
帧中继和桥接
帧中继和内存
帧中继的故障排查
"Serial0 is down, line protocol is down"
"Serial0 is up, line protocol is down"
"Serial0 is up, line protocol is up"
帧中继特性
IP 分界检查
Ping 多点帧中继上您自己的 IP 地址
关键字广播
重新配置子接口
DLCI 限制
IP/IPX/AT 地址
RIP 和 IGRP
保持连接
串行接口
OSPF 和多点
源
相关信息

简介

帧中继是行业标准的交换数据链路层协议，它使用连接设备之间的高级数据链路控制(HDLC)封装来处理多个虚电路。在许多情况下，帧中继比X.25更有效率，X.25是一般考虑替换的协议。下图说明了帧中继帧(ANSI T1.618)。



注意在上图中，Q.922地址（如当前定义）是2个八位字节，并包含10-bit数据链路连接标识符(DLCI)。 在一些网络中，Q.922地址可能被随意增加到三个或四个八位位组。

“标志”字段限定了帧的开始和结束。前导的“标志”字段后面是两个字节的地址信息。这两个字节的十位数组成了实际电路ID(称为DLCI，用于数据链路连接标识符)。

10位DLCI值是帧中继报头的核心。它标识多路复用到物理通道中的逻辑连接。在基本的(即不由本地管理接口[LMI]进行扩展)寻址模式中，DLCI有本地意义；即二个不同连接端的终端设备可以在相同连接上使用不同的DLCI。

开始使用前

规则

有关文档规则的详细信息，请参阅 Cisco 技术提示规则。

先决条件

欲知更多信息和本文所用术语的定义，请参见帧中继术语表。

使用的组件

本文档不限于特定的软件和硬件版本。

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。

背景理论

帧中继最初被设想为一种协议，用于通过ISDN接口使用。1984年，初步提议被提交到国际电信联盟电信标委员会准化部门(ITU-T) (以前的国际电报电话咨询委员会[CCITT]) 。帧中继的工作也可以在美国ANSI认可的T1S1标准委员会里执行。

1990年，思科系统、StrataCom、Northern Telecom和Digital Equipment Corporation组建了一个机构，专门从事帧中继技术的开发，加快可互操作的帧中继产品的推出。他们制定了一个规范，符合在T1S1和ITU-T中讨论的基本帧中继协议，但在功能方面进行了扩展，提供了一些适用于复杂联网环境的其他功能。这些帧中继扩展统称为LMI。这是路由器中的“cisco”LMI，而不是“ansi”或“q933a”LMI。

帧中继提供了分组交换数据通信功能，可在用户设备(例如路由器、网桥、主机)和网络设备(例如交换节点)之间的接口上使用。 用户设备经常称为数据终端设备(DTE)，连接到DTE的网络设备通常称为数据电路终端设备(DCE) 。 提供帧中继接口的网络可以是运营商提供的公共网络或为单个企业服务的专有设备网络。

帧中继在功能和格式上与X.25有显着不同。尤其是，帧中继是一种更简化的协议，可提高性能和效率。

作为用户和网络设备之间的一个接口，帧中继提供了一种在单个物理传输链路上统计复用很多逻辑数据会话(指虚拟电路)的方式。这与仅使用时分复用(TDM)技术支持多个数据流的系统形成了对比。帧中继的统计多路复用使可用带宽的使用更加灵活和高效。无需TDM技术它也可以使用，或者由TDM系统提供在信道顶部。

帧中继的另一个重要特性是它开发了广域网(WAN)传输技术的最新进展。早期的WAN协议（如X.25）是在模拟传输系统和铜缆介质占主导地位时开发的。这些链路的可靠性远不及目前可用的光纤介质/数字传输链路。在这类链路上，链路层协议可以抛弃耗费时间长的错误改正算法，将这类算法留在更高协议层上执行。因此，在不牺牲数据完整性的情况下，可以实现更高的性能和效率。帧中继的设计考虑了这种方法。它包括循环冗余校验(CRC)算法，用于检测损坏的位(可能导致数据丢弃)，但不包括任何用于纠正坏数据(例如，在这个水平的协议上重新转发)的任何协议机制。

帧中继和X.25之间的另一个区别是帧中继中缺乏明确的每条虚拟电路的流控制。即然许多上层协议

能够有效执行它们自己的流控制算法，因此链路层对此功能的需求已经减少。因此，帧中继不包括复制较高层的显式流量控制过程。相反地，使用非常简单的拥塞通知机制是为了使网络通知用户设备现在网络资源接近拥塞状态。此通知可以提醒较高层协议可能需要流量控制。

配置基本的帧中继

一旦您在永久虚拟电路(PVC)的两端具有到本地帧中继交换机的可靠连接，便需开始规划帧中继配置。在第一个示例中，Spicey上的本地管理接口(LMI)类型默认为“cisco” LMI。"接口被默认为""多点""接口，因此frame-relay inverse-arp 是打开的(对于点到点的应用而言，这里没有反向ARP)。"IP水平分割检查默认禁用帧中继封装，路由更新将从相同接口流入流出。路由器通过LMI更新，获取它们需要从帧中继交换机使用的数据链路连接标识符(DLCI)。路由器将反向ARP传输到远程IP地址上，并创建本地DLCI和相关远程IP地址的映射。

网络图

配置

- 斯派西
- 普拉西

斯派西

```
Spicey#show running-config
Building configuration...

Current configuration : 1705 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 ip address 3.1.3.1 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 140
!
!
router rip
```

```
 network 3.0.0.0
 network 124.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...
Current configuration : 1499 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
!
interface Serial1
 ip address 3.1.3.2 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 150
!
!
router rip
 network 3.0.0.0
 network 123.0.0.0
!
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

debug 和 show 命令

在发出 **debug 命令之前，请参阅**有关 Debug 命令的重要信息。

- show frame-relay map
- show frame-relay pvc
- show frame-relay lmi
- ping <*device name*>

- show ip route

斯派西

```
Spicey#show frame-relay map
Serial0 (up): ip 3.1.3.2 dlci 140(0x8C,0x20C0), dynamic,
              broadcast,, status defined, active

Spicey#show frame-relay pvc
PVC Statistics for interface Serial0 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0
  input pkts 83            output pkts 87           in bytes 8144
  out bytes 8408           dropped pkts 0           in FECN pkts0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 41         out bcast bytes 3652
  pvc create time 01:31:50, last time pvc status changed 01:28:28
Spicey#show frame-relay lmi
LMI Statistics for interface Serial0 (Frame Relay DTE) LMI TYPE = CISCO
  Invalid Unnumbered info 0             Invalid Prot Disc 0
  Invalid dummy Call Ref 0              Invalid Msg Type 0
  Invalid Status Message 0              Invalid Lock Shift 0
  Invalid Information ID 0              Invalid Report IE Len 0
  Invalid Report Request 0              Invalid Keep IE Len 0
  Num Status Enq. Sent 550              Num Status msgs Rcvd 552
  Num Update Status Rcvd 0              Num Status Timeouts 0
Spicey#ping 123.123.123.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/40 ms
Spicey#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 route

Gateway of last resort is not set
     3.0.0.0/24 is subnetted, 1 subnets
C       3.1.3.0 is directly connected, Serial0
     124.0.0.0/24 is subnetted, 1 subnets
C       124.124.124.0 is directly connected, Ethernet0
R    123.0.0.0/8 [120/1] via 3.1.3.2, 00:00:08, Serial0
```

普拉西

```
Prasit#show frame-relay map
Serial1 (up): ip 3.1.3.1 dlci 150(0x96,0x2460), dynamic,
              broadcast,, status defined, active

Prasit#show frame-relay pvc
```

```
PVC Statistics for interface Serial1 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0
DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial1
  input pkts 87            output pkts 83           in bytes 8408
  out bytes 8144           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 38         out bcast bytes 3464
  pvc create time 01:34:29, last time pvc status changed 01:28:05

Prasit#show frame-relay lmi
LMI Statistics for interface Serial1 (Frame Relay DTE) LMI TYPE = CISCO
  Invalid Unnumbered info 0             Invalid Prot Disc 0
  Invalid dummy Call Ref 0              Invalid Msg Type 0
  Invalid Status Message 0              Invalid Lock Shift 0
  Invalid Information ID 0              Invalid Report IE Len 0
  Invalid Report Request 0              Invalid Keep IE Len 0
  Num Status Enq. Sent 569              Num Status msgs Rcvd 570
  Num Update Status Rcvd 0              Num Status Timeouts 0

Prasit#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
Prasit#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 route
Gateway of last resort is not set
     3.0.0.0/24 is subnetted, 1 subnets
C       3.1.3.0 is directly connected, Serial1
R    124.0.0.0/8 [120/1] via 3.1.3.1, 00:00:19, Serial1
     123.0.0.0/24 is subnetted, 1 subnets
C       123.123.123.0 is directly connected, Ethernet0
```

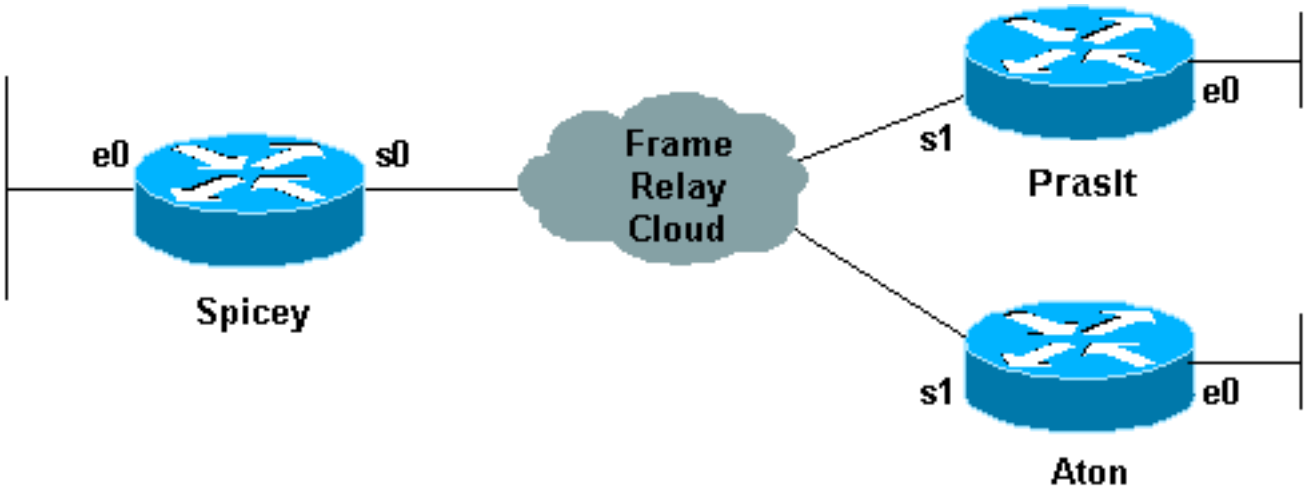
配置星形帧中继

在本例中，路由器知道它使用了哪些来自帧中继交换机的数据链路连接标识符(DLCI) ，并将它们分配到主接口。然后，路由器将逆向ARP获取远程IP地址。

注意：除非在每端明确添加帧中继映射，否则您将无法从Aton ping Prasit的串行IP地址。如果已经正确配置路由，在LAN上生成的数据流不会出现故障。如果在扩展的ping中将以太网IP地址用作源地址，您就能实现Ping操作。

启用frame-relay inverse-arp后，默认情况下，广播IP流量将通过连接传出。

网络图



配置

- 斯派西
- 普拉西
- 伊顿

斯派西

```
spicey#show running-config
Building configuration...
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname spicey
!
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 ip address 3.1.3.1 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 130
 frame-relay interface-dlci 140
!
!
router rip
 network 3.0.0.0
 network 124.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

普拉西

```
prasit#show running-config
Building configuration...

Current configuration : 1499 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname prasit
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
interface Serial1
 ip address 3.1.3.2 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 150
!
!
router rip
 network 3.0.0.0
 network 123.0.0.0
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

伊顿

```
aton#show running-config
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname aton
!
!
interface Ethernet0
ip address 122.122.122.1 255.255.255.0
!
interface Serial1
 ip address 3.1.3.3 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 160
!
router rip
 network 3.0.0.0
```

```
 network 122.0.0.0
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

显示命令

- show frame-relay map
- show frame-relay pvc
- ping <*device name*>

斯派西

```
spicey#show frame-relay map
Serial0 (up): ip 3.1.3.2 dlci 140(0x8C,0x20C0), dynamic,
              broadcast,, status defined, active
Serial0 (up): ip 3.1.3.3 dlci 130(0x82,0x2020), dynamic,
              broadcast,, status defined, active

spicey#show frame-relay pvc
PVC Statistics for interface Serial0 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          2            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 130, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0
  input pkts 32            output pkts 40           in bytes 3370
  out bytes 3928           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 30         out bcast bytes 2888
  pvc create time 00:15:46, last time pvc status changed 00:10:42

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0

  input pkts 282           output pkts 291          in bytes 25070
  out bytes 27876          dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 223        out bcast bytes 20884
  pvc create time 02:28:36, last time pvc status changed 02:25:14
spicey#
spicey#ping 3.1.3.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.1.3.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36 ms
spicey#ping 3.1.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.1.3.3, timeout is 2 seconds:
!!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36 ms
```

普拉西

```
prasit#show frame-relay map
Serial1 (up): ip 3.1.3.1 dlci 150(0x96,0x2460), dynamic,
              broadcast,, status defined, active

prasit#show frame-relay pvc

PVC Statistics for interface Serial1 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial1
  input pkts 311           output pkts 233          in bytes 28562
  out bytes 22648          dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 162        out bcast bytes 15748
  pvc create time 02:31:39, last time pvc status changed 02:25:14

prasit#ping 3.1.3.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.1.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
prasit#ping 3.1.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.1.3.3, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

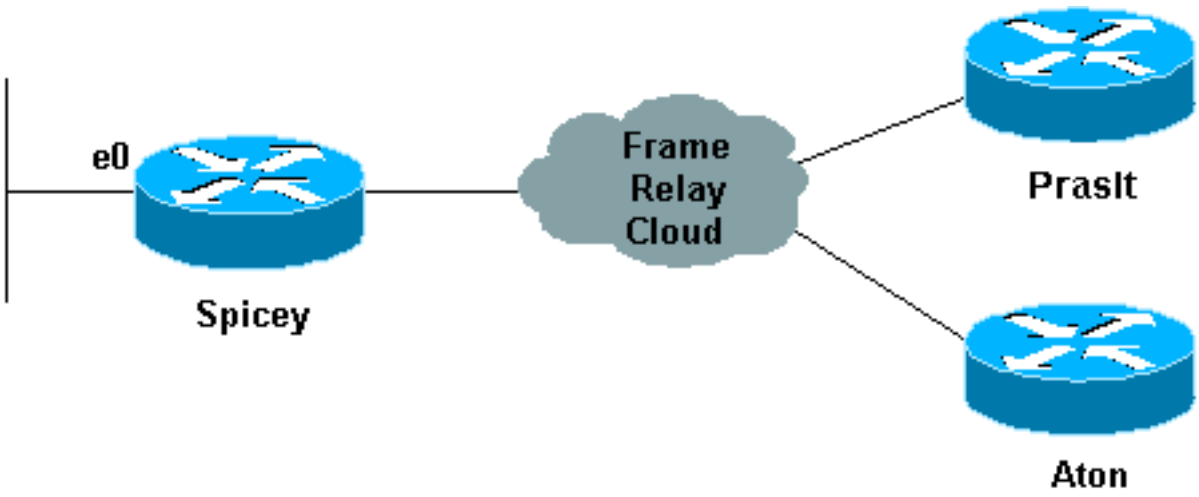
伊顿

```
aton#show frame-relay map
Serial1 (up): ip 3.1.3.1 dlci 160(0xA0,0x2800), dynamic,
              broadcast,, status defined, active

aton#show frame-relay pvc

PVC Statistics for interface Serial1 (Frame Relay DTE)

              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 160, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial1

  input pkts 35            output pkts 32           in bytes 3758
  out bytes 3366           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 27         out bcast bytes 2846
  pvc create time 00:10:53, last time pvc status changed 00:10:53

aton#ping 3.1.3.1

Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 3.1.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36 ms

aton#ping 3.1.3.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.1.3.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

分支间连接

在使用多点接口的星型结构中，您不能从一个支路ping通另一个支路， 因为没有其他支路的IP地址映射。只有集线器的地址通过逆向地址解析协议(IARP)获知。 如果您使用frame-relay map命令，将远程支路的IP地址配置静态映射，以使用本地的数据链路连接标识符(DLCI)，您也能够ping其他支路的地址。



配置

普拉西
prasit#**show running-config** interface Ethernet0 ip address 123.123.123.1 255.255.255.0 ! interface Serial ip address 3.1.3.2 255.255.255.0 encapsulation frame-relay frame-relay map ip 3.1.3.3 150 frame-relay interface-dlci 150

