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Cisco IOS Gateway as an MoH Resource

Document ID: 45761

Introduction

Prerequisites

- Requirements
- Components Used
- Conventions

Architecture

Cisco CallManager 3.3 Configuration and Troubleshooting

- Cisco CallManager Configuration
- Enable Multicast Audio Sources on the Cisco CallManager MoH Server
- Add a Multicast Enabled MoH Audio Source
- Add Multicast Enabled MRG
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- Region
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- Cisco CallManager Configuration
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Cisco IOS Configuration and Troubleshooting

- MoH Audio File in Flash
- Configuration
- Verify and Troubleshoot Basic Cisco IOS MoH Streaming
- Verify and Troubleshoot IOS MoH to PSTN
- Verify and Troubleshoot Cisco IOS MoH to IP Phone

Related Information

Introduction

As of Cisco Survivable Remote Site Telephony (SRST)/Cisco IOS® Telephony Service (ITS) 3.0, a Cisco IOS branch gateway has the capability to function as a multicast Music on Hold (MoH) resource. This allows for a distributed MoH design where MoH at remote sites is provided by the local gateway, which can save valuable bandwidth because MoH does not have to stream across the WAN. This document describes how to design such a distributed MoH solution. It also provides guidelines for you to configure Cisco CallManager and the remote SRST gateway, along with some suggestions for troubleshooting.

Prerequisites

Requirements

Readers of this document should have knowledge of these topics:

- Multicast concepts

- Cisco CallManager MoH concepts

Components Used

The information in this document is based on these software and hardware versions:

- Multicast MoH for H.323 and Media Gateway Control Protocol (MGCP) has been supported in Cisco CallManager since 3.1(1). However, this particular feature is broken in all versions of Cisco CallManager 3.3.2. For details, refer to Cisco bug ID CSCdz00697 (registered customers only) . The configurations in this document have been successfully tested with Cisco CallManager 3.3.(3)sr1 and Cisco CallManager 4.0(0.359).
- The Cisco MoH gateway must be running Cisco IOS Software Release 12.2(15)ZJ2, or Cisco IOS Software Release 12.3(2nd)T and later.

Note: Cisco IOS Software Release 12.3(2nd)T is *not* the same as Cisco IOS Software Release 12.3(2)T. Cisco IOS Software Release 12.3(2nd)T is the release that follows Cisco IOS Software Release 12.3(2)T. The configurations in this document have been successfully tested with Cisco IOS Software Release 12.2(15)ZJ5.

Note: Cisco bug ID CSCeb87600 (registered customers only) in Cisco IOS MoH causes MoH to not start streaming until at least one phone has opened a Transmission Control Protocol (TCP) connection to Cisco IOS. This is fixed in Cisco IOS Software Release 12.2(15)ZJ2. Do not attempt to use Cisco IOS Software Releases 12.2(15)ZJ or 12.2(15)ZJ1.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

Conventions

For more information on document conventions, refer to the Cisco Technical Tips Conventions.

Architecture

The MoH capabilities of Cisco IOS are simple. Cisco IOS can be configured to permanently multicast Real-Time Transport Protocol (RTP) packets from an audio file stored locally on Flash. This multicasting or streaming is not under the control of Cisco CallManager. Actually, Cisco CallManager is not even aware of the fact that a Cisco IOS MoH resource exists in the network. By configuring Cisco IOS MoH to multicast to the same multicast IP address and port as that used by Cisco CallManager, block multicast packets originated by Cisco CallManager, remote IP phones and gateways pickup the identical packets multicast by the local branch gateway instead of the Headquarters CallManager server.

Note: Cisco IOS MoH works for multicast MoH only. Unicast MoH is not supported.

