帧中继到 ATM 与LLQ 、PPP LFI 和cRTP 互工作的 VoIP QoS

目录

简介

本文为VoIP提供了示例配置，使用了PATM的多链路PPP和帧中继互联(VoIP使用了MLPoATM/MLPoFR)。 配置示例的中心重点是提供服务质量(QoS)，以便在ATM/帧中继互通WAN上正确支持语音。配置示例还使用压缩实时协议(cRTP)，自Cisco IOS®软件版本12.2(2)T以来,ATM上一直支持该协议。

文档可以独立阅读，以获取配置指南、配置示例和验证命令，以用于构建网络。提供部分背景信息，供与ATM/帧中继互联相关的特殊事件使用。有关帧中继或PPP上VoIP的QoS的详细信息，请参阅以下文档：

- 带有服务质量控制（LLQ/IP RTP 优先级、LFI、cRTP）的 VoIP-over-PPP
- 具有QoS的帧中继VoIP（分段、流量整形、LLQ/IP RTP优先级）

先决条件

要求

尝试进行此配置之前，请确保满足以下要求：

您应熟悉以下技术领域：

- 访问控制列表

- ATM永久虚电路(PVC)
- 帧中继永久虚电路(数据链路连接标识符(DLCI))
- 带宽管理
- LLQ
- LFI
- 虚拟模板和虚拟接入接口
- MLPPP
- cRTP

使用的组件

本文档中的信息基于以下软件和硬件版本：

- Cisco 3640作为ATM路由器
- Cisco 2620作为帧中继路由器
- 思科IOS软件版本12.2(8)T(IP Plus)

注意： 作为一般准则，最新的Cisco IOS 12.2主线维护版本是推荐的Cisco IOS软件版本，用于MLPoATM/FR。如果使用cRTP，则ATM路由器上需要Cisco IOS软件版本12.2T。

这些Cisco IOS软件版本引入了相关功能：

- LFI在Cisco IOS软件版本11.3中引入。
- LLQ在思科IOS软件版本12.0(7)T中引入。
- 在Cisco IOS软件版本12.1(2)T中引入了帧中继上的LLQ和每PVC的ATM。
- 在Cisco IOS软件版本12.1(5)T中引入了帧中继和ATM虚电路的多链路PPP LFI。
- 在Cisco IOS软件版本12.2(2)T中引入了基于ATM的cRTP。

本文档中的信息都是基于特定实验室环境中的设备编写的。本文档中使用的所有设备最初均采用原始（默认）配置。如果您使用的是真实网络，请确保您已经了解所有命令的潜在影响。

规则

有关文档规则的详细信息，请参阅 Cisco 技术提示规则。

背景信息

通过ATM/帧中继网际网络为VoIP提供最小化的端到端延迟和抖动避免的关键问题是：

- 语音流量的严格优先级(低延迟队列(LLQ))
- Link Fragmentation and Interleaving (LFI)
- 用于语音的帧中继流量整形(FRTS)
- ATM 流量整形