显示命令

- show frame-relay map
- ping <*device name*>
- show running-config

普拉西

```
prasit#show frame-relay map
 Serial1 (up): ip 3.1.3.1 dlci 150(0x96,0x2460), dynamic,
                   broadcast,, status defined, active
 Serial1 (up): ip 3.1.3.3 dlci 150(0x96,0x2460), static,
                   CISCO, status defined, active

 prasit#ping 3.1.3.3
 Type escape sequence to abort.
 Sending 5, 100-byte ICMP Echos to 3.1.3.3, timeout is 2 seconds:
 !!!!!
 Success rate is 100 percent (5/5), round-trip min/avg/max = 68/70/80 ms

 prasit#ping 122.122.122.1
 Type escape sequence to abort.
 Sending 5, 100-byte ICMP Echos to 122.122.122.1, timeout is 2 seconds:
 !!!!!
 Success rate is 100 percent (5/5), round-trip min/avg/max = 64/67/76 ms
```

伊顿

```
aton#show running-config
 interface Ethernet0
 ip address 122.122.122.1 255.255.255.0
 !
 interface Serial1
   ip address 3.1.3.3 255.255.255.0
   no ip directed-broadcast
   encapsulation frame-relay
   frame-relay map ip 3.1.3.2 160
   frame-relay interface-dlci 160

 aton#show frame-relay map
 Serial1 (up): ip 3.1.3.1 dlci 160(0xA0,0x2800), dynamic,
                   broadcast,, status defined, active
 Serial1 (up): ip 3.1.3.2 dlci 160(0xA0,0x2800), static,
                   CISCO, status defined, active
 aton#ping 3.1.3.2

 Type escape sequence to abort
 Sending 5, 100-byte ICMP Echos to 3.1.3.2, timeout is 2 seconds:
 !!!!!
 Success rate is 100 percent (5/5), round-trip min/avg/max = 68/68/68 ms

aton#ping 123.123.123.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/67/80 ms
```

配置帧中继子接口

帧中继子接口提供了一种机制，支持部分网状帧中继网络。大多数协议假定逻辑网络具有传递性；也就是说，如果A站能与B站通话，B站能与C站通话，则A站应该能够与C站直接通话。实际上传输在LAN上而不在帧中继网络上进行，除非A直接连接到C。

此外，部分网状网络不支持某些协议，例如AppleTalk、透明桥接和IPX，因为它们需要"水平分割"。在这些网络中，在一个接口上收到的信息包不能通过同一接口发出，即使信息包在不同的虚拟电路上接收和传输。

配置帧中继子接口可将单个物理接口用作多个虚拟接口。此功能使我们能够克服水平分割规则。虚拟接口收到的信息包现在可以转发给另一个虚拟接口，即使它们配置在同一个物理接口。

子接口通过将部分网状帧中继网络划分为许多较小的完全网状（或点对点）子网，为帧中继网络的限制问题提供了一种解决方法。每个子网络分配了它自己的网络编号，并且协议看起来好象可以通过独立接口达到。(注意，点到点子接口可能没有分配IP地址，以降低编址的负担)

点到点子接口

网络图

配置

- 斯派西
- 普拉西

斯派西

```
Spicey#show running-config
Building configuration...

Current configuration : 1338 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
enable password ww
!
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 no ip address
 encapsulation frame-relay
!
interface Serial0.1 point-to-point
 ip address 3.1.3.1 255.255.255.0
 frame-relay interface-dlci 140
!
!
```

```
router igrp 2
 network 3.0.0.0
 network 124.0.0.0
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...

Current configuration : 1234 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
 interface Serial1
 no ip address
 encapsulation frame-relay
!
interface Serial1.1 point-to-point
 ip address 3.1.3.2 255.255.255.0
 frame-relay interface-dlci 150
!
router igrp 2
 network 3.0.0.0
 network 123.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

显示命令

- show frame-relay map
- show frame-relay pvc

斯派西

```
Spicey#show frame-relay map
Serial0.1 (up): point-to-point dlci, dlci 140(0x8C,0x20C0), broadcast
             status defined, active

Spicey#show frame-relay pvc
PVC Statistics for interface Serial0 (Frame Relay DTE)

                 Active     Inactive      Deleted          Static
  Local          1               0            0               0
  Switched       0               0            0               0
  Unused         0               0            0               0

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0.1

  input pkts 193              output pkts 175          in bytes 20450
  out bytes 16340             dropped pkts 0           in FECN pkts 0
  in BECN pkts 0              out FECN pkts 0          out BECN pkts 0
  in DE pkts 0                out DE pkts 0
  out bcast pkts 50         out    bcast bytes 3786
  pvc create time 01:11:27, last time pvc status changed 00:42:32

Spicey#ping 123.123.123.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

普拉西

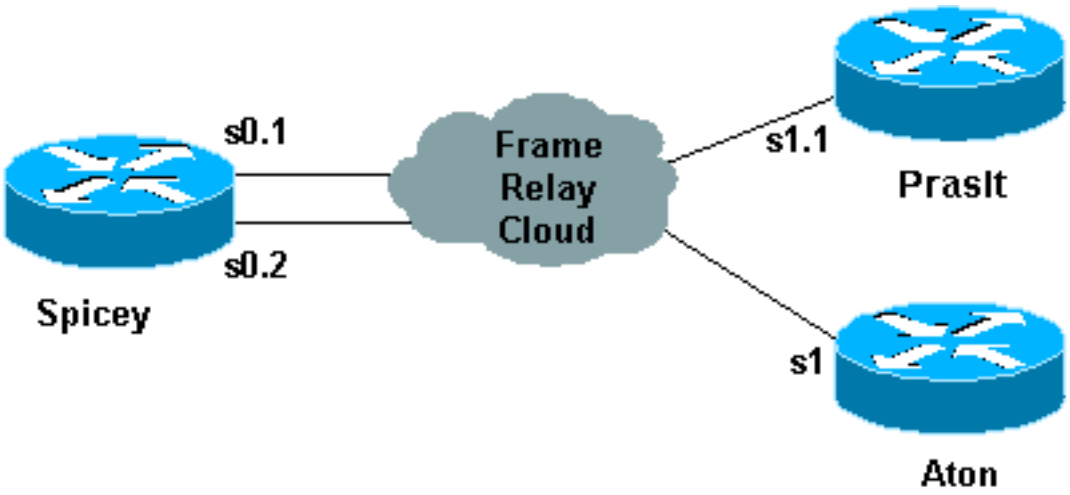
```
Prasit#show frame-relay map
Serial1.1 (up): point-to-point dlci, dlci 150(0x96,0x2460), broadcast
             status defined, active

Prasit#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)

                Active     Inactive      Deleted          Static
 Local          1               0            0               0
 Switched       0               0            0               0
 Unused         0               0            0               0

DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1.1

     input pkts 74               output pkts 89           in    bytes 7210
     out bytes 10963             dropped pkts 0           in    FECN pkts 0
     in BECN pkts 0              out FECN pkts 0          out BECN    pkts 0
     in DE pkts 0                out DE pkts 0
     out bcast pkts 24           out bcast bytes 4203
     pvc create time 00:12:25, last time pvc status changed 00:12:25

Prasit#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

星型连接子接口

以下中心辐射点配置示例显示两个点对点子接口，并在一个远程站点上使用动态地址解析。每个子接口带有单个协议地址和子网掩码，并且interface-dlci命令将子接口与一个指定的数据链路连接标

识符(DLCI)关联起来。 每个点到点子接口的远程目的地地址没有被解析，因为它们是点到点接口，流量必须发送到另一端的对等接口。远程终端(Aton)使用反向ARP进行映射，中心相应地回复子接口的IP地址。出现此情况是因为多点接口默认启用帧中继逆向ARP。

网络图



配置

- 斯派西
- 普拉西
- 伊顿

斯派西

```
Spicey#show running-config
Building configuration...
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 no ip address
 encapsulation frame-relay
!
interface Serial0.1 point-to-point
 ip address 4.0.1.1 255.255.255.0
 frame-relay interface-dlci 140
!
interface Serial0.2 point-to-point
 ip address 3.1.3.1 255.255.255.0
 frame-relay interface-dlci 130
```

```
!
router igrp 2
 network 3.0.0.0
 network 4.0.0.0
 network 124.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...

version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
interface Serial1
 no ip address
 encapsulation frame-relay
!
interface Serial1.1 point-to-point
 ip address 4.0.1.2 255.255.255.0
 frame-relay interface-dlci 150
!
router igrp 2
 network 4.0.0.0
 network 123.0.0.0
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

伊顿

```
Aton#show running-config
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
!
```

```
hostname Aton
!
!
!
interface Ethernet0
 ip address 122.122.122.1 255.255.255.0
!
interface Serial1
 ip address 3.1.3.3 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 160
!
router igrp 2
 network 3.0.0.0
 network 122.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

显示命令

- show frame-relay map
- show frame-relay pvc

斯派西

```
Spicey#show frame-relay map
Serial0.2 (up): point-to-point dlci, dlci 130(0x82,0x2020), broadcast
          status defined, active
Serial0.1 (up): point-to-point dlci, dlci 140(0x8C,0x20C0), broadcast
          status defined, active

Spicey#show frame-relay pvc
PVC Statistics for interface Serial0 (Frame Relay DTE)

               Active     Inactive      Deleted       Static
  Local           2            0            0            0
  Switched        0            0            0            0
  Unused          0            0            0            0

DLCI = 130, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0.2

  input pkts 11            output pkts 22           in bytes 1080
  out bytes 5128           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 17         out bcast bytes 4608
  pvc create time 00:06:36, last time pvc status changed 00:06:36

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0.1

  input pkts 33            output pkts 28           in bytes 3967
  out bytes 5445           dropped pkts 0           in FECN pkts 0
```

```
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 17        out bcast bytes 4608
  pvc create time 00:06:38, last time pvc status changed 00:06:38

Spicey#ping 122.122.122.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 122.122.122.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36 ms

Spicey#ping 123.123.123.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

普拉西

```
Prasit#show frame-relay map
Serial1.1 (up): point-to-point dlci, dlci 150(0x96,0x2460), broadcast
          status defined, active

Prasit#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)

              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1.1

  input pkts 45            output pkts 48           in bytes 8632
  out bytes 6661           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 31         out bcast bytes 5573
  pvc create time 00:12:16, last time pvc status changed 00:06:23

Prasit#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

伊顿

```
Aton#show frame-relay map
Serial1 (up): ip 3.1.3.1 dlci 160(0xA0,0x2800), dynamic,
              broadcast,, status defined, active

Aton#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)

              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 160, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial1
```

```
  input pkts 699           output pkts 634          in bytes 81290
  out bytes 67008          dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 528        out bcast bytes 56074
  pvc create time 05:46:14, last time pvc status changed 00:05:57

Aton#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

配置多点子接口的动态和静态映射

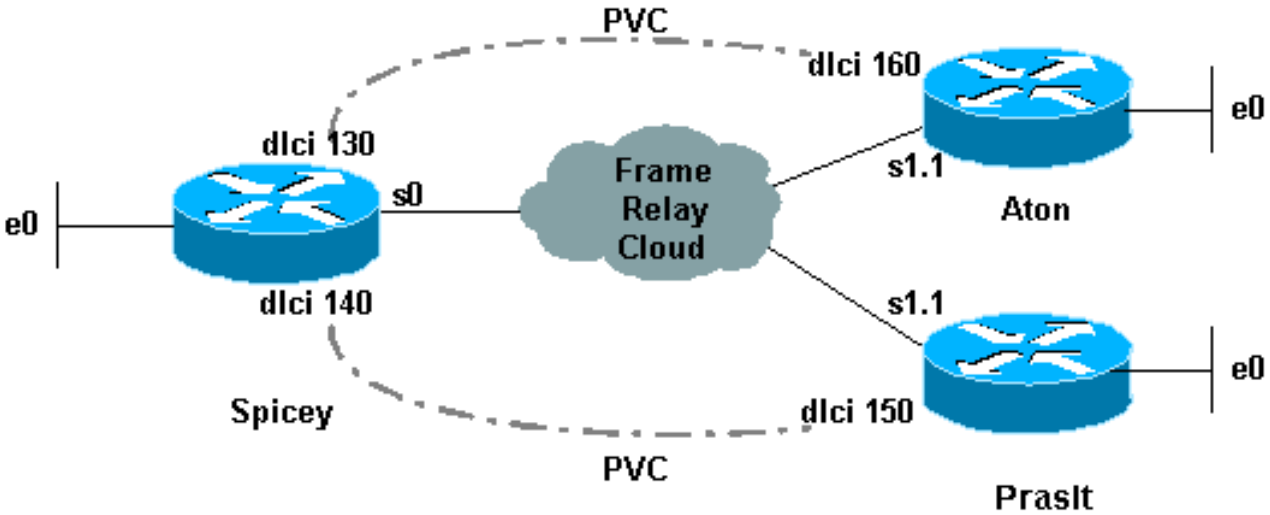
在给定了数据链路连接标识符(DLCI)的情况下，动态地址映射使用帧中继逆向ARP，以请求实现特殊连接的下一跳协议地址。 反向ARP请求的回应被输入到路由器或接入服务器上的地址到DLCI的映射表中。然后表可以为流出的数据流提供下一跳协议地址或DLCI。

由于物理接口现在配置为多个子接口，您必须提供一些信息，以区分子接口和物理接口，将特定子接口与特定DLCI关联。

在默认情况下，所有支持协议都能使用反向ARP，而但在某些特殊协议DLCI对中则可能被限制使用。结果是，您可以把动态映射用于某些协议，把静态映射用于相同DLCI上的其他协议。如果您知道连接的另一端不支持协议，您就能明确地禁用协议DLCI对的反向ARP。由于反向ARP默认在它支持的所有协议上都是启动的，因此不需要使用其他命令在子接口上配置动态地址映射。静态映射将指定的下一跳协议地址链接到指定的DLCI。静态映射无需逆向ARP请求；在您提供静态映射时，特定DLCI上的指定的协议将自动禁用反向ARP。如果路由器在另一端完全不支持反向ARP，或者不支持您要在帧中继上使用的特定协议的反向ARP，您必须使用静态映射。

网络图

我们已经了解如何配置思科路由器以执行逆向ARP。下例显示的是如何在您需要用于多点接口或子接口的情况下配置静态映射：



配置

- 伊顿

- 斯派西
- 普拉西

伊顿

```
Aton#show running-config
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Aton
!
!
interface Ethernet0
 ip address 122.122.122.1 255.255.255.0
!
interface Serial1
 no ip address
 encapsulation frame-relay
!
interface Serial1.1 multipoint
 ip address 4.0.1.3 255.255.255.0
 frame-relay map ip 4.0.1.1 160 broadcast
!
router igrp 2
 network 4.0.0.0
 network 122.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

斯派西

```
Spicey#show running-config
Building configuration...Current configuration : 1652
bytes!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
!
interface Ethernet0
ip address 124.124.124.1 255.255.255.0
!
interface Serial0
ip address 4.0.1.1 255.255.255.0
encapsulation frame-relay
frame-relay map ip 4.0.1.2 140 broadcast
frame-relay map ip 4.0.1.3 130 broadcast
```

```
!
router igrp 2
network 4.0.0.0
network 124.0.0.0
!
!
line con 0
exec-timeout 0 0
transport input none
line aux 0
line vty 0 4
login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...
Current configuration : 1162 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
interface Serial1
 no ip address
 encapsulation frame-relay
!
interface Serial1.1 multipoint
 ip address 4.0.1.2 255.255.255.0
 frame-relay map ip 4.0.1.1 150 broadcast
!
router igrp 2
 network 4.0.0.0
 network 123.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

debug 和 show 命令

- show frame-relay map
- show frame-relay pvc

伊顿

```
Aton#show frame-relay map
Serial1.1 (up): ip 4.0.1.1 dlci 160(0xA0,0x2800), static, broadcast,
CISCO, status defined, active

Aton#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0
DLCI = 160, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1.1

  input pkts 16            output pkts 9            in bytes 3342
  out bytes 450            dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 9          out bcast bytes 450
  pvc create time 00:10:02, last time pvc status changed 00:10:02

Aton#ping 124.124.124.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36 ms
```

斯派西

```
Spicey#show frame-relay map
Serial0 (up): ip 4.0.1.2 dlci 140(0x8C,0x20C0), static, broadcast,
              CISCO, status defined, active
Serial0 (up): ip 4.0.1.3 dlci 130(0x82,0x2020), static, broadcast,
              CISCO, status defined, active

Spicey#show frame-relay pvc
PVC Statistics for interface Serial0 (Frame Relay DTE)

              Active     Inactive      Deleted       Static
  Local          2            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 130, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0

  input pkts 9              output pkts 48           in bytes 434
  out bytes 11045           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0            out FECN pkts 0          out BECN pkts 0
  in DE pkts 0              out DE pkts 0
  out bcast pkts 48         out bcast bytes 11045
  pvc create time 00:36:25, last time pvc status changed 00:36:15

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0

  input pkts 17             output pkts 26           in bytes 1390
  out bytes 4195            dropped pkts 0           in FECN pkts 0
  in BECN pkts 0            out FECN pkts 0          out BECN pkts 0
  in DE pkts 0              out DE pkts 0
  out bcast pkts 16         out bcast bytes 3155
pvc create time 00:08:39, last time pvc status changed 00:08:39
```

```
Spicey#ping 122.122.122.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 122.122.122.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/40 ms

Spicey#ping 123.123.123.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36
```

普拉西

```
Prasit#show frame-relay map
Serial1.1 (up): ip 4.0.1.1 dlci 150(0x96,0x2460), static,
              broadcast,
              CISCO, status defined, active

Prasit#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0
DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial1.1
  input pkts 28            output pkts 19           in bytes 4753
  out bytes 1490           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 9         out bcast bytes 450
pvc create time 00:11:00, last time pvc status changed 00:11:00

Prasit#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

有关这些命令的详细信息，请参阅帧中继命令。

配置 IP 无编号帧中继

如果您没有IP地址空间来使用许多子接口，您可以在每个子接口上使用未编号的IP。如果出现这种情况，您需要使用静态路由或动态路由，以便您的数据流照常被路由，并且您必须使用点到点子接口。

网络图

以下示例说明如下：

配置

- 斯派西
- 普拉西

斯派西

```
Spicey#show running-config
Building configuration...
Current configuration : 1674 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 no ip address
 encapsulation frame-relay
!
interface Serial0.1 point-to-point
 ip unnumbered Ethernet0
 frame-relay interface-dlci 140
!
router igrp 2
 network 124.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...