Cisco CallManager 3.3 Configuration and Troubleshooting

Cisco CallManager Configuration

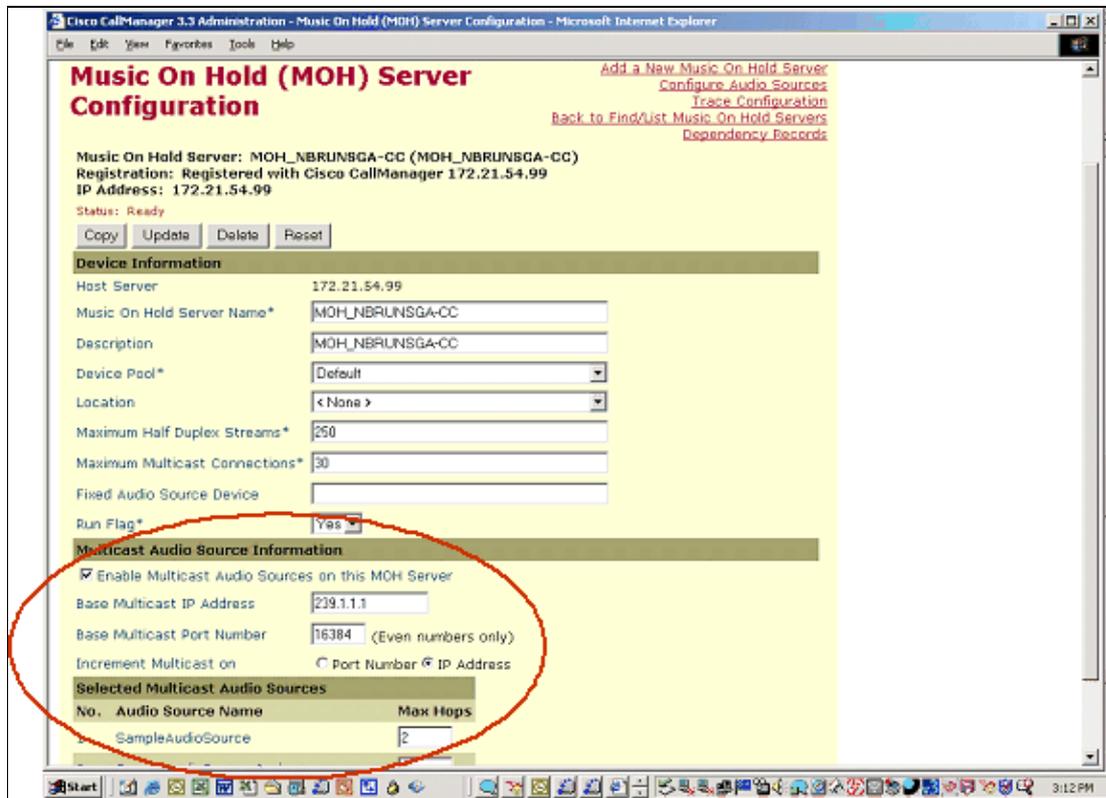
In order to take advantage of Cisco IOS MoH, the Cisco CallManager configuration must be designed appropriately. You must enable multicast MoH and configure Media Resource Groups (MRGs) and Media

Resource Group Lists (MRGLs) to control which devices get multicast and which get unicast MoH. You must also assign regions, so that G.711 is used whenever a Cisco IOS MoH resource is invoked.

Enable Multicast Audio Sources on the Cisco CallManager MoH Server

From the Cisco CallManager administration page, go to the **Service** menu, select **Media Resource** and then **Music On Hold server**.

On the MoH server configuration, check the **Enable Multicast Audio Sources on this MOH Server** box. This MoH server can still unicast MoH. Its capabilities are just being expanded to include multicast MoH. Specify a base for the IP multicast address and port numbers. For example, IP address 239.1.1.1 and port 16384.



The setting for *Increment Multicast on* affects the configuration to be completed later in the Cisco IOS section of this document. If it is set to **IP Address**, then each MoH audio source and codec combination is multicasted to a different IP address but uses the same port number. If it is set to **Port Number**, then each MoH audio source and codec combination is multicasted to the same IP address but uses a different destination port number. This table illustrates this, when the base IP address is 293.1.1.1 and the base port is 16384:

Note: When *Increment Multicast on* is set to **Port Number**, then port number increments by multiples of two. For example, for the audio stream "1", port number for G.711 u-law is 16384 and for G.711 a-law, it increments by two which is equal to 16386 as shown in the table.