这些文档提供了进一步背景信息的有用来源：

- IP 语音的服务质量
- 为帧中继和ATM虚电路配置链路分段和交织

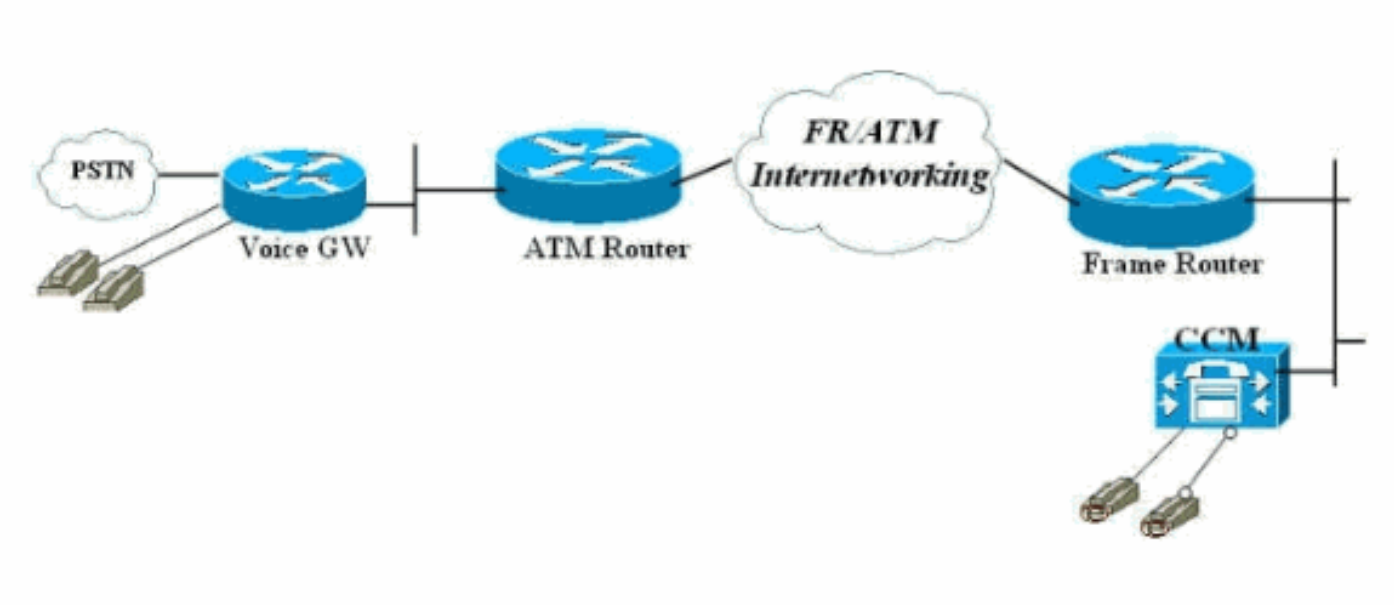
配置

本部分提供有关如何配置本文档所述功能的信息。

注意：使用命令查找工具(仅限注册客户)可查找有关本文档中使用的命令的详细信息。

网络图

本文档使用以下网络设置：



配置

本文档使用以下配置：

- 帧中继连接的路由器
- ATM连接路由器

注意：请注意，在此配置中，两台路由器通过帧中继背靠背连接到ATM互通交换机。但是，在大多数拓扑中，支持语音的路由器可以存在于任何位置。通常，语音路由器使用LAN连接到其它路由器，这些路由器连接到ATM/帧WAN。在这些情况下，必须为LLQ、LFI和MLPPP配置连接到WAN、帧中继和ATM的路由器，以便它们能提供QoS，而不是像这些配置所示的语音网关。