Current configuration : 1188 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
```

```
interface Serial1
 no ip address
 encapsulation frame-relay
!
interface Serial1.1 point-to-point
 ip unnumbered Ethernet0
 frame-relay interface-dlci 150
!
router igrp 2
 network 123.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 login
!
end
```

显示命令

- show frame-relay map
- show frame-relay pvc

斯派西

```
Spicey#show frame-relay map
Serial0.1 (up): point-to-point dlci, dlci 140(0x8C,0x20C0), broadcast
          status defined, active

Spicey#show frame-relay pvc

PVC Statistics for interface Serial0 (Frame Relay DTE)

               Active     Inactive      Deleted       Static
  Local           1            0            0            0
  Switched        0            0            0            0
  Unused          0            0            0            0

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0.1

  input pkts 23            output pkts 24           in bytes 3391
  out bytes 4952           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 14         out bcast bytes 3912
  pvc create time 00:04:47, last time pvc status changed 00:04:47

Spicey#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 route
```

```
Gateway of last resort is not set
     124.0.0.0/24 is subnetted, 1 subnets
C       124.124.124.0 is directly connected, Ethernet0
     123.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
I       123.0.0.0/8 [100/8576] via 123.123.123.1, 00:01:11, Serial0.1
I       123.123.123.0/32 [100/8576] via 123.123.123.1, 00:01:11,
Serial0.1

Spicey#ping 123.123.123.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

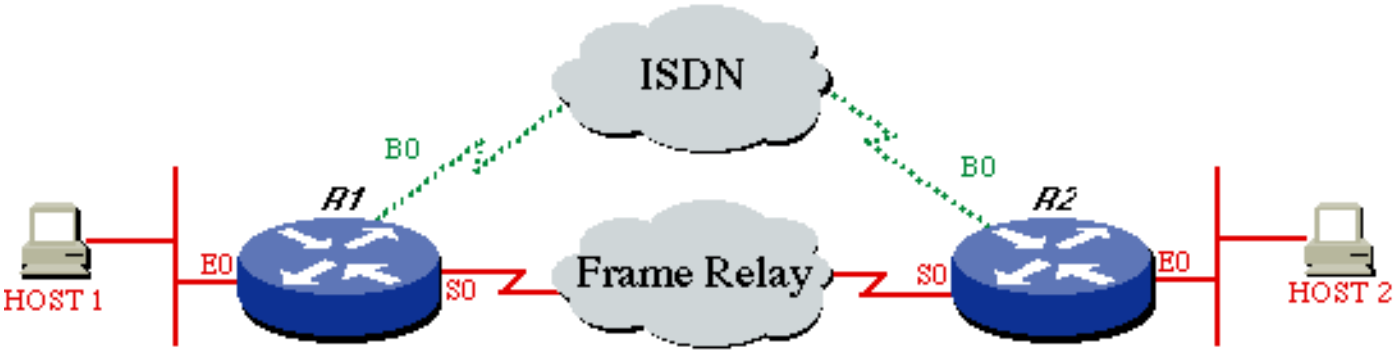
普拉西

```
Prasit#show frame-relay map
Serial1.1 (up): point-to-point dlci, dlci 150(0x96,0x2460), broadcast
          status defined, active

Prasit#show frame-relay pvc

PVC Statistics for interface Serial1 (Frame Relay DTE)
              Active     Inactive      Deleted       Static
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0
DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1.1

  input pkts 24            output pkts 52           in bytes 4952
  out bytes 10892          dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 41         out bcast bytes 9788
  pvc create time 00:10:54, last time pvc status changed 00:03:51

Prasit#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 route

Gateway of last resort is not set
     124.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
I       124.0.0.0/8 [100/8576] via 124.124.124.1, 00:00:18, Serial1.1
I       124.124.124.0/32 [100/8576] via 124.124.124.1, 00:00:18,
Serial1.1
     123.0.0.0/24 is subnetted, 1 subnets
C       123.123.123.0 is directly connected, Ethernet0

Prasit#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/120/436 ms
```

配置帧中继备份

ISDN 上的帧中继备份

您可能希望使用ISDN备份帧中继电路。实现的方式有几种。第一个，也很可能是最佳一个，使用浮动静态路由，将流量路由到基本速率接口(BRI) IP地址，并使用适当的路由度量指标。您也可以在主要接口上或根据每个数据链接的连接标识符(DLCI)使用备份接口。对于备份主要接口，它的作用可能不大，因为您可能丢失永久虚拟电路(PVC)，而主要接口不会断开。请记住，协议是与本地帧中继交换机而不是远程路由器交换的。



配置

- 路由器 1
- 路由器 2

路由器 1

```
ROUTER1#
!
hostname ROUTER1
!
username ROUTER2 password same
 isdn switch-type basic-dms100
!
interface Ethernet 0
 ip address 172.16.15.1 255.255.255.248
!
interface serial 0
 ip address 172.16.24.129 255.255.255.128
 encapsulation FRAME-RELAY
!
interface BRI0
 description Backup ISDN for frame-relay
 ip address 172.16.12.1 255.255.255.128
 encapsulation PPP
 dialer idle-timeout 240
 dialer wait-for-carrier-time 60
 dialer map IP 172.16.12.2 name ROUTER2 broadcast
7086639706
 ppp authentication chap
 dialer-group 1
 isdn spid1 0127280320 2728032
 isdn spid2 0127295120 2729512
!
router igrp 1
```

```
 network 172.16.0.0
!
ip route 172.16.15.16 255.255.255.248 172.16.12.2 150
!--- Floating static route. ! access-list 101 deny igrp
0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255 access-
list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0
255.255.255.255 dialer-list 1 LIST 101 !
```

路由器 2

```
ROUTER2#
!
hostname ROUTER2
!
username ROUTER1 password same
 isdn switch-type basic-dms100
!
interface Ethernet 0
 ip address 172.16.15.17 255.255.255.248
!
interface Serial 0
 ip address 172.16.24.130 255.255.255.128
 encapsulation FRAME-RELAY
!
interface BRI0
 description ISDN backup interface for frame-relay
 ip address 172.16.12.2 255.255.255.128
 encapsulation PPP
 dialer idle-timeout 240
 dialer map IP 172.16.12.1 name ROUTER1 broadcast
 ppp authentication chap
 pulse-time 1
 dialer-group 1
 isdn spid1 0191933333 4445555
 isdn spid2 0191933334 4445556
!
router igrp 1
 network 172.16.0.0
!
ip route 172.16.15.0 255.255.255.248 172.16.12.1 150
!--- Floating static route. ! access-list 101 deny igrp
0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255 access-
list 101 permit ip 0.0.0.0 255.255.255.255 162.27.9.0
0.0.0.255 dialer-list 1 LIST 101 !
```

显示命令

要验证ISDN是否工作，请使用以下**debug**命令。在发出 **debug 命令之前，请参阅**有关 Debug 命令的重要信息。

- **debug isdn q931**
- **debug ppp neg**
- **debug ppp auth**

尝试从主叫方向中心方发出ISDN呼叫，而不使用backup命令。如果成功，请将backup命令添加到主叫方。

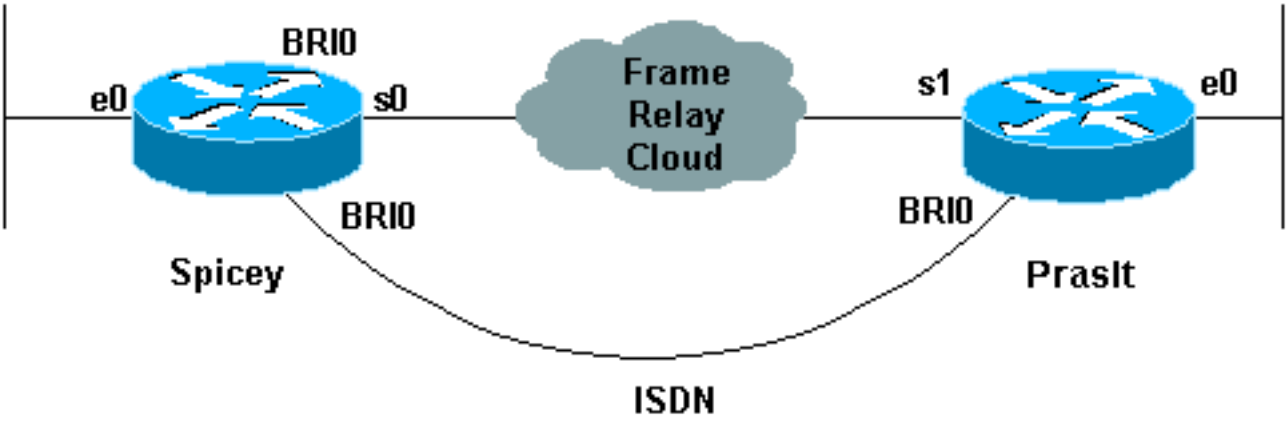
注意：要测试备份，请勿在串行接口上使用**shutdown** 命令，而是通过从串行线路拔出电缆来模拟实际串行线路问题。

配置每个 DCLI 备份

我们现在假设Spicey是中心端，Prasit是与中心端(Spicey)建立连接的端。 注意您只能将backup命令添加到呼叫中心端上。

注意： 子接口不支持备份负载。由于我们不跟踪子接口上的流量级别，因此不计算负载。

网络图



配置

- 斯派西
- 普拉西

斯派西

```
Spicey#show running-config
Building configuration...

Current configuration : 1438 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
!
username Prasit password 0 cisco
!
!
isdn switch-type basic-net3
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 no ip address
 encapsulation frame-relay
!
```

```
interface Serial0.1 point-to-point
 ip address 4.0.1.1 255.255.255.0
 frame-relay interface-dlci 140
!
interface BRI0
 ip address 3.1.6.1 255.255.255.0
 encapsulation ppp
 dialer map ip 3.1.6.2 name Prasit broadcast
 dialer-group 1
 isdn switch-type basic-net3
 no peer default ip address
 no cdp enable
 ppp authentication chap
!
router igrp 2
 network 3.0.0.0
 network 4.0.0.0
 network 124.0.0.0
!
ip classless
 ip route 123.123.123.0 255.255.255.0 3.1.6.2 250
!
access-list 101 deny   igrp any any
 access-list 101 permit ip any any
 dialer-list 1 protocol ip list 101
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...

Current configuration : 1245 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
username Spicey password 0 cisco
!
!
isdn switch-type basic-net3
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
interface Serial1
 no ip address
 encapsulation frame-relay
!
```

```
interface Serial1.1 point-to-point
 backup delay 5 10
 backup interface BRI0
 ip address 4.0.1.2 255.255.255.0
 frame-relay interface-dlci 150
!
interface BRI0
 ip address 3.1.6.2 255.255.255.0
 encapsulation ppp
 dialer map ip 3.1.6.1 name Spicey broadcast 6106
 dialer-group 1
 isdn switch-type basic-net3
 ppp authentication chap
!
router igrp 2
 network 3.0.0.0
 network 4.0.0.0
 network 123.0.0.0
!
ip route 124.124.124.0 255.255.255.0 3.1.6.1 250
!
access-list 101 deny   igrp any any
 access-list 101 permit ip any any
 dialer-list 1 protocol ip list 101
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

显示命令

- show frame-relay map
- show ip route
- show isdn history
- show isdn status
- show interface bri 0
- show isdn active

斯派西

```
Spicey#show frame-relay map
   Serial0.2 (up): point-to-point dlci, dlci 130(0x82,0x2020), broadcast
             status defined, active
   Serial0.1 (up): point-to-point dlci, dlci 140(0x8C,0x20C0), broadcast
             status defined, active

   Spicey#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 route

Gateway of last resort is not set

     3.0.0.0/24 is subnetted, 2 subnets C
     3.1.3.0 is directly connected, Serial0.2 C
     3.1.6.0 is directly connected, BRI0
     4.0.0.0/24 is subnetted, 1 subnets C
     4.0.1.0 is directly connected, Serial0.1
     124.0.0.0/24 is subnetted, 1 subnets C
     124.124.124.0 is directly connected, Ethernet0
     123.0.0.0/8 is variably subnetted, 2 subnets, 2 masks I
     123.0.0.0/8 [100/8576] via 4.0.1.2, 00:00:00, Serial0.1 S
     123.123.123.0/24 [250/0] via 3.1.6.2 I
     122.0.0.0/8 [100/8576] via 3.1.3.3, 00:00:37, Serial0.2

Spicey#
*Mar  1 00:59:12.527: %LINK-3-UPDOWN: Interface BRI0:1, changed state to up
*Mar  1 00:59:13.983: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:1, changed state to up
*Mar  1 00:59:18.547: %ISDN-6-CONNECT: Interface BRI0:1 is now connected to 6105 Prasit

Spicey#show isdn history
------------------------------------------------------------------------------
                                ISDN CALL HISTORY
------------------------------------------------------------------------------
Call History contains all active calls, and a maximum of 100 inactive calls.
Inactive call data will be retained for a maximum of 15 minutes.
------------------------------------------------------------------------------
Call    Calling      Called          Remote  Seconds Seconds Seconds
Charges
Type    Number       Number          Name    Used    Left    Idle  Units/Currency
------------------------------------------------------------------------------
In         6105           6106       Prasit          31      90     29
------------------------------------------------------------------------------

Spicey#
*Mar  1 01:01:14.547: %ISDN-6-DISCONNECT: Interface BRI0:1  disconnected
from 6105 Prasit, call lasted 122 seconds
*Mar  1 01:01:14.663: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
*Mar  1 01:01:15.663: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:1, changed state to down
```

普拉西

```
Prasit#show frame-relay map
   Serial1.1 (up): point-to-point dlci, dlci 150(0x96,0x2460), broadcast
             status defined, active

   Prasit#ping 124.124.124.1

   Type escape sequence to abort.
   Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
   !!!!!
   Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/40 ms

   Prasit#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 route

   Gateway of last resort is not set

   I    3.0.0.0/8 [100/10476] via 4.0.1.1, 00:00:55, Serial1.1
        4.0.0.0/24 is subnetted, 1 subnets
   C    4.0.1.0 is directly connected, Serial1.1
        124.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
   S    124.124.124.0/24 [250/0] via 3.1.6.1
   I    124.0.0.0/8 [100/8576] via 4.0.1.1, 00:00:55, Serial1.1
        123.0.0.0/24 is subnetted, 1 subnets
   C    123.123.123.0 is directly connected, Ethernet0
   I    122.0.0.0/8 [100/10576] via 4.0.1.1, 00:00:55, Serial1.1
```

串行线路断开。

```
Prasit#
   *Mar  1 01:23:50.531: %LINK-3-UPDOWN: Interface Serial1, changed state to down
   *Mar  1 01:23:51.531: %LINEPROTO-5-UPDOWN: Line protocol on Interface
   Serial1, changed state to down
   *Mar  1 01:23:53.775: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
   *Mar  1 01:23:53.791: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down
   *Mar  1 01:23:53.827: %LINK-3-UPDOWN: Interface BRI0, changed state to up
   *Mar  1 01:23:57.931: %ISDN-6-LAYER2UP: Layer 2 for Interface BR0, TEI 64 changed to up

   Prasit#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 route

   Gateway of last resort is not set

        3.0.0.0/24 is subnetted, 1 subnets
   C    3.1.6.0 is directly connected, BRI0
        124.0.0.0/24 is subnetted, 1 subnets
   S    124.124.124.0 [250/0] via 3.1.6.1
        123.0.0.0/24 is subnetted, 1 subnets
   C    123.123.123.0 is directly connected, Ethernet0