		Increment Multicast in IP Address		Increment Multicast on Port Number	
Audio	Codec	Destination	Destination	Destination	Destination

Stream		IP Address	Port Number	IP Address	Port Number
1	G.711 u-law	239.1.1.1	16384	239.1.1.1	16384
1	G.711 a-law	239.1.1.2	16384	239.1.1.1	16386
1	G.729	239.1.1.3	16384	239.1.1.1	16388
1	Wideband	239.1.1.4	16384	239.1.1.1	16390
2	G.711 u-law	239.1.1.5	16384	239.1.1.1	16392
2	G.711 a-law	239.1.1.6	16384	239.1.1.1	16394
2	G.729	239.1.1.7	16384	239.1.1.1	16396
2	Wideband	239.1.1.8	16384	239.1.1.1	16398

Furthermore, you should configure multicast audio sources to increment on the IP address and not the port number, for the these reasons:

- IP phones placed on hold join multicast IP addresses, not port numbers. Cisco IP phones have no concept of multicast port numbers. Therefore, if all of the configured codecs for a particular audio stream transmit to the same multicast IP address (even on different port numbers), all streams are sent to the IP phone even though only one stream is needed. This has the potential to saturate the network with unnecessary traffic because the IP phone can receive only a single MoH stream.
- IP network routers route multicast based on IP addresses, not port numbers. Routers have no concept of multicast port numbers. Thus, when a router encounters multiple streams sent to the same multicast group address (even on different port numbers), the router forwards all streams of the multicast group. Because only one stream is needed, network bandwidth is over-utilized and network congestion can eventually result.

It is important to know exactly which audio stream and codec Cisco CallManager chooses when you place a device that receives Cisco IOS MoH. Only then can you specify the correct multicast IP address and port number in Cisco IOS.

- If you set the important parameter Max Hops count to 1, MoH can be prevented from crossing the WAN. This eliminates the need for access lists to block the multicast packets, or for other measures to limit multicast.

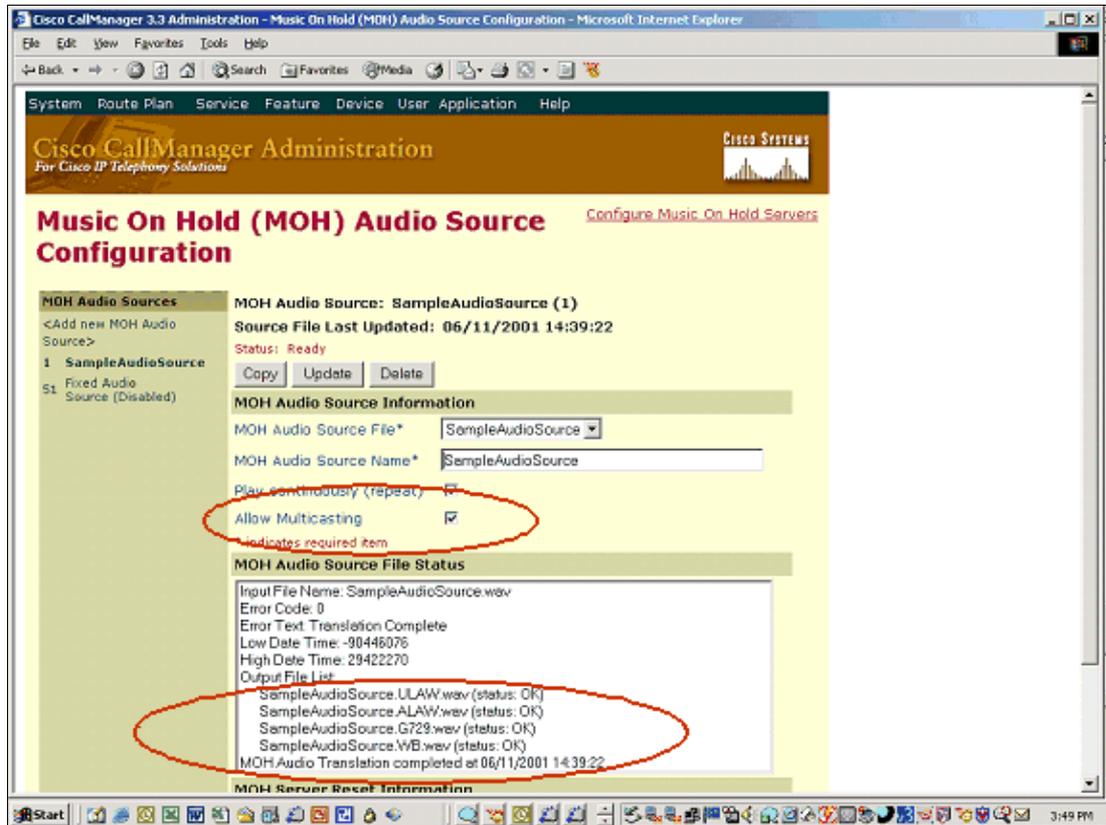
Add a Multicast Enabled MoH Audio Source