帧中继连接的路由器

```
!--- Note: This configuration is commented and numbered
!--- in the order that commands should be entered.


version 12.2
service timestamps debug datetime msec
service timestamps log uptime
no service password-encryption
!
hostname FR
!
enable password cisco
!
username ATM password 0 cisco
voice-card 0
```

```
dspfarm
!
ip subnet-zero
!
!
!
!

!--- access-list 105 permit ip any any dscp ef specifies
!--- that all traffic with Differentiated Services Code
Point (DSCP) !--- are set to 40 falls into this access-
list. !--- This class-map command defines a class of
traffic called "voice".

access-list 105 permit ip any any dscp ef
access-list 105 permit udp any any  range 16384 32767
access-list 105 permit ip any any precedence critical
!
class-map match-all voice
match access-group 105
!

!
!
 !--- This policy-map command defines a policy for LLQ
called "VoIP" and !--- maps the "voice" class to the
"VOIP" policy. !--- "priority" defines the amount of
bandwidth reserved for the priority queue. !--- "class-
default" specifies that the default class is also mapped
to this policy. !--- "fair-queue" specifies that all
other traffic is served in the WFQ.


policy-map VOIP
  class voice
    priority 48
  class class-default
   fair-queue

 !--- Note: Although it is possible to queue various
types of !--- real-time traffic to the priority queue,
!--- Cisco recommends that you direct only voice traffic
!--- to it. Real-time traffic such as video or voice !--
- could introduce variations in delay. Please note voice
and !--- video should not be combined in the same PVC.
!--- (the priority queue is a First In First Out (FIFO)
!--- queue). Voice traffic requires that delay be !---
nonvariable in order to avoid jitter. !--- Note: The sum
of the values for priority and !--- bandwidth statements
needs to be less !--- than or equal to 75% of the link
bandwidth. !--- Otherwise service-policy cannot be !---
assigned to the link. When configuring VoIP over a !---
64 Kbps link to support two !--- voice calls, it is
common to allocate more than 75% !--- (48 Kbps) of the
link bandwidth to !--- the priority queue. In such
cases, you can use the !--- max-reserved-bandwidth <#%>
command in order to raise !--- available bandwidth to a
value more than 75%.


!
!
!
fax interface-type fax-mail
```

```
mta receive maximum-recipients 0
!
interface Loopback0
 ip address 10.1.1.2 255.255.255.0
!
!
interface FastEthernet0/0
 ip address 172.17.111.16 255.255.255.224
 duplex auto
 speed auto
!
interface Serial0/0
 no ip address
 encapsulation frame-relay IETF
 no ip route-cache
 no ip mroute-cache
 frame-relay traffic-shaping
!
!--- Choose the frame relay interface to be !---
associated with the virtual interface. The !--- virtual
template could equally have been associated !--- with
the physical interface. !--- The "class mlp" associates
the virtual template interface !--- defined in
"interface Virtual-Template1" with a Frame Relay DLCI.
!--- Associates a Frame Relay map class with a DLCI.
interface Serial0/0.1 point-to-point no ip route-cache
no ip mroute-cache frame-relay interface-dlci 16 ppp
Virtual-Template1 class mlp !--- The interface command
creates a virtual !--- template called Virtual-
Template1. !--- A bandwidth of 64 Kbps is assigned to
this !--- template interface. This bandwidth is used !--
- by Cisco IOS to calculate the data fragment size as
noted regarding !--- interleaving of PPP segments. !---
"ip rtp header-compression"—cRTP is supported in an
ATM/Frame Relay Interworking !--- environment. It
requires Cisco IOS Software Release 12.2(2)T on the !---
ATM router. !--- "service-policy output VOIP"—The VoIP
policy created earlier is assigned !--- to this
interface in the outbound direction. !--- PPP multilink
is enabled and the !--- maximum delay per segment is
specified. This bandwidth is !--- used by Cisco IOS to
calculate the data fragement size as noted. !---
Interleaving of PPP segments is enabled, which allows !-
-- voice packets to be expedited. Voice !--- packets
need only wait behind a single segment of !--- a
previously queued data packet (for example, 10 ms !---
delay) rather than wait until the end of the !--- entire
data packet. Cisco IOS calculates the !--- data fragment
size using the following formula: !--- fragment size =
delay x bandwidth/8

!
interface Virtual-Template1
 bandwidth 64
 ip unnumbered loopback0
 ip rtp header-compression
 no ip route-cache
 load-interval 30
 max-reserved-bandwidth 99
 service-policy output VOIP
 ppp multilink
 ppp multilink fragment-delay 10
 ppp multilink interleave
!
```

```
!
ip classless
ip route 0.0.0.0 0.0.0.0 172.17.111.1
no ip http server
ip pim bidir-enable
!
!
!
 !--- A map class called mlp is created. !--- With "no
frame-relay adaptive-shaping", adaptive !--- shaping is
disabled. You do not !--- want to exceed CIR and have
voice packets !--- possibly queued within the Frame
Relay network. !--- Waiting for a BECN to resolve this
!--- situation could result in poor voice quality. !---
The frame-relay cir 64000 command forces the router to
transmit !--- at the desired CIR rate rather than line
!--- rate for the port. !--- "frame-relay bc 640"
configures the Bc value to force the desired !--- Tc
(shaping interval) value is 10 ms. !--- This formula
should be used to determine !--- the Bc value to use: Tc
= Bc/CIR. A !--- smaller Tc value reduces the interval a
voice !--- packet has to wait to be sent. !--- As in
"frame-relay be 0", the Be value should be set to zero
!--- in order to avoid voice being sent as part of a
burst !--- that is not guaranteed by the Frame Relay
network.


map-class frame-relay mlp

 no frame-relay adaptive-shaping
 frame-relay cir 64000
 frame-relay bc 640
 frame-relay be 0


!
call rsvp-sync
!
voice-port 1/0/0
!
voice-port 1/0/1
!
!
mgcp profile default
!
dial-peer cor custom
!
!
!
dial-peer voice 123 voip
 destination-pattern 123
 session target ipv4:10.1.1.1
 ip qos dscp cs5 media
 ip qos dscp cs5 signaling
 no vad
!
dial-peer voice 456 pots
 destination-pattern 456
 port 1/0/0
!
!
```

```
line con 0
line aux 0
line vty 0 4
 exec-timeout 0 0
 password cisco
 login
!
!
end
```