   Prasit#show isdn status
   Global ISDN Switchtype = basic-net3
   ISDN BRI0 interface
           dsl 0, interface ISDN Switchtype = basic-net3
       Layer 1 Status:
           ACTIVE
       Layer 2 Status:
           TEI = 64, Ces = 1, SAPI = 0, State = MULTIPLE_FRAME_ESTABLISHED
       Layer 3 Status:
           0 Active Layer 3 Call(s)
       Active dsl 0 CCBs = 0
       The Free Channel Mask:  0x80000003
       Total Allocated ISDN CCBs = 0

   Prasit#ping 124.124.124.1

   Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!
*Mar  1 01:25:47.383: %LINK-3-UPDOWN: Interface BRI0:1, changed state to up!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 36/36/36 ms
Prasit#
*Mar  1 01:25:48.475: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:1, changed state to up

Prasit#
*Mar  1 01:25:53.407: %ISDN-6-CONNECT: Interface BRI0:1 is now connected
to 6106 Spicey

Prasit#show isdn status
Global ISDN Switchtype = basic-net3
ISDN BRI0 interface
        dsl 0, interface ISDN Switchtype = basic-net3
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 64, Ces = 1, SAPI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Layer 3 Status:
        1 Active Layer 3 Call(s)
        CCB:callid=8003, sapi=0, ces=1, B-chan=1, calltype=DATA
    Active dsl 0 CCBs = 1
    The Free Channel Mask: 0x80000002
    Total Allocated ISDN CCBs = 1

Prasit#show isdn active
------------------------------------------------------------------------------
                                ISDN ACTIVE CALLS
------------------------------------------------------------------------------
Call    Calling      Called          Remote  Seconds Seconds Seconds Charges
Type    Number       Number          Name    Used    Left    Idle    Units/Currency
------------------------------------------------------------------------------
Out                   6106         Spicey      21     100      19       0
------------------------------------------------------------------------------

Prasit#
*Mar  1 01:27:49.027: %ISDN-6-DISCONNECT: Interface BRI0:1  disconnected
from 6106 Spicey, call lasted 121 seconds
*Mar  1 01:27:49.131: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
*Mar  1 01:27:50.131: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:1, changed state to down
*Mar  1 01:28:09.215: %LINK-3-UPDOWN: Interface Serial1, changed state to up
*Mar  1 01:28:10.215: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial1, changed state to up
*Mar  1 01:28:30.043: %ISDN-6-LAYER2DOWN: Layer 2 for Interface BRI0,
TEI 64 changed to down
*Mar  1 01:28:30.047: %ISDN-6-LAYER2DOWN: Layer 2 for Interface BR0, TEI
64 changed to down
*Mar  1 01:28:30.371: %LINK-5-CHANGED: Interface BRI0, changed state to standby mode
*Mar  1 01:28:30.387: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
*Mar  1 01:28:30.403: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down
Prasit#
```

串行连接再次恢复。

```
Prasit#show isdn status
   Global ISDN Switchtype = basic-net3
   ISDN BRI0 interface
           dsl 0, interface    ISDN Switchtype = basic-net3
       Layer 1 Status:
           DEACTIVATED
```

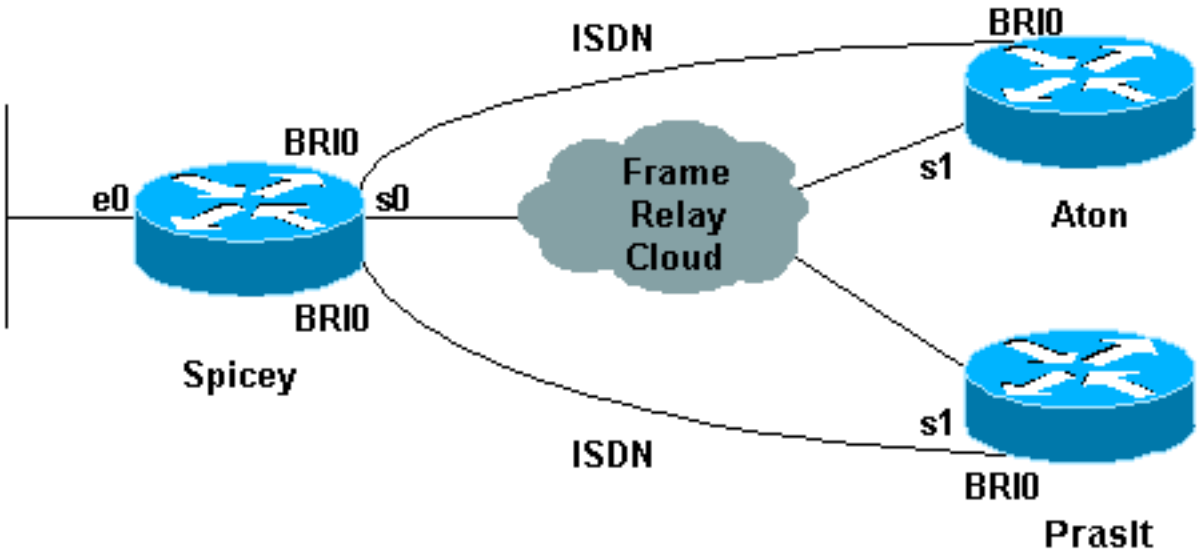
```
    Layer 2 Status:
        Layer 2 NOT Activated
    Layer 3 Status:
        0 Active Layer    3 Call(s)
    Active dsl 0 CCBs = 0
    The Free Channel Mask:  0x80000003
    Total Allocated ISDN CCBs = 0

Prasit#show interface bri 0
BRI0 is standby mode, line protocol is down
  Hardware is BRI
  Internet address is 3.1.6.2/24
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, loopback not set
  Last input 00:01:00, output 00:01:00, output hang never
  Last clearing of "show interface" counters 01:28:16
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/16 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     128 packets input, 601 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
     132 packets output, 687 bytes, 0 underruns
     0 output errors, 0 collisions, 10 interface resets
     0 output buffer failures, 0 output buffers swapped out
     14 carrier transitions

Prasit#ping 124.124.124.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
```

带有拨号程序配置文件的星型网

以下是按DLCI备份配置的中心辐射点示例。分支路由器正在呼叫中心路由器。您可以看到，我们在中心端的拨号池上使用max-link选项，每端只允许一条B信道。

注意：子接口不支持备份负载。由于我们不跟踪子接口上的流量级别，因此不计算负载。

网络图



配置

- 伊顿
- 斯派西
- 普拉西

伊顿

```
Aton#show running-config
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Aton
!
!
username Spicey password 0 cisco
!
isdn switch-type basic-net3
!
!
!
interface Ethernet0
 ip address 122.122.122.1 255.255.255.0
!
!
interface Serial1
 no ip address
 encapsulation frame-relay
!
interface Serial1.1 point-to-point
 ip address 3.1.3.3 255.255.255.0
 backup delay 5 10
 backup interface BRI0
 frame-relay interface-dlci 160
```

```
!
interface BRI0
 ip address 155.155.155.3 255.255.255.0
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 dialer map ip 155.155.155.2 name Spicey broadcast 6106
 dialer-group 1
 isdn switch-type basic-net3
 ppp authentication chap
!
router igrp 2
 network 3.0.0.0
 network 122.0.0.0
 network 155.155.0.0
!
ip route 124.124.124.0 255.255.255.0 155.155.155.2 250
!
access-list 101 deny   igrp any any
 access-list 101 permit ip any any
 dialer-list 1 protocol ip list 101
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

斯派西

```
Spicey#show running-config
Building configuration...
Current configuration : 1887 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
username Prasit password 0 cisco
username Aton password 0 cisco
!
isdn switch-type basic-net3
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 no ip address
 encapsulation frame-relay
!
interface Serial0.1 point-to-point
 ip address 4.0.1.1 255.255.255.0
 frame-relay interface-dlci 140
!
interface Serial0.2 point-to-point
```

```
 ip address 3.1.3.1 255.255.255.0
 frame-relay interface-dlci 130
!
interface BRI0
 no ip address
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 dialer pool-member 2 max-link 1
 dialer pool-member 1 max-link 1
 isdn switch-type basic-net3
 no peer default ip address
 no cdp enable
 ppp authentication chap
!
interface Dialer1
 ip address 160.160.160.1 255.255.255.0
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 dialer pool 1
 dialer remote-name Prasit
 dialer-group 1
 ppp authentication chap
!
interface Dialer2
 ip address 155.155.155.2 255.255.255.0
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 dialer pool 2
 dialer remote-name Aton
 dialer-group 1
 ppp authentication chap
!
router igrp 2
 network 3.0.0.0
 network 4.0.0.0
 network 124.0.0.0
 network 155.155.0.0
 network 160.160.0.0
!
access-list 101 deny   igrp any any
 access-list 101 permit ip any any
 dialer-list 1 protocol ip list 101
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...

Current configuration : 1267 bytes
!
version 12.1
```

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
username Spicey password 0 cisco
!
isdn switch-type basic-net3
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
interface Serial1
  no ip address
  encapsulation frame-relay
!
interface Serial1.1 point-to-point
 backup delay 5 10
 backup interface BRI0
 ip address 4.0.1.2 255.255.255.0
 frame-relay interface-dlci 150
!
interface BRI0
 ip address 160.160.160.2 255.255.255.0
 encapsulation ppp
 dialer map ip 160.160.160.1 name Spicey broadcast 6106
 dialer-group 1
 isdn switch-type basic-net3
 ppp authentication chap
!
router igrp 2
 network 4.0.0.0
 network 123.0.0.0
 network 160.160.0.0
!
ip route 124.124.124.0 255.255.255.0 160.160.160.1 250
!
access-list 101 deny   igrp any any
 access-list 101 permit ip any any
 dialer-list 1 protocol ip list 101
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

显示命令

- show frame-relay map
- show ip route
- show frame map
- show frame-relay pvc

伊顿

```
Aton#show frame-relay map
   Serial1.1 (up): point-to-point dlci, dlci 160(0xA0,0x2800), broadcast
             status defined, active

   Aton#ping 124.124.124.1
   Type escape sequence to abort.
   Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
   !!!!!
   Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms

   Aton#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, * - candidate default
          U - per-user static route, o - ODR, P - periodic downloaded static route
          T - traffic engineered route

   Gateway of last resort is not set

   I    155.155.0.0/16 [100/182571] via 3.1.3.1, Serial1.1
        3.0.0.0/24 is subnetted, 1 subnets
   C    3.1.3.0 is directly connected, Serial1.1
   I    4.0.0.0/8 [100/10476] via 3.1.3.1, Serial1.1
   I    160.160.0.0/16 [100/182571] via 3.1.3.1, Serial1.1
        124.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
   S    124.124.124.0/24 [250/0] via 155.155.155.2
   I    124.0.0.0/8 [100/8576] via 3.1.3.1, Serial1.1
   I    123.0.0.0/8 [100/10576] via 3.1.3.1, Serial1.1
        122.0.0.0/24 is subnetted, 1 subnets
   C    122.122.122.0 is directly connected, Ethernet0
   Aton#
```

串行1断开。

```
Aton#
   01:16:33: %LINK-3-UPDOWN: Interface Serial1, changed state to down
   01:16:34: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1,
   changed state to down
   01:16:37: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
   01:16:37: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down
   01:16:37: %LINK-3-UPDOWN: Interface BRI0, changed state to up
   01:16:41: %ISDN-6-LAYER2UP: Layer 2 for Interface BR0, TEI 64 changed to up

   Aton#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, * - candidate default
          U - per-user static route, o - ODR, P - periodic downloaded static route
          T - traffic engineered route

   Gateway of last resort is not set
        155.155.0.0/24 is subnetted, 1 subnets
   C    155.155.155.0 is directly connected, BRI0
        124.0.0.0/24 is subnetted, 1 subnets
   S    124.124.124.0 [250/0] via 155.155.155.2
```

```
     122.0.0.0/24 is subnetted, 1 subnets
C    122.122.122.0 is directly connected, Ethernet0

Aton#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:

01:21:33: %LINK-3-UPDOWN: Interface BRI0:1, changed state to up.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 36/36/36 ms
Aton#
01:21:34: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:1,
changed state to up
01:21:39: %ISDN-6-CONNECT: Interface BRI0:1 is now connected to 6106
Spicey

Aton#ping 124.124.124.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/123/296 ms
Aton#
```

Serial 1再次变为活动状态

```
Aton#
01:24:02: %ISDN-6-DISCONNECT: Interface BRI0:1  disconnected from 6106
Spicey, call lasted 149 seconds
01:24:02: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
01:24:03: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:1,
changed state to down

Aton#show frame map
Serial1.1 (down): point-to-point dlci, dlci 160(0xA0,0x2800), broadcast
          status deleted
Aton#
01:26:35: %LINK-3-UPDOWN: Interface Serial1, changed state to up
01:26:36: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1,
changed state to up
01:26:56: %ISDN-6-LAYER2DOWN: Layer 2 for Interface BRI0, TEI 64 changed
to down
01:26:56: %ISDN-6-LAYER2DOWN: Layer 2 for Interface BR0, TEI 64 changed
to down
01:26:56: %LINK-5-CHANGED: Interface BRI0, changed state to standby mode
01:26:56: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
01:26:56: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down

Aton#show frame map
Serial1.1 (up): point-to-point dlci, dlci 160(0xA0,0x2800), broadcast
          status defined, active
Aton#ping 124.124.124.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms

Aton#ping 124.124.124.1

Aton#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)
                 Active     Inactive      Deleted          Static
  Local          1               0            0               0
```

```
  Switched       0               0            0               0
  Unused         0               0            0               0

DLCI = 160, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1.1
  input pkts 60               output pkts 69           in    bytes 9694
  out bytes 10811             dropped pkts 0           in    FECN pkts 0
  in BECN pkts 0              out FECN pkts 0          out BECN pkts 0
  in DE pkts 0                out DE pkts 0
  out bcast pkts 44         out    bcast bytes 7565
  pvc create time 01:28:35, last time pvc status changed 00:02:19
```

[斯派西]

```
Spicey#show frame-relay map
   Serial0.1 (up): point-to-point dlci, dlci 140(0x8C,0x20C0), broadcast
             status defined, active
   Serial0.2 (up): point-to-point dlci, dlci 130(0x82,0x2020), broadcast
             status defined, active

   Spicey#ping 122.122.122.1
   Type escape sequence to abort.
   Sending 5, 100-byte ICMP Echos to 122.122.122.1, timeout is 2 seconds:
   !!!!!
   Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36 ms

   Spicey#ping 123.123.123.1
   Type escape sequence to abort.
   Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
   !!!!!
   Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms

   Spicey#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 route
   Gateway of last resort is not set
        155.155.0.0/24 is subnetted, 1 subnets
   C    155.155.155.0 is directly connected, Dialer2
        3.0.0.0/24 is subnetted, 1 subnets
   C    3.1.3.0 is directly connected, Serial0.2
        4.0.0.0/24 is subnetted, 1 subnets
   C    4.0.1.0 is directly connected, Serial0.1
        160.160.0.0/24 is subnetted, 1 subnets
   C    160.160.160.0 is directly connected, Dialer1
        124.0.0.0/24 is subnetted, 1 subnets
   C    124.124.124.0 is directly connected, Ethernet0
   I    123.0.0.0/8 [100/8576] via 4.0.1.2, 00:00:55, Serial0.1
   I    122.0.0.0/8 [100/8576] via 3.1.3.3, 00:00:35, Serial0.2
```

来自主叫方的两条串行线路都断开。

```
Spicey#

   *Mar  1 01:21:30.171: %LINK-3-UPDOWN: Interface BRI0:1, changed state toup
   *Mar  1 01:21:30.627: %DIALER-6-BIND: Interface BR0:1 bound to profile Di2
   *Mar  1 01:21:31.647: %LINEPROTO-5-UPDOWN: Line protocol on Interface
```

```
BRI0:1, changed state to up
*Mar  1 01:21:36.191: %ISDN-6-CONNECT: Interface BRI0:1 is now connected
to 6104 Aton
*Mar  1 01:21:40.923: %LINK-3-UPDOWN: Interface BRI0:2, changed state to up
*Mar  1 01:21:41.359: %DIALER-6-BIND: Interface BR0:2 bound to profile Di1
*Mar  1 01:21:42.383: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:2, changed state to up
*Mar  1 01:21:46.943: %ISDN-6-CONNECT: Interface BRI0:2 is now connected
to 6105 Prasit
*Mar  1 01:23:59.819: %DIALER-6-UNBIND: Interface BR0:1 unbound from
profile Di2
*Mar  1 01:23:59.831: %ISDN-6-DISCONNECT: Interface BRI0:1  disconnected
from 6104 Aton, call lasted 149 seconds
*Mar  1 01:23:59.927: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
*Mar  1 01:24:00.923: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:1, changed state to down
*Mar  1 01:24:03.015: %DIALER-6-UNBIND: Interface BR0:2 unbound from
profile Di1
*Mar  1 01:24:03.023: %ISDN-6-DISCONNECT: Interface BRI0:2  disconnected
from 6105 Prasit, call lasted 142 seconds
*Mar  1 01:24:03.107: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down
*Mar  1 01:24:04.107: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:2, changed state to down

Spicey#show frame map
Serial0.1 (down): point-to-point dlci, dlci 140(0x8C,0x20C0), broadcast
          status defined, inactive
Serial0.2 (down): point-to-point dlci, dlci 130(0x82,0x2020), broadcast
          status defined, inactive
Spicey#
```