From the Cisco CallManager administration page, go to the **Service** menu, select **Media Resource** and then **Music On Hold Audio Source**.

On the MoH audio source configuration, select **audio source 1**. Check the **Allow Multicasting** box to allow this audio source to be used for multicast MoH. It can still be used simultaneously for unicast MoH.

It is important to realize that only a single audio source can be used throughout the network when Cisco IOS MoH is used. Even if you have 500 sites and only one site using Cisco IOS MoH, you are subject to this restriction. All devices must be configured to use the same audio source for user and network hold. This is because Cisco IOS MoH can only stream audio to a single multicast address. Hence, all devices must be

configured to use an audio source that corresponds to the IP address and port used by Cisco IOS MoH. The simplest way to achieve this is to not configure a specific Network Hold MoH Audio Source or User Hold MoH Audio Source, as all devices then use audio source 1 by default.



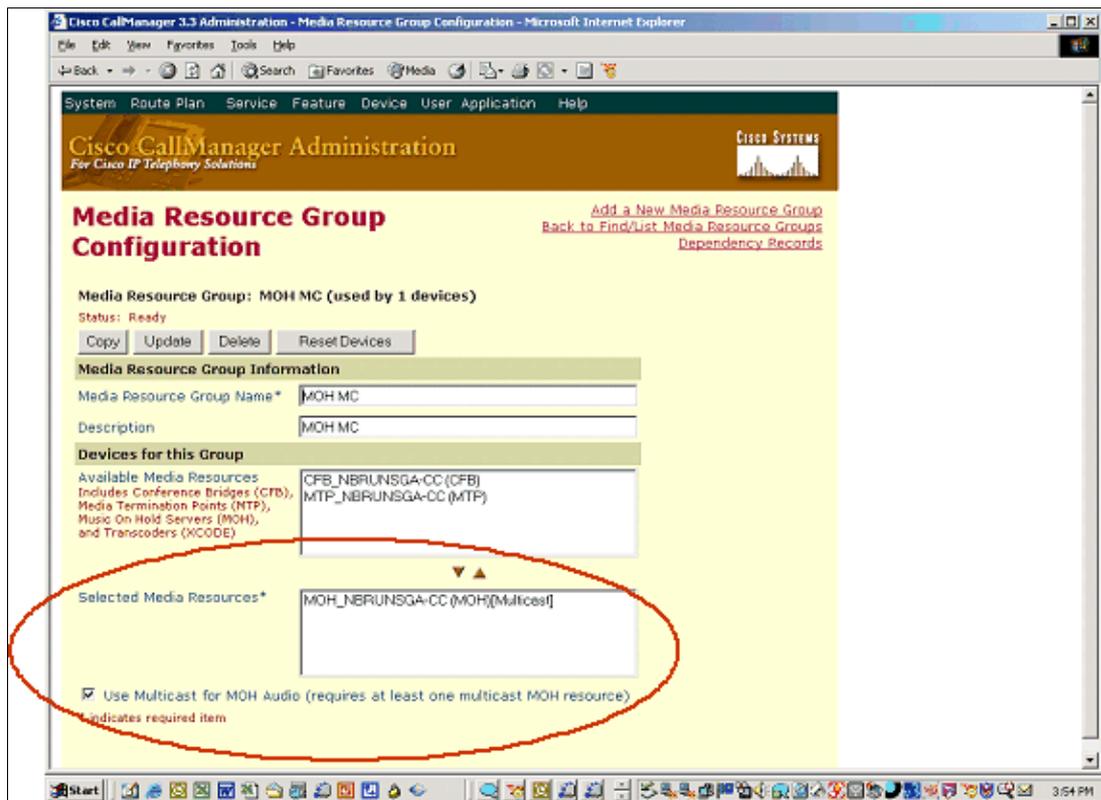
Note: This audio source is available in four codec formats. You can relate this back to the IP address and port number shown in the table above.