ATM连接路由器

```
!--- Note: This configuration is commented only !---
where additional consideration is required from the !---
above configuration of the Frame Relay router.


version 12.2
service timestamps debug datetime msec
service timestamps log uptime
no service password-encryption
!
hostname ATM
!
enable password cisco
!
username FR password 0 cisco
memory-size iomem 25
ip subnet-zero
!
!
!
access-list 105 permit ip any any dscp ef
access-list 105 permit udp any any  range 16384 32767
access-list 105 permit ip any any precedence critical
!
class-map match-all voice
 match access-group 105
!
!
!--- Note: Matching commands to the Frame Relay !---
router side of the network.


!
!
policy-map VOIP
  class voice
    priority 48
  class class-default
   fair-queue

!--- Note: Matching commands to the Frame Relay !---
router side of the network.


!
!
fax interface-type fax-mail
mta receive maximum-recipients 0
!
controller T1 2/0
```

```
 framing sf
 linecode ami
!
!
!
!
interface ATM0/0
 no ip address
 ip route-cache
 no atm ilmi-keepalive
!
!--- "interface ATM0/0.1 point-to-point" chooses the ATM
subinterface. !--- The physical interface could equally
have been used. !--- "pvc 10/100" creates an ATM PVC. !-
-- "cbr 64"—A VBR PVC has been defined on this example.
!--- This exapmle uses VBR non-realtime and the
sustained !--- cell rate (SCR) should be equal to the
peak !--- cell rate (PCR) in order to avoid bursting. !-
-- ATM cell tax and the possibility !--- of ATM
bandwidth expansion due to poor !--- fragment/cell
alignment, means that it !--- cannot be assumed that the
PCR/SCR on the ATM !--- side should equal the CIR of the
Frame Relay side. !--- Maintain the value of CIR on the
Frame-Relay side to define !--- our SCR, in this case,
64 kbps. This value may in some networks !--- require
some fine-tuning as the CIR on the Frame side does not
!--- exactly match the SCR on the ATM but makes for a
good-enough estimation !--- for most purposes. !---
Refer to Designing and Deploying !--- Multilink PPP over
Frame Relay and ATM !--- for more information. !---
"encapsulation aal5snap" is required. !--- "protocol ppp
Virtual-Template1" associates the virtual !--- template
with the ATM PVC. interface ATM0/0.1 point-to-point ip
route-cache pvc 10/100 cbr 64 encapsulation aal5snap
protocol ppp Virtual-Template1 ! ! interface loopback0
ip address 10.1.1.1 255.255.255.0 ! interface
Ethernet3/0 ip address 172.17.111.15 255.255.255.224
half-duplex ! interface Ethernet3/1 no ip address
shutdown half-duplex ! interface Virtual-Template1
bandwidth 64 ip unnumbered loopback0 ip rtp header-
compression no ip route-cache load-interval 30 max-
reserved-bandwidth 99 service-policy output VOIP ppp
multilink ppp multilink fragment-delay 10 ppp multilink
interleave !--- Note: The virtual template is created in
!--- exactly the same way as for the !--- Frame Relay
router side of the network. !--- An additional
consideration for !--- the ATM router is that the
fragment size !--- should be optimized to fit into !---
an integral number of ATM cells. !--- Refer to Designing
and Deploying !--- Multilink PPP over Frame Relay and
ATM !--- for more information on this issue. ! ip
classless ip route 0.0.0.0 0.0.0.0 172.17.111.1 ip http
server ip pim bidir-enable ! ! call rsvp-sync ! voice-
port 1/0/0 description FXS ! voice-port 1/0/1 ! voice-
port 1/1/0 description FXO ! voice-port 1/1/1 ! ! mgcp
profile default ! dial-peer cor custom ! ! ! dial-peer
voice 456 voip destination-pattern 456 session target
ipv4:10.1.1.2 ip qos dscp cs5 media ip qos dscp cs5
signaling no vad ! dial-peer voice 123 pots destination-
pattern 123 port 1/1/0 ! ! line con 0 line aux 0 line
vty 0 4 exec-timeout 0 0 password cisco login ! ! end
```