两条串行线路都可用。

```
Spicey#show frame pvc
   PVC Statistics for interface Serial0 (Frame Relay DTE)
                   Active     Inactive      Deleted          Static
     Local          2               0            0               0
     Switched       0               0            0               0
     Unused         0               0            0               0

   DLCI = 130, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
   Serial0.2

     input pkts 54               output pkts 61           in    bytes 7014
     out bytes 9975              dropped pkts 3           in    FECN pkts 0
     in BECN pkts 0              out FECN pkts 0          out BECN    pkts 0
     in DE pkts 0                out DE pkts 0
     out bcast pkts 40         out    bcast bytes 7803
     pvc create time 01:28:14, last time pvc status changed 00:02:38

   DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
   Serial0.1

     input pkts 56               output pkts 60           in    bytes 7604
     out bytes 10114             dropped pkts 2           in    FECN pkts 0
     in BECN pkts 0              out FECN pkts 0          out BECN    pkts 0
     in DE pkts 0                out DE pkts 0
     out bcast pkts 39           out    bcast bytes 7928
     pvc create time 01:28:15, last time pvc status changed 00:02:29
```

普拉西

```
Prasit#show frame-relay map
   Serial1.1 (up): point-to-point dlci, dlci 150(0x96,0x2460), broadcast
             status defined, active

   Prasit#ping 124.124.124.1
   Type escape sequence to abort.
   Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
   !!!!!
   Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/40 ms

   Prasit#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 route

   Gateway of last resort is not set

   I    155.155.0.0/16 [100/182571] via 4.0.1.1, 00:00:41, Serial1.1
   I    3.0.0.0/8 [100/10476] via 4.0.1.1, 00:00:41, Serial1.1
        4.0.0.0/24 is subnetted, 1 subnets
   C    4.0.1.0 is directly connected, Serial1.1
   I    160.160.0.0/16 [100/182571] via 4.0.1.1, 00:00:41, Serial1.1
        124.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
   S    124.124.124.0/24 [250/0] via 160.160.160.1
   I    124.0.0.0/8 [100/8576] via 4.0.1.1, 00:00:41, Serial1.1
        123.0.0.0/24 is subnetted, 1 subnets
   C    123.123.123.0 is directly connected, Ethernet0
   I    122.0.0.0/8 [100/10576] via 4.0.1.1, 00:00:42, Serial1.1
   Prasit#
```

Serial 1关闭。

```
Prasit#
   *Mar  1 01:16:08.287: %LINK-3-UPDOWN: Interface Serial1, changed state to down
   *Mar  1 01:16:09.287: %LINEPROTO-5-UPDOWN: Line protocol on Interface
   Serial1, changed state to down
   *Mar  1 01:16:11.803: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
   *Mar  1 01:16:11.819: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down
   *Mar  1 01:16:11.855: %LINK-3-UPDOWN: Interface BRI0, changed state to up
   *Mar  1 01:16:15.967: %ISDN-6-LAYER2UP: Layer 2 for Interface BR0, TEI
   64 changed to up

   Prasit#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 route

   Gateway of last resort is not set

        160.160.0.0/24 is subnetted, 1 subnets
   C    160.160.160.0 is directly connected, BRI0
        124.0.0.0/24 is subnetted, 1 subnets
   S    124.124.124.0 [250/0] via 160.160.160.1
```

```
     123.0.0.0/24 is subnetted, 1 subnets
C    123.123.123.0 is directly connected, Ethernet0

Prasit#ping 124.124.124.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:

*Mar  1 01:21:38.967: %LINK-3-UPDOWN: Interface BRI0:1, changed state to
up.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 36/36/36 ms
Prasit#
*Mar  1 01:21:40.063: %LINEPROTO-5-UPDOWN: Line protocol on Interface
BRI0:1, changed state to up
*Mar  1 01:21:44.991: %ISDN-6-CONNECT: Interface BRI0:1 is now connected
to 6106 Spicey

Prasit#ping 124.124.124.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/36 ms
Prasit#
```

串行接口1再次变为活动状态。

```
Prasit#

*Mar  1 01:26:40.579: %LINK-3-UPDOWN: Interface Serial1, changed state to up
*Mar  1 01:26:41.579: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial1, changed state to up
*Mar  1 01:27:01.051: %ISDN-6-LAYER2DOWN: Layer 2 for Interface BRI0,
TEI 64 changed to down
*Mar  1 01:27:01.055: %ISDN-6-LAYER2DOWN: Layer 2 for Interface BR0, TEI
64 changed to down
*Mar  1 01:27:01.363: %LINK-5-CHANGED: Interface BRI0, changed state to standby mode
*Mar  1 01:27:01.379: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
*Mar  1 01:27:01.395: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down

Prasit#show frame map
Serial1.1 (up): point-to-point dlci, dlci 150(0x96,0x2460), broadcast
          status defined, active

Prasit#ping 124.124.124.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/116/432 ms

Prasit#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)

                Active     Inactive      Deleted          Static
  Local         1               0            0               0
  Switched      0               0            0               0
  Unused        0               0            0               0

DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial1.1

  input pkts 58              output pkts 66           in    bytes 9727
  out bytes 10022            dropped pkts 0           in    FECN pkts 0
```

```
in BECN pkts 0              out FECN pkts 0          out BECN    pkts 0
in DE pkts 0                out DE pkts 0
out bcast pkts 46         out    bcast bytes 7942
pvc create time 01:27:37, last time pvc status changed 00:01:59
```

配置帧中继交换

帧中继交换是根据数据链路连接标识符(DLCI)交换数据包的一种方法。 我们可以将其视为帧中继等效于介质访问控制(MAC)地址。通过将思科路由器或接入服务器配置到帧中继网络来执行交换。帧中继网络有两个部分：

- 帧中继数据终端设备(DTE) — 路由器或接入服务器。
- 帧中继数据电路终端设备(DCE)交换机。

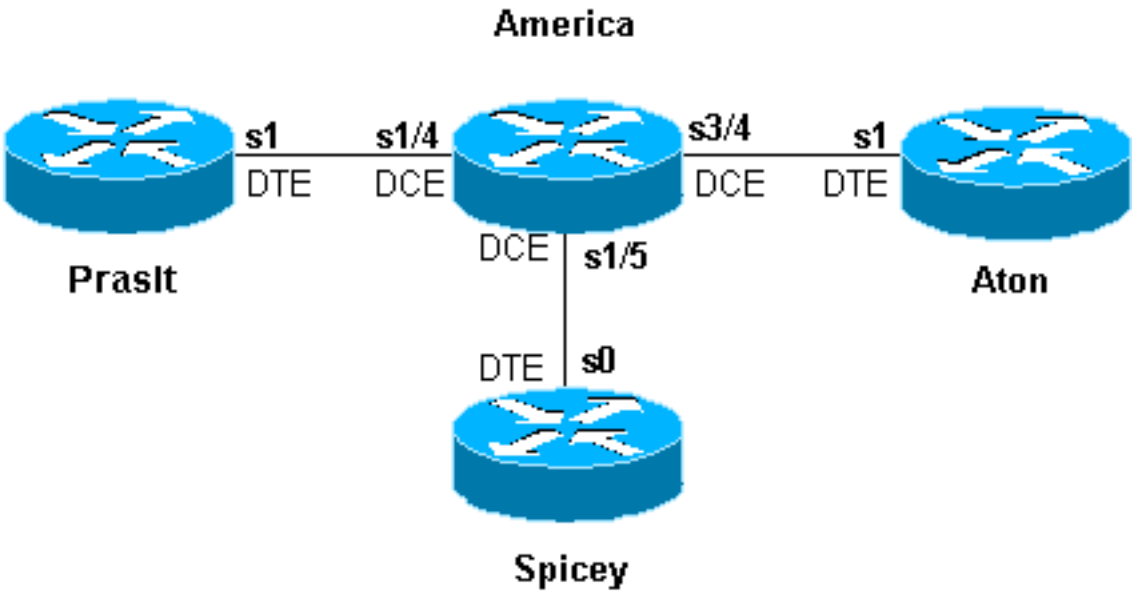
注意： 在Cisco IOS软件版本12.1(2)T及更高版本中，**frame route**命令已被**connect**命令取代。

我们来看一个配置示例。在以下配置中，我们使用路由器America作为帧中继交换机。我们将Spicey用作中心路由器，将Prasit和Aton用作分支路由器。我们已将其连接如下：

- Prasit Serial 1(s1)DTE连接到America Serial 1/4(s1/4)DCE。
- Spicey serial 0(s0)DTE连接到America Serial 1/5(s1/5)DCE。
- Aton Serial 1(s1)DTE连接到America Serial 3/4(s3/4)DCE。

网络图

本文档基于以下配置：



配置

- 斯派西
- 普拉西
- 伊顿
- 美洲

斯派西

```
Spicey#show running-config
Building configuration...

!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Spicey
!
!
!
interface Ethernet0
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 ip address 3.1.3.1 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 130
 frame-relay interface-dlci 140
!
!
router rip
 network 3.0.0.0
 network 124.0.0.0
!
line con 0
!
exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...
Current configuration : 1499 bytes
!
 version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Prasit
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
interface Serial1
 ip address 3.1.3.2 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 150
!
!
```

```
router rip
 network 3.0.0.0
 network 123.0.0.0
!
 !
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

伊顿

```
Aton#show running-config
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Aton
!
!
!
interface Ethernet0
 ip address 122.122.122.1 255.255.255.0
!
interface Serial1
 ip address 3.1.3.3 255.255.255.0
 encapsulation frame-relay
 frame-relay interface-dlci 160
!
router rip
 network 3.0.0.0
 network 122.0.0.0
!
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

美洲

```
america#show running-config
Building configuration...
Current configuration:
!
!
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname america
```

```
!
frame-relay switching
!
!
interface Serial1/4
 description *** static DCE connection to s1 Prasit
 no ip address
 encapsulation frame-relay
 clockrate 2000000
 frame-relay intf-type dce
 frame-relay route 150 interface Serial1/5 140
!
interface Serial1/5
 description *** static DCE connection to s0 spicy
 no ip address
 encapsulation frame-relay
 bandwidth 1000000
 tx-queue-limit 100
 frame-relay intf-type dce
 frame-relay route 130 interface Serial3/4 160
 frame-relay route 140 interface Serial1/4 150
 transmitter-delay 10
!
interface Serial3/4
 description *** static DCE connection to s1 Aton
 encapsulation frame-relay
 no ip mroute-cache
 clockrate 2000000
 frame-relay intf-type dce
 frame-relay route 160 interface Serial1/5 130
!
```

显示命令

使用以下show命令测试您的网络是否正常运行：

- show frame-relay map
- show frame-relay pvc

以下所示的输出是在我们在此示例配置中使用的设备上输入这些命令的结果。

斯派西

```
Spicey#show frame-relay map
Serial0 (up): ip 3.1.3.2 dlci 140(0x8C,0x20C0), dynamic,
              broadcast,, status defined, active
Serial0 (up): ip 3.1.3.3 dlci 130(0x82,0x2020), dynamic,
              broadcast,, status defined, active

Spicey#show frame-relay pvc

PVC Statistics for interface Serial0 (Frame Relay DTE)
                   Active     Inactive      Deleted            Static
 Local          2                  0            0                 0
 Switched       0                  0            0                 0
 Unused         0                  0            0                 0

 DLCI = 130, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0
```

```
  input pkts 32                output pkts 40               in bytes 3370
  out bytes 3928               dropped pkts 0               in FECN pkts 0
  in BECN pkts 0               out FECN pkts 0              out BECN pkts 0
  in DE pkts 0                 out DE pkts 0
  out bcast pkts 30            out bcast bytes 2888
  pvc create time 00:15:46, last time pvc status changed 00:10:42

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0

   input pkts 282               output pkts 291          in bytes 25070
   out bytes 27876              dropped pkts 0           in FECN pkts 0
   in BECN pkts 0               out FECN pkts 0          out BECN pkts 0
   in DE pkts 0                 out DE pkts 0
   out bcast pkts 223           out bcast bytes 20884
   pvc create time 02:28:36, last time pvc status changed 02:25:14
```

普拉西

```
Prasit#show frame-relay map
Serial1 (up): ip 3.1.3.1 dlci 150(0x96,0x2460), dynamic,
                  broadcast,, status defined, active

Prasit#show frame-relay pvc

PVC Statistics for interface Serial1 (Frame Relay DTE)
                  Active     Inactive      Deleted            Static
  Local          1                0            0                 0
  Switched       0                0            0                 0
  Unused         0                0            0
DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial1
  input pkts 311               output pkts 233          in bytes 28562
  out bytes 22648              dropped pkts 0           in FECN pkts 0
  in BECN pkts 0               out FECN pkts 0          out BECN pkts 0
  in DE pkts 0                 out DE pkts 0
  out bcast pkts 162           out bcast bytes 15748
  pvc create time 02:31:39, last time pvc status changed 02:25:14
```

伊顿

```
Aton#show frame-relay map
Serial1 (up): ip 3.1.3.1 dlci 160(0xA0,0x2800), dynamic, broadcast, status defined, active

Aton#show frame-relay pvc
PVC Statistics for interface Serial1 (Frame Relay DTE)
               Active     Inactive      Deleted            Static
Local          1                0            0                 0
Switched       0                0            0                 0
Unused         0                0            0                 0

DLCI = 160, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial
 input pkts 35                output pkts 32               in bytes 3758
 out bytes 3366               dropped pkts 0               in FECN pkt 0
 in BECN pkts 0               out FECN pkts 0              out BECN pkts 0
 in DE pkts 0                 out DE pkts 0
 out bcast pkts 27 out bcast bytes 2846
 pvc create time 00:10:53, last time pvc status changed 00:10:53
```

配置帧中继 DLCI 优先级

通过数据链路连接标识符(DLCI)优先级排列很多不同的业务类型能够放置在独立的DLCI上，以便帧中继网络能为每个业务类型提供不同的承诺信息速率。它可以与自定义排队或优先级排队结合使用

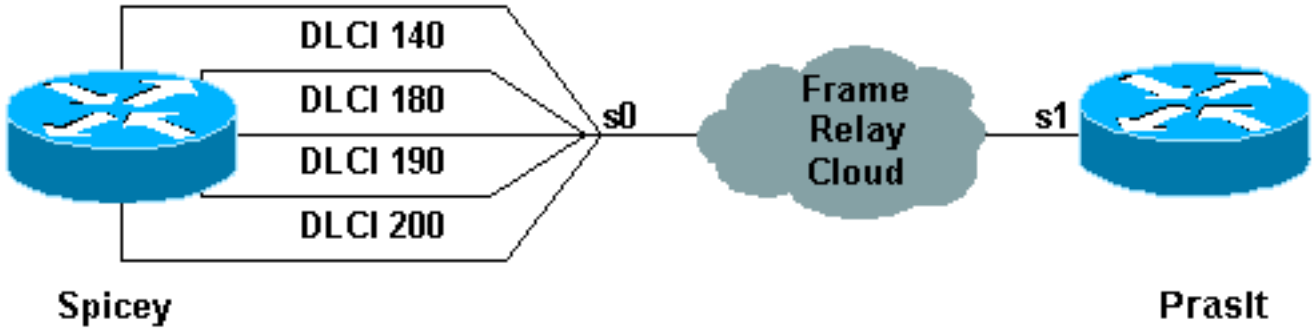
，提供帧中继网络的接入链路的带宽管理控制。另外，一些帧中继服务提供商和帧中继交换机(例如Stratacom互联网络信息包交换[IPX]、IGX、BPX或AXIS交换机)可根据优先级设置，在帧中继网云中提供优先级排列。

实施注意事项

在实施DLCI优先级时，请注意以下几点：

- 如果附属DLCI断开，您将丢失定向到该队列的数据流。
- 如果您丢失主要DLCI，那么子接口断开并且丢失所有数据流。

网络图



为了使用此设置，您需为使用DLCI优先级划分的一端提供四个DLCI。在本示例中，我们为优先级队列配置了Spicey，如下所示：

- Ping位于高优先级队列中。
- Telnet位于中优先级队列中。
- 文件传输协议(FTP)位于正常优先级队列中。
- 所有其他IP流量都在低优先级队列中。