Add Multicast Enabled MRG

From the Cisco CallManager administration page, go to the **Service** menu, select **Media Resource** and then **Media Resource Group**.

Click **Add a New Media Resource Group**, check the **Use Multicast for MoH Audio** box, and add the MoH server that was previously multicast enabled to this MRG, to create a new MRG.

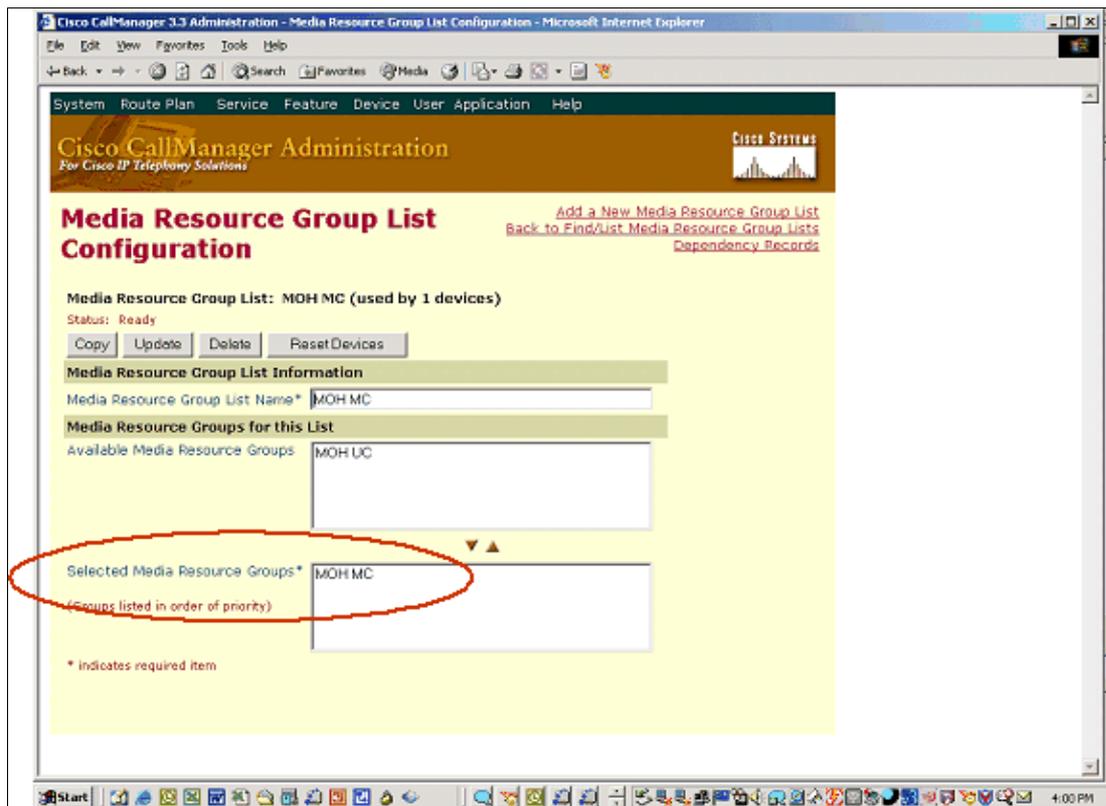
Note: If you forget to check the **Use Multicast for MoH Audio** box here and applied the corresponding MRGL to the devices, then you get unicast MoH transmission to the devices although you have configured multicast enabled audio source and MoH servers.