验证

使用本部分可确认配置能否正常运行。

命令输出解释程序（仅限注册用户）(OIT) 支持某些 show 命令。使用 OIT 可查看对 show 命令输出的分析。

以下**show**命令可用于验证ATM/帧中继互通环境的运行状态，包括DLCI和PVC统计信息、物理和虚拟接口状态、策略(QoS)应用和cRTP信息：

- **show ppp multilink interface** ***interface-name*** — 验证捆绑是否处于up/down状态，哪个虚拟访问接口是捆绑（MLPPP捆绑），哪些是成员（PPP链路）。 此命令还验证载波是否丢弃信元/帧（丢失分片<> 0）。 唯一可接受的分段丢失是由循环冗余校验(CRC)错误引起的。
- **show user** — 显示与虚拟访问接口关联的编号。您可以使用此命令或show ppp multilink命令输出中的信息，这样您便可以显示接口的统计数据或者清除接口。
- **show frame-relay pvc dlci — *显***示流量整形参数、分段值和丢弃的数据包等信息。此命令还显示物理接口是否已绑定到虚拟接口。
- **show atm pvc** ***pvc*** — 显示所有活动ATM PVC和流量信息。
- **show policy-map interface interface-*name*** — 显示PQ中的所有LLQ操作和任何丢包。有关此命令的各个字段的详细信息，**请参阅show policy-map interface**命令输出中的“了解数据包计数器”。**注意**：花式队列始终应用于virtual-access2接口。其他接口使用FIFO队列。
- **show ip rtp header-compression** — 显示RTP报头压缩统计信息（如果已配置）。请注意，统计信息已附加到虚拟访问2接口，即捆绑接口。

以下是这些命令的示例：

```
FR#show ppp multilink interface virtual-access 2
Virtual-Access2, bundle name is ATM
Bundle up for 00:22:42
0 lost fragments, 0 reordered, 0 unassigned
0 discarded, 0 lost received, 231/255 load
0x2E5 received sequence, 0x10C31 sent sequence
Member links: 1 (max not set, min not set)
Virtual-Access1, since 00:22:42, last rcvd seq 0002E4 160 weight
```

此输出显示了帧中**继路由器**上的show users。

```
FR#show users
Line User Host(s) Idle Location
67 vty 1 idle 00:00:00 10.1.1.1
Interface User Mode Idle Peer Address
Vi1 Virtual PPP (FR ) -
Vi2 Virtual PPP (Bundle) 00:00:00 10.1.1.1
FR#
```

此输出显示ATM路**由器上**的show users。

```
ATM#show users
Line User Host(s) Idle Location
131 vty 1 idle 00:00:00 64.104.207.95
Interface User Mode Idle Peer Address
Vi1 Virtual PPP (ATM ) -
Vi2 Virtual PPP (Bundle) 00:00:02 10.1.1.2
ATM#
```

此输出显示**show frame-relay pvc命令**。

```
FR#show frame-relay pvc 16
 PVC Statistics for interface Serial0/0 (Frame Relay DTE)
 DLCI = 16, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0.1

      input pkts 2301 output pkts 2295 in bytes 152266
      out bytes 151891 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
      5 minute input rate 9000 bits/sec, 9 packets/sec
      5 minute output rate 9000 bits/sec, 9 packets/sec
      pvc create time 23:46:56, last time pvc status changed 00:22:56
      Bound to Virtual-Access1 (up, cloned from Virtual-Template1)
      !--- PPP link interface. cir 64000 bc 640 be 0 byte limit 80 interval 10 mincir 64000 byte
increment 80 Adaptive Shaping none pkts 2296 bytes 152053 pkts delayed 9 bytes delayed 375
shaping active traffic shaping drops 0 Queueing strategy: fifo Output queue 0/40, 0 drop, 0
dequeued FR#
```