注意：确保将DLCI配置为与优先级列表对应，否则系统不会使用正确的队列。

配置

- 斯派西
- 普拉西

斯派西

```
Spicey#show running-config
Building configuration...

Current configuration : 1955 bytes
!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
!
hostname Spicey
!
!
interface Ethernet0
```

```
 ip address 124.124.124.1 255.255.255.0
!
interface Serial0
 no ip address
 encapsulation frame-relay
 priority-group 1
!
interface Serial0.1 point-to-point
 ip address 4.0.1.1 255.255.255.0
 frame-relay priority-dlci-group 1 140 180 190 200
 frame-relay interface-dlci 140
!
router igrp 2
 network 4.0.0.0
 network 124.0.0.0
!
access-list 102 permit icmp any any
 priority-list 1 protocol ip high list 102
 priority-list 1 protocol ip medium tcp telnet
 priority-list 1 protocol ip normal tcp ftp
 priority-list 1 protocol ip low
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
end
```

普拉西

```
Prasit#show running-config
Building configuration...

!
version 12.1
service timestamps debug datetime msec
service timestamps log datetime msec
!
hostname Prasit
!
!
!
interface Ethernet0
 ip address 123.123.123.1 255.255.255.0
!
interface Serial1
 ip address 4.0.1.2 255.255.255.0
 encapsulation frame-relay
!
router igrp 2
 network 4.0.0.0
 network 123.0.0.0
!
line con 0
 exec-timeout 0 0
 transport input none
 line aux 0
 line vty 0 4
 login
!
```

```
end
```

debug 和 show 命令

使用以下**show**和**debug**命令测试您的网络是否正常运行。在发出 **debug 命令之前，请参阅**有关 Debug 命令的重要信息。

- **show frame-relay pvc**
- **show frame-relay map**
- **show queueing priority**
- **debug priority**

以下所示的输出是在我们在此示例配置中使用的设备上输入这些命令的结果。

斯派西

```
Spicey#show frame-relay pvc
PVC Statistics for interface Serial0 (Frame Relay DTE)

               Active     Inactive      Deleted       Static
  Local           4            0            0            0
  Switched        0            0            0            0
  Unused          0            0            0            0

DLCI = 140, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0.1

  input pkts 106           output pkts 15           in bytes 6801
  out bytes 1560           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  pvc create time 00:29:22, last time pvc status changed 00:20:37
  Priority DLCI Group 1, DLCI 140 (HIGH), DLCI 180 (MEDIUM)
  DLCI 190 (NORMAL), DLCI 200 (LOW)

DLCI = 180, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0.1

  input pkts 0             output pkts 51           in bytes 0
  out bytes 2434           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  pvc create time 00:29:23, last time pvc status changed 00:14:48

DLCI = 190, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0.1

  input pkts 0             output pkts 13           in bytes 0
  out bytes 3653           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 13        out bcast bytes 3653
  pvc create time 00:29:23, last time pvc status changed 00:14:28

DLCI = 200, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0.1

  input pkts 0             output pkts 42           in bytes 0
  out bytes 2554           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
```

```
  out bcast pkts 10        out bcast bytes 500
  pvc create time 00:29:24, last time pvc status changed 00:14:09

Spicey#show frame-relay map
Serial0.1 (up): point-to-point dlci, dlci 140(0x8C,0x20C0), broadcast
  status defined, active
  Priority DLCI Group 1, DLCI 140 (HIGH), DLCI 180 (MEDIUM)
  DLCI 190 (NORMAL), DLCI 200 (LOW)

Spicey#show queueing priority
Current priority queue configuration:

List   Queue  Args
1      high   protocol ip          list 102
1      medium protocol ip          tcp port telnet
1      normal protocol ip          tcp port ftp
1      low    protocol ip
```

要验证优先级队列，请使用debug priority命令。

```
Spicey#debug priority
Priority output queueing debugging is on

Spicey#ping 123.123.123.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 123.123.123.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/45/48 ms
Spicey#
*Mar  1 00:32:30.391: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.395: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.399: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:32:30.439: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.443: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.447: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:32:30.487: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.491: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.495: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:32:30.535: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.539: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.543: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:32:30.583: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.587: PQ: Serial0: ip (s=4.0.1.1, d=123.123.123.1) ->high
*Mar  1 00:32:30.587: PQ: Serial0 output (Pk size/Q 104/0)Spicey#

Spicey#telnet 123.123.123.1
Trying 123.123.123.1 ... Open

User Access Verification

Password:
*Mar  1 00:32:59.447: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.451: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.451: PQ: Serial0 output (Pk size/Q 48/1)
*Mar  1 00:32:59.475: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.479: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.483: PQ: Serial0 output (Pk size/Q 44/1)
*Mar  1 00:32:59.487: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.487: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.491: PQ: Serial0 output (Pk size/Q 53/1)
*Mar  1 00:32:59.495: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.499: PQ: Serial0: ip (tcp 23) -> medium
```

```
*Mar  1 00:32:59.499: PQ: Serial0 output (Pk size/Q 44/1)
*Mar  1 00:32:59.511: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.511: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.515: PQ: Serial0 output (Pk size/Q 47/1)
*Mar  1 00:32:59.519: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.519: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.523: PQ: Serial0 output (Pk size/Q 47/1)
*Mar  1 00:32:59.527: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.527: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.531: PQ: Serial0 output (Pk size/Q 53/1)
*Mar  1 00:32:59.539: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.543: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.547: PQ: Serial0 output (Pk size/Q 47/1)
*Mar  1 00:32:59.751: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.755: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:32:59.755: PQ: Serial0 output (Pk size/Q 44/1)
Password:
```

其他IP流量通过低队列。

```
Spicey#
*Mar  1 00:53:57.079: PQ: Serial0 output (Pk size/Q 13/0)
*Mar  1 00:53:58.851: PQ: Serial0: ip -> low
*Mar  1 00:53:58.907: PQ: Serial0: ip -> low
*Mar  1 00:53:58.907: PQ: Serial0 output (Pk size/Q 36/3)
*Mar  1 00:53:59.459: PQ: Serial0: ip -> low
*Mar  1 00:53:59.463: PQ: Serial0: ip -> low
*Mar  1 00:53:59.463: PQ: Serial0 output (Pk size/Q 50/3)
Spicey#
```

普拉西

```
Prasit#show frame-relay pvc

PVC Statistics for interface Serial1 (Frame Relay DTE)

               Active     Inactive      Deleted       Static
  Local           1            0            0            0
  Switched        0            0            0            0
  Unused          0            0            0            0

DLCI = 150, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial1

  input pkts 134           output pkts 119          in bytes 12029
  out bytes 7801           dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  out bcast pkts 18         out bcast bytes 1260
  pvc create time 00:21:15, last time pvc status changed 00:21:15

Prasit#show frame-relay map
Serial1 (up): ip 4.0.1.1 dlci 150(0x96,0x2460), dynamic,
              broadcast, status defined, active

Prasit#ping 124.124.124.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 124.124.124.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/45/48
Here is the debug output shown on Spicey when you use the command above to ping to Spicey from
Prasit.
```

```
Spicey#
*Mar  1 00:33:26.755: PQ: Serial0 output (Pk size/Q 13/0)
*Mar  1 00:33:28.535: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.539: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.543: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:33:28.583: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.587: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.587: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:33:28.631: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.635: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.635: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:33:28.679: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.683: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.683: PQ: Serial0 output (Pk size/Q 104/0)
*Mar  1 00:33:28.723: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.727: PQ: Serial0: ip (s=124.124.124.1, d=4.0.1.2) ->high
*Mar  1 00:33:28.731: PQ: Serial0 output (Pk size/Q 104/0)

Prasit#telnet 124.124.124.1
Trying 124.124.124.1 ... Open


User Access Verification
Password:
Spicey>exit

[Connection to 124.124.124.1 closed by foreign host]
Prasit#
```

当您使用调试命令从Prasit远程登录到Spicey时，这便是Spicey上显示的调试输出。

```
Spicey#
*Mar  1 00:33:54.499: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.499: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.503: PQ: Serial0 output (Pk size/Q 48/1)
*Mar  1 00:33:54.527: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.531: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.531: PQ: Serial0 output (Pk size/Q 56/1)
*Mar  1 00:33:54.547: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.551: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.555: PQ: Serial0 output (Pk size/Q 86/1)
*Mar  1 00:33:54.559: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.563: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.563: PQ: Serial0 output (Pk size/Q 47/1)
*Mar  1 00:33:54.571: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.575: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.575: PQ: Serial0 output (Pk size/Q 47/1)
*Mar  1 00:33:54.779: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.783: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:54.783: PQ: Serial0 output (Pk size/Q 44/1)
*Mar  1 00:33:56.755: PQ: Serial0 output (Pk size/Q 13/0)
*Mar  1 00:33:57.143: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:57.143: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:57.147: PQ: Serial0 output (Pk size/Q 44/1)
*Mar  1 00:33:57.447: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:57.447: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:57.451: PQ: Serial0 output (Pk size/Q 44/1)
*Mar  1 00:33:57.899: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:57.899: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:57.903: PQ: Serial0 output (Pk size/Q 53/1)
*Mar  1 00:33:59.491: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:59.495: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:59.495: PQ: Serial0 output (Pk size/Q 45/1)
```

```
*Mar  1 00:33:59.711: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:59.715: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:59.715: PQ: Serial0 output (Pk size/Q 45/1)
*Mar  1 00:33:59.951: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:59.951: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:33:59.955: PQ: Serial0 output (Pk size/Q 45/1)
*Mar  1 00:34:00.123: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.123: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.127: PQ: Serial0 output (Pk size/Q 45/1)
*Mar  1 00:34:00.327: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.327: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.331: PQ: Serial0 output (Pk size/Q 46/1)
*Mar  1 00:34:00.495: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.499: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.499: PQ: Serial0 output (Pk size/Q 44/1)
*Mar  1 00:34:00.543: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.543: PQ: Serial0: ip (tcp 23) -> medium
*Mar  1 00:34:00.547: PQ: Serial0 output (Pk size/Q 44/1)
```

帧中继广播队列

广播队列是在中型到大型IP或IPX网络中使用的一种主要功能，在这些网络中，路由和服务接入点(SAP)广播必须在帧中继网络上传送。广播队列在正常接口队列中进行独立管理，有它自己的缓冲区、可配置大小和服务速率。由于时间敏感性，此广播队列不用于桥接生成树更新(BPDU)。这些数据包将流经正常队列。用于启用广播队列的接口命令如下：

frame-relay broadcast-queue size byte-rate packet-rate

广播队列被指定最大传输速率(吞吐量)限额，该限额按每秒字节数和每秒信息包数测量。队列会得到服务，以确保仅提供此最大值。传输速率低于配置的最大速率时，广播队列会有优先级，并且保证有最小带宽分配。两个传输速率限制旨在避免广播泛洪接口。任何秒中的实际限制是达到的第一个速率限制。根据传输速率限制，存储广播数据包需要额外的缓冲。广播队列可配置为存储大量广播数据包。应设置队列大小以避免广播路由更新数据包丢失。确切大小取决于正在使用的协议和每次更新所需的信息包数量。为安全起见，队列大小的设置应该确保来自每个协议的、每个数据链路连接标识符(DLCI)的完整路由更新能够存储。通常，从每个DLCI 20个数据包开始。字节速率应小于以下两项：

- N/4乘以最低远程访问速率(以字节/秒为单位)，其中的N是广播必须复制到的DLCI的数量。
- 1/4本地访问速率（以每秒字节为单位）

如果字节速率是保守设置的，则数据包速率不是关键。通常，应该设置数据包速率（假设250字节数据包）。默认串行接口为64个队列大小、每秒256,000个字节(2,048,000 bps)和36 pps。高速串行接口(HSSI)的默认值为256个队列大小、1,024,000字节/秒(8,192,000 bps)和144 pps。

流量整形

流量整形使用称为令牌桶过滤器的速率控制机制。此令牌桶过滤器的设置如下：

超额突发量加承诺突发量(Bc + Be)=虚电路(VC)的最大速度

超出最大速度的数据流在流量整形队列中缓冲，该队列的大小与加权公平排队(WFQ)相等。 令牌桶过滤器不过滤数据流，但控制出局接口上的数据流发送速率。有关令牌桶过滤器的详细信息，请参阅策略和整形概述。

本文档概述了通用流量整形和帧中继流量整形。

流量整形参数

我们可以使用以下流量整形参数：

- CIR =承诺信息速率（=平均时间）
- EIR =超额信息速率
- TB =令牌桶(= Bc + Be)
- Bc =承诺突发大小（=持续突发大小）
- Be =超额突发大小
- DE =放弃资格
- Tc =测量间隔
- AR = 与物理接口速率对应的接入速率(如果您使用T1，AR约为1.5 Mbps)。

让我们更详细地看一下其中一些参数：

接入速率(AR)

终端站到网络的最高传输速度(比特/秒)受到用户网络接口的接入速率的限制。用户网络连接的线速限制了访问速率。您可以在向服务提供商订用时建立此关系。

承诺突发大小(Bc)

您可以向网络提供的最大承诺数据量定义为Bc。Bc是保证网络正常情况下交付的数据量的测量。它在承诺速率Tc期间测量。

超额突发大小(Be)

仍被帧中继交换机接受、但被标志为符合丢弃条件(DE)的非承诺位(CIR以外)的数量。

令牌桶是“虚拟”缓冲区。它包含许多令牌，使您可以按时间间隔发送有限数量的数据。令牌桶中填充了Bc位/Tc。桶的最大大小是Bc + Be。如果Be非常大，在T0时段，令牌桶填满了BC+Be令牌，则您能够以接入速率发送BC+Be位。这不是通过TC而是通过发送Be的时间限制的。这是访问速率的函数。

承诺信息速率 (CIR)

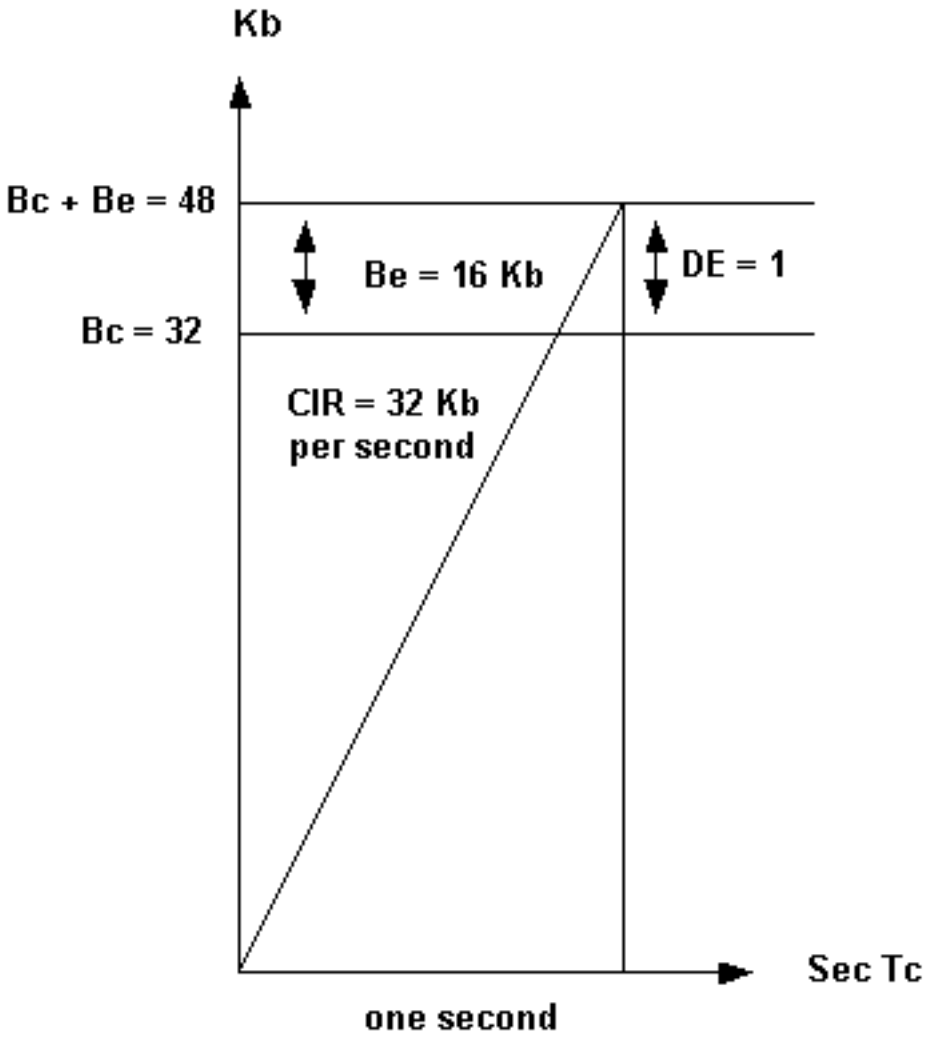
CIR是网络承诺在通常情况下传输的允许数据流量。速率在时间Tc的增量内平均。CIR也称为最低可接受吞吐量。Bc和Be以位为单位、Tc以秒为单位、接入速率和CIR以比特/秒为单位。