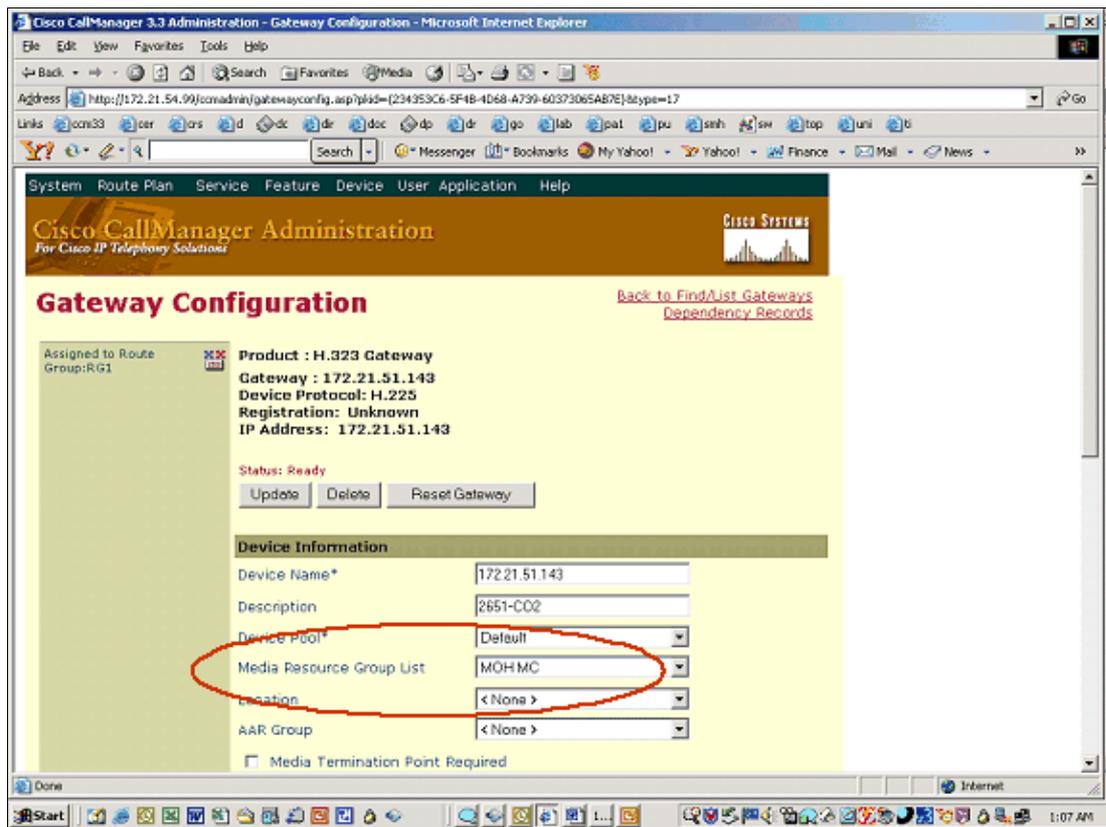
Add Multicast Enabled MRGL

From the Cisco CallManager administration page, go to the **Service** menu, select **Media Resource** and then **Media Resource Group List**.

Click **Add a New Media Resource Group List** and make the MRG that was previously multicast enabled a member of this MRGL, to create a new MRGL.