此输出显示**ATM路由器上的show atm pvc 10/100命令**。

```
ATM#show atm pvc 10/100
      ATM0/0.1: VCD: 1, VPI: 10, VCI: 100
      CBR, SusRate: 128
      AAL5-LLC/SNAP, etype:0x0, Flags: 0x820, VCmode: 0x0
      OAM frequency: 0 second(s), OAM retry frequency: 1 second(s)
      OAM up retry count: 3, OAM down retry count: 5
      OAM Loopback status: OAM Disabled
      OAM VC state: Not Managed
      ILMI VC state: Not Managed
      InARP frequency: 15 minutes(s)
      Transmit priority 1
      InPkts: 729, OutPkts: 729, InBytes: 49700, OutBytes: 51158
      InPRoc: 0, OutPRoc: 729
      InFast: 729, OutFast: 0, InAS: 0, OutAS: 0
      InPktDrops: 0, OutPktDrops: 0/0/0 (holdq/outputq/total)
      CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0, LengthViolation: 0,
      CPIErrors: 0
      OAM cells received: 0
      F5 InEndloop: 0, F5 InSegloop: 0, F5 InAIS: 0, F5 InRDI: 0
      F4 InEndloop: 0, F4 InSegloop: 0, F4 InAIS: 0, F4 InRDI: 0
      OAM cells sent: 0
      F5 OutEndloop: 0, F5 OutSegloop: 0, F5 OutRDI: 0
      F4 OutEndloop: 0, F4 OutSegloop: 0, F4 OutRDI: 0
      OAM cell drops: 0
      Status: UP
   PPP: Virtual-Access2 from Virtual-Template1
    !--- MLPPP bundle interface. ATM#
```

这是帧中**继路由器**上的show policy-map。

```
FR#show policy-map interface Virtual-Access2
Service-policy output: VoIP
Class-map: voice (match-all)
15483 packets, 959502 bytes
30 second offered rate 24000 bps, drop rate 0 bps
Match: ip dscp 40
Weighted Fair Queueing
Strict Priority
!--- LLQ Strict Priority Queue for voice. Output Queue: Conversation 24 Bandwidth 48(kbps) Burst
```

```
1500 (Bytes) (pkts matched/bytes matched) 15536/962784 (total drops/bytes drops) 0/0
!--- No drops in the voice queue. Class-map: class-default (match-any)
139 packets, 19481 bytes
30 second offered rate 1000 bps, drop rate 0 bps
Match: any
Weighted Fair Queueing
Flow Based Fair Queueing
Maximum Number of Hashed Queues 16
(total queued/total drops/no-buffer drops) 0/0/0
```

此输出显示ATM路由器上的show policy map命令。

```
ATM#show policy-map interface Virtual-Access2
Service-policy output: VOIP
Class-map: voice (match-all)
11293 packets, 699718 bytes
30 second offered rate 24000 bps, drop rate 0 bps
Match: ip dscp 40
Weighted Fair Queueing
Strict Priority
!--- LLQ Strict Priority Queue for voice. Output Queue: Conversation 24 Bandwidth 48 (kbps)
Burst 1500 (Bytes) (pkts matched/bytes matched) 11352/703376 (total drops/bytes drops) 0/0 !---
No drops in the voice queue. Class-map: class-default (match-any) 63 packets, 9772 bytes 30
second offered rate 0 bps, drop rate 0 bps Match: any Weighted Fair Queueing Flow Based Fair
Queueing Maximum Number of Hashed Queues 16 (total queued/total drops/no-buffer drops) 0/0/0
ATM#
```

此输出显示了帧中继路由器上的show ip rtp header-compression命令。

```
FR#show ip rtp header-compression
RTP/UDP/IP header compression statistics:
Interface Virtual-Access1:
Rcvd: 0 total, 0 compressed, 0 errors
0 dropped, 0 buffer copies, 0 buffer failures
Sent: 0 total, 0 compressed,
0 bytes saved, 0 bytes sent
Connect: 16 rx slots, 16 tx slots,
0 long searches, 0 misses 0 collisions

Interface Virtual-Template1:
Rcvd: 0 total, 0 compressed, 0 errors
0 dropped, 0 buffer copies, 0 buffer failures
Sent: 0 total, 0 compressed,
0 bytes saved, 0 bytes sent
Connect: 16 rx slots, 16 tx slots,
0 long searches, 0 misses 0 collisions

Interface Virtual-Access2:
Rcvd: 23682 total, 23681 compressed, 0 errors
0 dropped, 0 buffer copies, 0 buffer failures
Sent: 327 total, 233 compressed,
8821 bytes saved, 5159 bytes sent
2.70 efficiency improvement factor
Connect: 16 rx slots, 16 tx slots,
0 long searches, 94 misses 0 collisions
71% hit ratio, five minute miss rate 0 misses/sec, 0 max
```