Bc、Be、Tc和CIR根据数据链路连接标识符(DLCI)定义。 因此，令牌桶过滤器控制每个DLCI的速率。每个用户网络接口的访问速率有效。对于Bc，可以区分Be和CIR传入和传出值。如果连接是对称的，则两个方向的值相同。对于永久虚电路，我们在订用时定义传入和传出Bc、Be和CIR。

- Peak = DLCI的最大速度。特定DLCI的带宽。
- Tc = Bc / CIR
- 峰值= CIR + Be/Tc = CIR(1 + Be/Bc)

如果Tc为1秒，则：

- 峰值= CIR + Be = Bc + Be
- EIR = Be



在我们的示例中，路由器根据网络中的拥塞情况，选择使用48 Kbps还是32 Kbps的速率发送数据流。网络可能在BC上用DE标记帧，但是仍有大量空闲容量可以用来传输帧。反之亦然：它们的容量可能有限，但会立即丢弃过多的帧。网络可以使用DE标记Bc + Be以上的帧，并可能传输帧，或者只是丢弃国际电信联盟电信标准化扇区规范ITU-T I.370建议的帧。流量整形根据来自交换机网络的后向显式拥塞通知(BECN)标记的数据包来限制流量。如果您收到50%的BECN，路由器将把特定DLCI减少到当前传输带宽的八分之一。

示例

传输速度为42 Kb。路由器将速度降低到42 - 42/8，为36.75千字节。如果更改后拥塞减少，路由器将进一步减少流量，从而使当前传输带宽下降至原来的八分之一。流量会减少，直到达到所配置的CIR值。然而，当我们仍然能看见BECN时，速度可以降至CIR以下。您可以指定最低限制，如CIR/2。在给定时间间隔内，当从网络接收的所有帧不再具有BECN位时，网络将不再拥塞。200毫秒是此间隔的默认值。

一般流量整形

通用流量整形功能是一种独立于媒体和封装的流量整形工具，当网云、链路和接受终端路由器发生拥塞时，它可以减少出局流量。我们可以在路由器的接口或子接口上设置它。

通用流量整形在以下情况下非常有用：

- 当您的网络拓扑由中心站点的高速连接(T1线路速度)、分支机构或远程办公人员站点的低速连接(低于56kbps)组成时。由于速度不匹配，当中心站点发送数据的速度高于远程站点能够接收的速度时，分支机构或远程办公人员站点的流量通常存在瓶颈。这会导致远程点路由器之前最后一台交换机出现瓶颈。
- 如果您是提供子速率服务的服务提供商，此功能将使您能够使用路由器，将您的T1或T3链路分为更小的信道。您可以为每个子接口配置令牌过滤器桶，使之与用户定购的服务匹配。

在帧中继连接上，您可能希望路由器抑制数据流，而不是将数据流发送到网络中。限制流量将限制服务提供商云中的数据包丢失。基于BECN的控制功能，使您能够根据从网络中收到的BECN标记数据包，让路由器动态控制数据流。这种控制将信息包保留在路由器的缓冲区，以便减少从路由器到帧中继网络的数据流。路由器控制子接口上的数据流，当少量的BECN标记的信息包收到时，速率也会增加。

通用流量整形命令

要定义速率控制，请使用以下命令：

traffic-shape rate bit-rate [burst-size [excess-burst-size]] [group access-list]

要限制帧中继接口上的BECN，请使用以下命令：

traffic-shape adaptive [bit-rate]

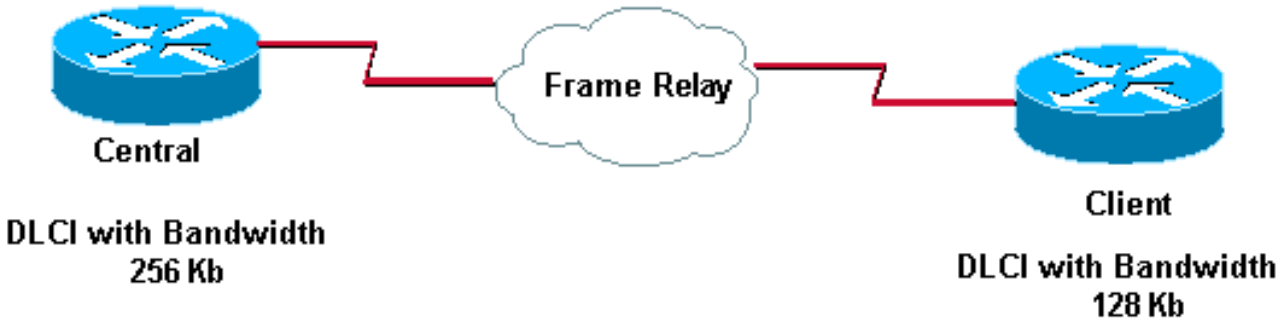
如果要配置帧中继子接口来评估接收BECN的可用带宽，请使用traffic-shape adaptive命令。

注意：在使用traffic-shape adaptive命令之前，必**须使用traffic-shape rate**命令在接口上启**用流量整形**。

为traffic-shape rate命令指定的比特率是上限，为traffic-shape adaptive命令指定的比特率是下限(通常为CIR值)，当接口接收BECN时，数据流整形的比特率在此范围之内。实际使用的速率通常介于这两个速率之间。您应该在链路两端配置traffic-shape adaptive命令，因为该命令也会配置流末端的设备，将转发显式拥塞通知(FECN)信号作为反映为BECN。既使数据流主要在一个方向，这也能使高速端的路由器发现和适应拥塞。

示例

以下示例配置了接口0.1上的流量整形，上限为(通常为Bc + Be)128 kbps，下限为64 kbps。这允许链路运行速率从64kbps到128kbps，具体取决于拥塞程度。如果中心侧有一个256 kbps的上限，您应该使用最低的上限值。



以下是我们在这些路由器上配置的内容：

```
Central#
 interface serial 0
  encapsulation-frame-relay
 interface serial 0.1
  traffic-shape rate 128000
  traffic-shape adaptive 64000


Client#
 interface serial 0
  encapsulation-frame-relay
 interface serial 0.1
  traffic-shape rate 128000
  traffic-shape adaptive 64000
```

帧中继流量整形

在通用流量整形中，您只能为每个物理接口的指定一个峰值速率(上限)，为每个子接口指定一个CIR (下限)。通过帧中继流量整形，您可以按虚电路启动令牌桶过滤器。

帧中继流量整形功能提供以下功能：

- 每VC的速率实施：您可以配置峰值速率，把出局流量限制为CIR或某些其他定义值，例如突发信息速率(EIR)。
- 基于每VC的广义BECN支持：路由器能监控BECN，并从帧中继网络限制根据BECN标记的信息包反馈的流量。
- 在VC级别支持优先级队列(PQ)、自定义队列(CQ)或WFQ。这使数据流的优先级排列和排队能够有好的间隔，使您能够更多地控制单个VC上的数据流。帧中继流量整形功能适用于帧中继永久虚电路(PVC)和交换虚电路(SVC)。

示例

```
Interface Serial 0
 no ip address
 encapsulation frame-relay
 frame-relay traffic-shaping
!
interface Serial0.100
 ip address 1.1.1.1 255.255.255.252
 frame-relay interface-dlci 100
 frame-relay class fast
!
interface Serial0.200
 ip address 1.1.1.5 255.255.255.252
 frame-relay interface-dlci 200
 frame-relay class slow
!
map-class frame-relay slow
 frame-relay traffic-rate 64000 128000
!
map-class
 frame-relay fast
 frame-relay traffic-rate 16000 64000
!
```

在本例中，路由器添加了两个令牌桶。

- 一个在64000(CIR)和128000(Bc + Be)之间运行。
- 其它运行在16000(CIR)和64000(Bc + Be)之间。

如果从以太网流入的流量大于令牌桶过滤器，流量会被缓冲在帧中继流量队列。

要查看实施帧中继流量整形时显示数据包流的流程图，请参阅帧中继流量整形流程图。要特别使用令牌桶过滤器查看流程图，请参阅帧中继流量整形 — 令牌桶流程图。

常用帧中继命令

本章节描述了两个在配置帧中继时特别有用的Cisco IOS命令。

show frame-relay pvc

该命令可显示永久虚拟电路(PVC)的状态、进入和流出的信息包。如果线路上有拥塞，它还可以通过前向显式拥塞通知(FECN)和后向显式拥塞通知(BECN)，显示丢弃的数据包。有关show frame-relay pvc命令所用字段的**详细说明**，请单击此处。

如果您的Cisco设备输出了**show frame-relay pvc命令**，则可以使用输出解释程序(仅限注册客户)来显示潜在问题和解决方法。

输出解释仅注

输出示例如下所示：

```
RouterA#show frame-relay pvc
PVC Statistics for interface Serial0 (Frame Relay DTE)
DLCI = 666, DLCI USAGE = UNUSED, PVC STATUS = DELETED, INTERFACE = Serial0
  input pkts 0             output pkts 0            in bytes 0
  out bytes 0              dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  pvc create time 0:03:18  last time pvc status changed 0:02:27
  Num Pkts Switched 0
DLCI = 980, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0
  input pkts 19            output pkts 87           in bytes 2787
  out bytes 21005          dropped pkts 0           in FECN pkts 0
  in BECN pkts 0           out FECN pkts 0          out BECN pkts 0
  in DE pkts 0             out DE pkts 0
  pvc create time 1:17:47  last time pvc status changed 0:58:27
```

DLCI USAGE字段包含以下条目之一：

- 交换 — 路由器或接入服务器用作交换机。
- 本地 — 路由器或接入服务器用作数据终端设备(DTE)。
- UNUSED — 路由器上用户输入的配置命令不引用数据链路连接标识符(DLCI)。

PVC可能有四种状态。PVC STATUS字段显示如下：

- 活动 — PVC已打开且工作正常。
- 非活动 — PVC不是端到端的。这可能是因为帧中继网云中没有本地DLCI的映射(或不正确映射)，或者PVC的远程终端被删除。

- 删除-本地管理接口(LMI)没有在路由器和本地交换机之间交换，或者本地交换机上没有配置DLCI。
- 静态 — 路由器的帧中继接口上未配置keepalive。

show frame-relay map

使用此命令确定frame-relay inverse-arp**是否将远程IP地**址解析为本地DLCI。此命令未对点对点子接口启用。它仅适用于多点接口和子接口。输出示例如下所示：

```
RouterA#show frame-relay map
Serial0 (up): ip 157.147.3.65 dlci 980(0x3D4,0xF440), dynamic,
         broadcast,, status defined, active
```

欲知使用show frame-relay map命令的字段的详细说明，请参见“帧中继命令的说明文档”。

如果您有来自Cisco设备**的show frame-relay map命令的输出**，则可以使用输出解释器(仅注册客户)来显示潜在问题和解决方法。

输出解释仅注

帧中继和桥接

称为网桥协议数据单元(BPDU)的配置消息用于Cisco网桥和路由器支持的生成树协议。这些流量在网桥之间按固定间隔传输，并且由于经常发生，因此会构成大量流量。透明桥接中有两种类型的生成树协议。算法最先由Digital Equipment Corporation (DEC)引入，随后被IEEE 802委员会修正，并发布在IEEE 802.1d规格中。DEC生成树协议在一秒钟的间隔发出BPDU，而IEEE在2秒钟的间隔发出BPDU。每个数据包为41个字节，其中包括35字节的配置BPDU消息、2字节的帧中继报头、2字节的以太网类型和2字节的FCS。

帧中继和内存

帧中继资源的内存消耗发生在以下四个方面：

1. 每个数据链路连接标识符(DLCI):216 bytes
2. 每条map语句：96字节（或动态构建的映射）
3. 每个IDB（硬件接口+封装帧中继）：5040 + 8346 = 13,386字节
4. 每个IDB（软件子接口）：2260 bytes

例如，Cisco 2501使用二个帧中继接口，每个接口带有四个子接口，总共有八个DLCI，关联映射需要以下：

- 2接口硬件IDB x 13,386 = 26,772
- 8子接口IDB x 2260 = 18,080子接口
- 8个DLCI x 216 = 1728个DLCI
- 8个映射语句x 96 = 768个映射语句或dynamics

总数等于使用的RAM的47,348字节。

注意：此处使用的值对Cisco IOS版本11.1、12.0和12.1软件有效。

帧中继的故障排查

本部分包含故障排除时**可能**遇到的show interface命令输出的部分。还对输出作了说明。

"Serial0 is down, line protocol is down"

此输出意味着您的电缆、信道服务单元/数据服务单元(CSU/DSU)或串行线路发生了问题。您需要排除环回测试的故障。要执行环回测试，请执行以下步骤：

1. 将串行线路封装设置为HDLC，将keepalive设置为10秒。为此，请在串行接口下**发出encapsulation hdlc** 和**keepalive 10**命令。
2. 将CSU/DSU或调制解调器置于本地环路模式。如果当CSU、DSU或调制解调器处于本地环回模式(通过“线路协议为up(looped))”消息指示)时线路协议启动，则表明问题发生在本地CSU/DSU之外。如果状态行没有更改状态，则可能路由器、连接电缆、CSU/DSU或调制解调器存在问题。在大多数情况下，问题出在 CSU/DSU 或调制解调器上。
3. 使用CSU/DSU或调制解调器环路对您自己的IP地址执行ping操作。命令应该全部成功。0x0000的扩展ping有助于解决线路问题，因为T1或E1从数据获取时钟，需要每8位进行转换。B8ZS确保了这一点。重零数据模式帮助确定中继上实现的转换是否正确实施。路径中如果有一对数据变换器，将使用重一模式适当模拟高零负荷。交替模式(0x5555)表示“典型”数据模式。如果ping失败，或者收到循环冗余校验(CRC)错误，则您需要一个带有电信公司提供的相应分析器的误码率测试器(BERT)。
4. 完成测试后，请确保将封装返回到帧中继。

"Serial0 is up, line protocol is down"

输出中的此线路意味着路由器正从CSU/DSU或调制解调器获取载波信号。检查确定帧中继提供商是否已经激活了他们的端口，您的本地管理接口(LMI)是否设置了匹配。一般来说，帧中继交换机会忽略数据终端设备(DTE)，除非看到正确的LMI (使用Cisco默认的"cisco" LMI) 。 检查以确保Cisco路由器正在传输数据。您很可能需要使用环路测试来检查线路完整性，从本地CSU开始进行，直到您到达提供商的帧中继交换机。有关如何执行环回测试，请参阅上一节。

"Serial0 is up, line protocol is up"

如果没有关闭Keepalive，此输出线路则意味着路由器正与帧中继提供商的交换机进行对话。您应该看到串行接口上双向流量交换成功，且没有CRC错误。"Keepalive(保活)在帧中继中是必要的，因为它们是路由器""学习""到提供商提供了哪些数据链路连接标识符(DLCI)的机制。"要观看交换，您几乎可以在所**有情况下都安**全地使用debug frame-relay lmi。**debug frame-relay lmi**命令会生成很少的消息，并且可以回答以下问题：

1. Cisco路由器是否与本地帧中继交换机通信？
2. 路由器正可以从帧中继提供商获取预订的永久虚拟电路(PVC)的全部LMI状态消息吗？
3. DLCI是否正确？

以下是成功连**接的debug frame-relay lmi**输出示例：

```
*Mar  1 01:17:58.763: Serial0(out): StEnq, myseq 92, yourseen 64, DTE up
*Mar  1 01:17:58.763:  datagramstart = 0x20007C, datagramsize = 14
*Mar  1 01:17:58.763:  FR encap = 0x0001030800 75 95 01 01 01 03 02 5C 40
*Mar  1 01:17:58.767:
*Mar  1 01:17:58.815: Serial0(in): Status, myseq 92
*Mar  1 01:17:58.815: RT IE 1, length 1, type 1
*Mar  1 01:17:58.815: KA IE 3, length 2, yourseq 65, myseq 92
*Mar  1 01:18:08.763: Serial0(out): StEnq, myseq 93, yourseen 65, DTE up
```

```
*Mar  1 01:18:08.763:  datagramstart = 0x20007C, datagramsize = 14
*Mar  1 01:18:08.763:  FR encap = 0x0001030800 75 95 01 01 01 03 02 5D 41
*Mar  1 01:18:08.767:
*Mar  1 01:18:08.815: Serial0(in): Status, myseq 93
*Mar  1 01:18:08.815: RT IE 1, length 1, type 1
*Mar  1 01:18:08.815: KA IE 3, length 2, yourseq 66, myseq 93
*Mar  1 01:18:18.763: Serial0(out): StEnq, myseq 94, yourseen 66, DTE up
*Mar  1 01:18:18.763:  datagramstart = 0x20007C, datagramsize = 14
*Mar  1 01:18:18.763:  FR encap = 0x0001030800 75 95 01 01 00 03 02 5E 42
*Mar  1 01:18:18.767:
*Mar  1 01:18:18.815: Serial0(in): Status, myseq 94
*Mar  1 01:18:18.815: RT IE 1, length 1, type 0
*Mar  1 01:18:18.819: KA IE 3, length 2, yourseq 67, myseq 94
*Mar  1 01:18:18.819: PVC IE 0x7 , length 0x3 , dlci 980, status 0x2
```