此输出显示ATM路由器上的show ip rtp header-compression命令。

```
ATM#show ip rtp header-compression
RTP/UDP/IP header compression statistics:
```

```
Interface Virtual-Access1:
Rcvd: 0 total, 0 compressed, 0 errors
0 dropped, 0 buffer copies, 0 buffer failures
Sent: 0 total, 0 compressed,
0 bytes saved, 0 bytes sent
Connect: 16 rx slots, 16 tx slots,
0 long searches, 0 misses 0 collisions, 0 negative cache hits

Interface Virtual-Template1:
Rcvd: 0 total, 0 compressed, 0 errors
0 dropped, 0 buffer copies, 0 buffer failures
Sent: 0 total, 0 compressed,
0 bytes saved, 0 bytes sent
Connect: 16 rx slots, 16 tx slots,
0 long searches, 0 misses 0 collisions, 0 negative cache hits

Interface Virtual-Access2:
Rcvd: 283 total, 233 compressed, 0 errors
0 dropped, 0 buffer copies, 0 buffer failures
Sent: 25341 total, 25340 compressed,
955537 bytes saved, 564463 bytes sent
2.69 efficiency improvement factor
Connect: 16 rx slots, 16 tx slots,
0 long searches, 1 misses 0 collisions, 100 negative cache hits
99% hit ratio, five minute miss rate 0 misses/sec, 0 max
```

故障排除

使用本部分可排除配置的故障。

此部分提供部分澄清MLP LFI的示例调试，它同时充当您排除配置故障的操作示例。

故障排除命令

命令输出解释程序（仅限注册用户）(OIT) 支持某些 show 命令。使用 OIT 可查看对 show 命令输出的分析。

注意：在使用debug命令之前，请参阅有关Debug命**令的**重要信息。

- **debug ppp negotiation** — 说明克隆两个虚拟访问接口以表示PPP和PPP捆绑链路的过程。虚拟访问接口1 (Vi1)是的PPP链路，其中绑定了PVC (ATM或帧)。虚拟接口2(Vi2)是连接排队策略的PPP捆绑链路。
- **debug ppp multilink fragment** — 说明大数据包与小语音数据包交错的概念。交叉发生在Vi2接口(MLP级别)，因为捆绑接口被分配了的理想的排队。

这是debug ppp negotiation命令的**命令输**出。

```
FR(config-if)#no shut
FR(config-if)#^Z
FR#
FR#
6d23h: %LINK-3-UPDOWN: Interface Virtual-Access1, changed state to up
*Mar 7 23:20:42.842: Vi1 PPP: Treating connection as
a dedicated line
!--- Vi1 is the PPP link to which the PVC is bound. *Mar 7 23:20:42.842: Vi1 PPP: Phase is
ESTABLISHING, Active Open *Mar 7 23:20:42.842: Vi1 LCP: O CONFREQ [Closed] id 197 len 19 *Mar 7
23:20:42.842: Vi1 LCP: MagicNumber 0xF44128D2 (0x0506F44128D2) *Mar 7 23:20:42.842: Vi1 LCP:
MRRU 1524 (0x110405F4) *Mar 7 23:20:42.842: Vi1 LCP: EndpointDisc 1 FR (0x1305014652)
```

```
!--- Router FR at one end of PPP discovery. *Mar 7 23:20:42.858: Vi1 LCP: I CONFREQ [REQsent] id
14 len 20 *Mar 7 23:20:42.858: Vi1 LCP: MagicNumber 0x294819D4 (0x0506294819D4) *Mar 7
23:20:42.858: Vi1 LCP: MRRU 1524 (0x110405F4) *Mar 7 23:20:42.858: Vi1 LCP: EndpointDisc 1 ATM
(0x13060141544D)
!--- Router ATM at the other end of PPP discovery. *Mar 7 23:20:42.858: Vi1 LCP: O CONFACK
[REQsent] id 14 len 20 *Mar 7 23:20:42.862: Vi1 LCP: MagicNumber 0x294819D4 (0x0506294819D4)
*Mar 7 23:20:42.862: Vi1 LCP: MRRU 1524 (0x110405F4) *Mar 7 23:20:42.862: Vi1 LCP: EndpointDisc
1 ATM (0x13060141544D) *Mar 7 23:20:42.870: Vi1 LCP: I CONFACK [ACKsent] id 197 len 19 *Mar 7
23:20:42.870: Vi1 LCP: MagicNumber 0xF44128D2 (0x0506F44128D2) *Mar 7 23:20:42.870: Vi1 LCP:
MRRU 1524 (0x110405F4) *Mar 7 23:20:42.870: Vi1 LCP: EndpointDisc 1 FR (0x1305014652) *Mar 7
23:20:42.870: Vi1 LCP: State is Open *Mar 7 23:20:42.870: Vi1 PPP: Phase is FORWARDING,
Attempting Forward *Mar 7 23:20:42.874: Vi1 PPP: Phase is ESTABLISHING, Finish LCP *Mar 7
23:20:42.874: Vi1 PPP: Phase is VIRTUALIZED *Mar 7 23:20:42.942: Vi2 PPP: Phase is DOWN, Setup
*Mar 7 23:20:43.222: Vi1 IPCP: Packet buffered while building MLP bundle interface
6d23h: %LINK-3-UPDOWN: Interface Virtual-Access2, changed state to up
!--- MLP level queuing. *Mar 7 23:20:43.226: Vi2 PPP: Treating connection as a dedicated line
*Mar 7 23:20:43.226: Vi2 PPP: Phase is ESTABLISHING, Active Open *Mar 7 23:20:43.226: Vi2 LCP: O
CONFREQ [Closed] id 1 len 19 *Mar 7 23:20:43.226: Vi2 LCP: MagicNumber 0xF4412A53
(0x0506F4412A53) *Mar 7 23:20:43.226: Vi2 LCP: MRRU 1524 (0x110405F4) *Mar 7 23:20:43.230: Vi2
LCP: EndpointDisc 1 FR (0x1305014652) *Mar 7 23:20:43.230: Vi2 MLP:
Added first link Vi1 to bundle ATM
!--- PVCs make up the bundle. *Mar 7 23:20:43.230: Vi2 PPP: Phase is UP *Mar 7 23:20:43.230: Vi2
IPCP: O CONFREQ [Closed] id 1 len 10 *Mar 7 23:20:43.234: Vi2 IPCP: Address 10.1.1.2
(0x03060A010102) *Mar 7 23:20:43.234: Vi2 PPP: Pending ncpQ size is 1 *Mar 7 23:20:43.234: Vi1
IPCP: Redirect packet to Vi1 *Mar 7 23:20:43.234: Vi2 IPCP: I CONFREQ [REQsent] id 1 len 10 *Mar
7 23:20:43.234: Vi2 IPCP: Address 10.1.1.1 (0x03060A010101) *Mar 7 23:20:43.234: Vi2 IPCP: O
CONFACK [REQsent] id 1 len 10 *Mar 7 23:20:43.234: Vi2 IPCP: Address 10.1.1.1 (0x03060A010101)
*Mar 7 23:20:43.266: Vi2 IPCP: I CONFACK [ACKsent] id 1 len 10 *Mar 7 23:20:43.266: Vi2 IPCP:
Address 10.1.1.2 (0x03060A010102) *Mar 7 23:20:43.266: Vi2 IPCP: State is Open *Mar 7
23:20:43.266: Vi2 IPCP: Install route to 10.1.1.1 *Mar 7 23:20:43.270: Vi2 IPCP: Add link info
for cef entry 10.1.1.1
```

此命令输出来自debug ppp multilink fragment命令。

```
*Mar 7 23:16:08.034: Vi2 MLP:
Packet interleaved from queue 24
*Mar 7 23:16:08.038: Vi1 MLP: O ppp UNKNOWN(0x0000) (0000) size 64
*Mar 7 23:16:08.038: Vi2 MLP: Packet interleaved from queue 24
*Mar 7 23:16:08.038: Vi1 MLP: O ppp UNKNOWN(0x0000) (0000) size 64
*Mar 7 23:16:08.038: Vi2 MLP: Packet interleaved from queue 24
*Mar 7 23:16:08.038: Vi1 MLP: O ppp UNKNOWN(0x0000) (0000) size 64
*Mar 7 23:16:08.038: Vi1 MLP: O frag 0000829B size 160
*Mar 7 23:16:08.042: Vi1 MLP: I ppp IP (0021) size 64 direct
*Mar 7 23:16:08.046: Vi1 MLP: I ppp IP (0021) size 64 direct
```

相关信息

- 在帧中继与 ATM 上设计与部署多链路 PPP
- 带有服务质量控制（LLQ/IP RTP 优先级、LFI、cRTP）的 VoIP-over-PPP
- 具有QoS的帧中继VoIP（分段、流量整形、LLQ/IP RTP优先级）
- 语音技术支持
- 语音和统一通信产品支持
- Cisco IP 电话故障排除
- 技术支持和文档 - Cisco Systems