注意上述输出中“DLCI 980”的状态。状态字段的可能值说明如下：

1. **0x0-Added/inactive意味着交换机为该DLC进行了编程，但由于某种原因(例如PVC的另一端发生故障)，它无法使用。**
2. **0x2-**Added/active表示帧中继交换机具有DLCI，并且一切正常。您可以开始在报头中使用此DLCI发送流量。
3. **0x3-0x3是有效状态(0x2)与被设置为(0x1)的RNR (或r-bit) 的组合。** 这意味着这个PVC的交换机(或交换机上的一个特定队列)进行了备份，您中止了传输，以防帧溢出。
4. **0x4-Deleted表明帧中继交换机没有为路由器提供DLCI编程。**但它是在过去某个时刻编程的。这可能是由于在路由器上倒转的DLCI导致的，或者是由在帧中继网云中被删除的PVC导致。配置DLCI （交换机没有)将显示为0x4。
5. **0x8 — 新**/非活动
6. **0x0a** — 新/活动

帧中继特性

本节介绍您应该注意的几个帧中继特征。

IP 分界检查

IP水平分割检查默认禁用帧中继封装，路由更新将从相同接口流入流出。路由器通过本地管理接口(LMI)更新，获取它们需要从帧中继交换机使用的数据链路连接标识符(DLCI)。然后路由器向远程IP地址使用反向ARP，并创建本地DLCI和相关远程IP地址的映射。此外，部分网状网络不支持某些协议，例如AppleTalk、透明桥接和IPX，因为它们需要"水平分割"。在这些网络中，在一个接口上收到的信息包不能通过同一接口发出，即使信息包在不同的虚拟电路上接收和传输。配置帧中继子接口可将单个物理接口用作多个虚拟接口。此功能使我们能够克服水平分割规则。虚拟接口收到的信息包现在可以转发给另一个虚拟接口，即使它们配置在同一个物理接口。

Ping 多点帧中继上您自己的 IP 地址

您无法在多点帧中继接口上ping通自己的IP地址。这是因为帧中继多点(子)接口是非广播的(不同于以太网和点对点接口高级数据链路控制[HDLC])，以及帧中继点对点子接口。

此外，您不能在星型结构从一个分支ping到另一个分支。这是因为您自己的IP地址没有映射(没有通过反向ARP学到任何地址)。 但如果您为自己的IP 地址(或远程辐射点)配置了静态映射(使用frame-relay map命令)，以使用本地DLCI，您就能够ping通您的设备。

```
aton#ping  3.1.3.3
   Type escape sequence to abort.
   Sending 5, 100-byte ICMP Echos to 3.1.3.3, timeout is 2 seconds:
   .....
   Success rate is 0 percent (0/5)

   aton#configure terminal
   Enter configuration commands, one per line.  End with CNTL/Z.
   aton(config)#interface serial 1
   aton(config-if)#frame-relay map ip 3.1.3.3 160
   aton(config-if)#

   aton#show frame-relay map
   Serial1 (up): ip 3.1.3.1 dlci 160(0xA0,0x2800), dynamic,
                   broadcast,, status defined, active
   Serial1 (up): ip 3.1.3.2 dlci 160(0xA0,0x2800), static,
                   CISCO, status defined, active
   Serial1 (up): ip 3.1.3.3 dlci 160(0xA0,0x2800), static,
                   CISCO, status defined, active
   aton#ping 3.1.3.3

   Type escape sequence to abort.
   Sending 5, 100-byte ICMP Echos to 3.1.3.3, timeout is 2 seconds:
   !!!!!
   Success rate is 100 percent (5/5), round-trip min/avg/max = 64/68/76 ms
   aton#
   aton#show running-config
   !
   interface Serial1
   ip address 3.1.3.3 255.255.255.0
   no ip directed-broadcast
   encapsulation frame-relay
   frame-relay map ip 3.1.3.2 160
   frame-relay map ip 3.1.3.3 160
   frame-relay interface-dlci 160
   !
```

关键字广播

broadcast关键字提供两个功能：当组播没有启用时，它会转发广播，并简化使用帧中继的非广播网络的开放式最短路径优先（OSPF）配置。

某些路由协议（例如AppleTalk）可能还需要**broadcast**关键字，这些路由协议依赖于定期的路由表更新，特别是当位于远程端的路由器等待路由更新数据包到达后才添加路由时。

通过请求选择指定路由器，OSPF可以处理非广播的多路访问网络(例如帧中继)，处理方法与广播网络非常相似。在早先的版本中，OSPF配置必需的手工分配使用 neighbor interface router命令。当带有广播关键字的配置包括frame-relay map命令，并且配置了ip ospf network命令(带有广播关键字)配置时，不需要手工配置任何邻居。OSPF现在作为广播网络在帧中继网络上自动运行。(请参**阅ip ospf network interface**命令以了解详细信息。)

注意：OSPF广播机制假设IP D类地址从不用于帧中继上的常规流量。

示例

以下示例将目的IP地址172.16.123.1映射到DLCI 100:

```
interface serial 0
 frame-relay map IP 172.16.123.1 100 broadcast
```

OSPF使用DLCI 100广播更新。

重新配置子接口

一旦您创建了特殊类型的子接口，您就不能在不重新加载的情况下进行更改。例如，您不能创建多点子接口serial0.2，然后将其更改为点对点。如果要更改它，您需要重新加载路由器或创建另一个子接口。这是Cisco IOS®软件中帧中继代码的工作方式。

DLCI 限制

DLCI地址空间

假如提供10位地址，单个物理链路上大约可以配置1000个 DLCI。由于某些DLCI是保留的（取决于供应商实施），因此最大值约为1000。Cisco LMI的范围是16-1007。ANSI/ITU的规定范围是16-992。这些DLCI承载用户数据。

然而，在子接口上配置帧中继VC时，您需要考虑被称为IDB限制的实际限制。每个系统的接口和子接口的总数受到您的Cisco IOS版本支持的接口描述符块(IDB)的数量的限制。IDB是存储关于接口的信息(例如计数器、接口状态等)的存储器的一部分。IOS为每个平台上出现的每个接口维护IDB，为每个子接口维护IDB。高速接口比低速接口需要更多内存。每个平台包含不同最大数量的IDB，这些I限制可能会随每个Cisco IOS版本改变。

有关详细信息，请参阅Cisco IOS软件平台的最大接口和子接口数：IDB 限制。

LMI状态更新

LMI协议要求所有永久虚拟电路(PVC)状态报告符合单个数据包，一般会将DLCI的数量限制到少于800，取决于最大传输单位（MTU）的大小。

$$\text{MTU} = 4000 \text{ bytes}$$

$$\text{Max DLCIs} \cong \frac{\text{MTU bytes} - 20 \text{ bytes}}{5 \frac{\text{bytes}}{\text{DLCI}}}$$

$$\frac{4000 - 20}{5} \cong 796$$

DLCIs, where 20 = Frame Relay and LMI Header

串行接口上的默认MTU为1500字节，每个接口最多产生296个DLCI。您可以增加MTU以支持来自帧中继交换机的更大完整状态更新消息。如果完整状态更新消息大于接口MTU，那么丢失信息包，并且增加接口大型计数器。更改MTU时，保证远程路由器和相关网络设备上配置了相同值。

请注意，这些数字稍有不同，具体取决于LMI类型。根据Cisco 7000路由器平台上的经验数据得出的每个路由器(不是接口)平台的推荐最大DLCI值如下所示：

- Cisco 2500 ：1个X T1/E1链路，每个接口60个DLCI =共60个
- Cisco 4000 ：1个X T1/E1链路，每个接口120个DLCI =共120个
- Cisco 4500 ：3条X T1/E1链路@每个接口120个DLCI =共360条
- Cisco 4700 ：4条X T1/E1链路@每个接口120个DLCI =共480条
- Cisco 7000 ：4个X T1/E1/T3/E3链路，每个接口120个DLCI =总共480个
- Cisco7200 ：每个接口5个X T1/E1/T3/E3链路@ 120个DLCI =总计600个
- Cisco 7500 ：6个X T1/E1/T3/E3链路，每个接口120个DLCI =共720个

注意：这些数字仅是指导原则，并假设所有流量都是快速交换的。

其他注意事项

一个实际的DLCI限制也取决于VC是否运行动态或静态路由协议。动态路由协议和其他协议(如IPX SAP)交换数据库表将发送hello包，以及CPU必须识别和处理的转发信息消息。作为通用规则，使用静态路由使您能在单个帧中继接口配置大量VC。

IP/IPX/AT 地址

如果您正在使用子接口，请不要将IP、IPX或AT地址放置在主要接口。在启用主要接口之前，请将DLCI分配到它们的子接口上，以确保帧中继反向ARP正常工作。如果故障发生，请执行以下步骤：

1. 使用no frame-relay inverse-arp ip 16和clear frame-relay-inarp命令，关闭该DLCI的反向地址解析协议(ARP)。
2. 修复配置。
3. 再次打开frame-relay inverse-arp命令。

RIP 和 IGRP

路由信息协议(RIP)更新每30秒一次。每个RIP数据包可以包含25个路由条目，共536个字节。总共有36个字节是报头信息，每个路由条目为20个字节。所以，如果您通过为50 DLCI配置的帧中继链路通告1000个路由，路由更新数据速度将为 每30秒1MB，消耗285kbps的带宽。在T1链路上，此带宽表示18.7%的带宽 ，每一次更新的持续时间为5.6秒。开销相当高，并且处于可接受的边缘，但承诺信息速率(CIR)必须在这个接入速率范围内。显然，任何低于T1的设备都会产生过多的开销。例如：

- 1000/25 = 40个数据包X 36 = 1440个报头字节
- 1000 X 20字节= 20,000字节的路由条目
- 总计21,440字节X 50 DLCI =每30秒1072 MB的RIP更新
- 1,072,000字节/ 30秒X 8位= 285 kbps

内部网关路由协议(IGRP)每90秒更新一次（此间隔可配置）。 每个IGRP信息包能够包含104个路由条目，总共1492个字节，其中38个字节是报头信息，每个路由条目为14个字节。如果您在为配置了50个DLCI的帧中继链路上通告1000个路由，则请求每90秒将进行大约720 KB的路由更新，即消耗58.4 kbps的带宽。在T1链路上，此带宽表示4.2%的带宽 ，每一次更新的持续时间为3.7秒。此开销是可接受的金额：

- 1000/104 = 9个数据包X 38 = 342个报头字节
- 1000 X 14 = 14,000字节的路由条目

- 总计= 14,342字节X 50 DLCI =每90秒717 KB的IGRP更新
- 717,000字节/ 90 X 8位= 63.7 kbps

路由表维护协议(RTMP)路由更新每10秒（此间隔可配置）一次。 每个RTMP信息包最多可包含94个扩大路由条目，总共为564个字节，23个字节的报头信息，并且每个路由条目为6个字节。如果您在为配置了50个DLCI的帧中继链路上通告1000个AppleTalk网络，每10秒将进行大约313 KB的RTMP更新，即消耗250kbps带宽。要使开销保持在可接受的开销程度内（15%或更低)，则必须提供T1速率。例如：

- 1000/94 = 11个数据包X 23字节= 253个报头字节
- 1000 X 6 = 6000字节的路由条目
- 总计= 6253 X 50 DLCI =每10秒313 KB的RTMP更新
- 313,000 / 10秒X 8位= 250 kbps

IPX RIP数据包每60秒更新一次（此间隔可配置）。 每个IPX RIP数据包最多可包含50个路由条目，总共为536个字节，38个字节的报头信息，每个路由条目为8个字节。如果您在为配置50个DLCI的帧中继链路上通告1000个IPX路由，每60秒将进行大约536 KB的IPX更新，即消耗58.4 kbps的带宽。要维持在可接受的开销程度内(15%或更少)，应该达到512 kbps的速率。例如：

- 1000/50 = 20个数据包X 38个字节= 760个字节的报头
- 1000 X 8 = 8000字节的路由条目
- 总计= 8760 X 50 DLCI =每60秒438,000字节的IPX更新
- 438,000 / 60秒X 8位= 58.4 kbps

IPX服务接入点(SAP)数据包更新每60秒（此间隔可配置）一次。 每个IPX SAP数据包最多可包含7个通告条目，总共为536个字节，38个字节的报头信息，每个通告条目为64个字节。如果您在为50个DLCI配置的帧中继链路上广播1000 个IPX通告，您将以IPX每60秒将进行536 KB的更新而告终，或者消耗58.4 kbps的带宽。要维持在可接受的开销程度内(15%或更少)，应该达到高于2 Mbps的速率。显然，此场景需要SAP过滤。与本章节提及的所有其他协议相比，IPX SAP 新需要最大带宽：

- 1000/7 = 143个数据包X 38个字节= 5434个字节的报头
- 1000 X 64 = 64,000字节的路由条目
- 总计= 69,434 X 50 DLCI =每60秒3,471,700字节的IPX服务通告
- 3,471,700 / 60秒X 8位= 462 kbps

保持连接

在某些情况下，Cisco设备上的Keepalive需要设置成比交换机上的Keepalive稍短(大约短8秒)。如果接口保持忽开/忽关状态，您应查看此需求。

串行接口

串行接口（默认为多点）是非广播介质，而点对点子接口是广播。如果您使用静态路由，您可以指向下一跳或串行子接口。对于多点，您需要指向下一跳。在通过帧中继执行OSPF时，此概念非常重要。路由器需知道这是为OSPF操作提供的广播接口。

OSPF 和多点

OSPF和多点可能会非常麻烦。OSPF需要指定路由器(DR)。 如果您开始丢失PVC，则某些路由器可能会失去连接并尝试成为DR，即使其他路由器仍然看到旧DR。这会导致OSPF进程出现故障。

OSPF相关的开销不象传统距离矢量路由协议那样明显和可预测。不可预测性来自OSPF网络链路是否稳定。如果帧中继路由器的所有邻接设备都是稳定的，只有邻居hello数据包(Keepalive)通过，其开销低于距离矢量协议(例如RIP和IGRP)中的开销。 然而，如果路由(邻接)不稳定，则会发生连接状态泛洪，并且带宽可能迅速被消耗。在运行Dijkstra算法时（用来计算路由），OSPF非常占用处理器。

在Cisco IOS软件的早期版本中，当您在多路接入非广播媒介上(帧中继、x.25和ATM)配置OSPF时，应该特别注意。OSPF协议将这些介质视为与以太网等任何其他广播介质一样。非广播多路访问(NBMA)云通常构建在中心辐射型拓扑中。PVC或交换虚拟电路(SVC)在部分网状拓扑中，这种物理拓扑不提供OSPF认为存在的多通道。对于点对点串行接口，OSPF始终在邻居之间形成邻接关系。OSPF邻接交换数据库信息。为将在特定网段上交换的信息量减到最小，OSPF在每个多路访问网段上选择一台路由器作为DR，另一台路由器作为备份指定路由器(BDR)。BDR 选择作为 DR 停机时的备用机制。

此设置的思想是路由器具有用于信息交换的中心联系点。由于DR和BDR需要与网云上的所有路由器有全网状物理连接，这就使DR的选择成为一个问题。并且，由于缺乏广播功能，DR和BDR需要附在网云上的其他所有路由器的静态列表。此设置是使用neighbor命令**实现**的：

neighbor ip-address [priority number] [poll-interval seconds]

在Cisco IOS软件最新版本中，您可以使用不同的方法，避免静态地配置邻居和指定特定路由器成为非广播网络上的DR或BDR的复杂性。使用哪种方法取决于网络是否是新型网络，或者现有网络设计是否需要修改。

子接口是定义接口的逻辑方法。同一个物理接口可以被分离成多个逻辑接口，每个子接口被定义为点对点的接口。此方案最初创建的目的是更好地处理NBMA的水平分离和基于路由协议的向量引起的问题。

点对点子接口具有任何物理点对点接口的属性。就 OSPF 而言，邻接始终在不进行 DR 或 BDR 选择的点对点子接口上形成。OSPF将云视为一组点对点链路，而不是一个多路访问网络。点到点应用的唯一缺点是每个分段属于不同子网。由于一些管理员已经为全部网云分配一个IP子网，所以此方案可能无法实施。另一个解决方法是在网云上使用 IP 不编号的接口。此方案也可能成为根据串联线的IP地址管理WAN的某些管理员面临的一个问题。

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17. 4个LMI组合
18. Q.922附件A
19. ANSI T1.617 Annex D
20. ANSI T1.618、T1.606
21. ITU-T Q.933、Q.922
22. OSPF 设计指南
23. 增强型IGRP实施的配置说明

相关信息

- **有关帧中继命令的详细信息**
- **有关配置帧中继的详细信息**
- **有关Dial-Backup命令的详细信息**
- **有关ISDN调试命令的详细信息**
- **有关PPP调试命令的详细信息**
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