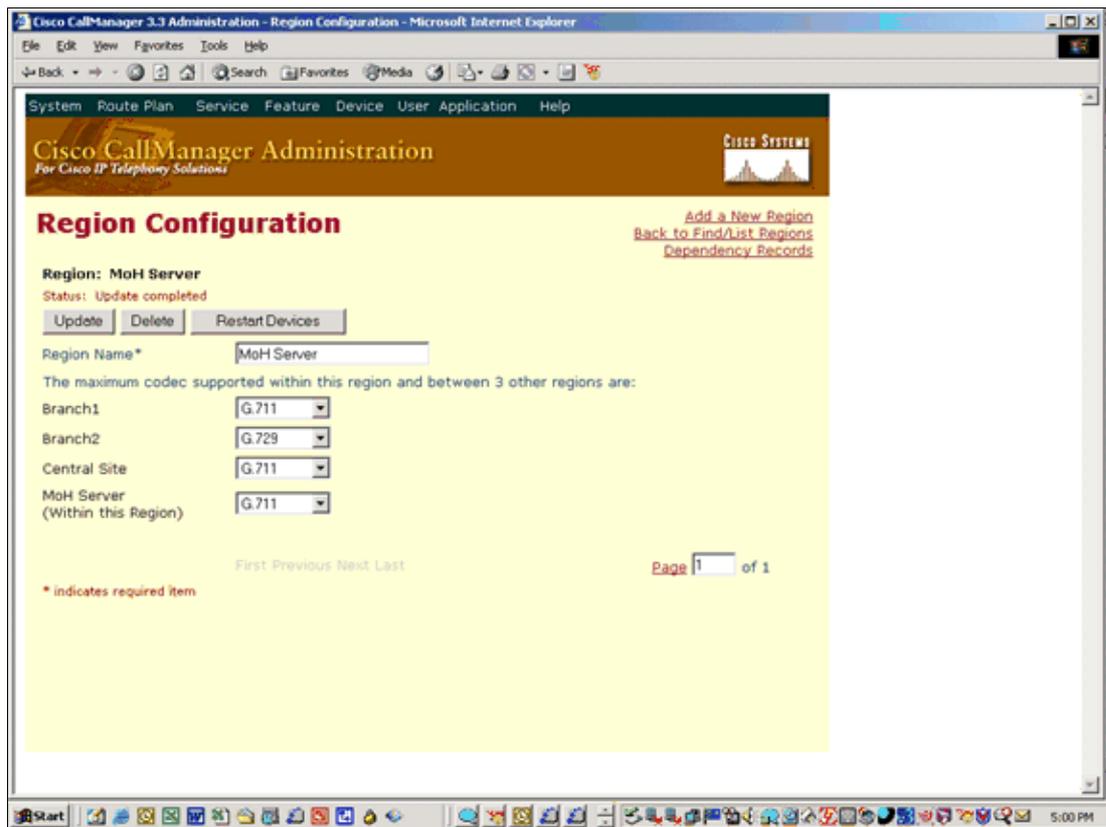
When a device is placed on hold, the MRGL controls the source of MoH RTP packets. In this case, you want the branch gateway and IP phones in the branch to source MoH packets from the local Cisco IOS MoH resource. Therefore, the above MRGL must be attached to both the branch gateway and branch phones. This screen capture shows the multicast MRGL attached to the branch gateway. The MRGL can also be applied indirectly to the phones and gateway if you apply it to their device pool instead.



Region

Cisco IOS MoH only supports G.711. Therefore, it is critical that Cisco CallManager be configured to open up a G.711 MoH connection when a device at the remote branch is placed on hold. At the same time, you typically want normal phone conversations across the WAN to use G.729. If you place the central MOH server(s) in a separate region, you can control the codec used for MoH and the codec used for regular calls separately. Cisco CallManager uses the region of the central MoH server to determine the codec to use, even though the central MoH server is not the one that will provide the multicast stream to the remote phone or gateway. However, Cisco CallManager is not aware of this.

In the sample screen shot shown here, all central MoH servers live in the region MoH server. This region uses G.711 to Branch 1, as it has a Cisco IOS MoH resource streaming G.711 packets. However, it uses G.729 to Branch 2, as this branch has no local Cisco IOS MoH resource. Therefore, you want to stream MoH across the WAN with G.729. Not shown is the fact that G.729 is configured between the Central Site and Branch 1.

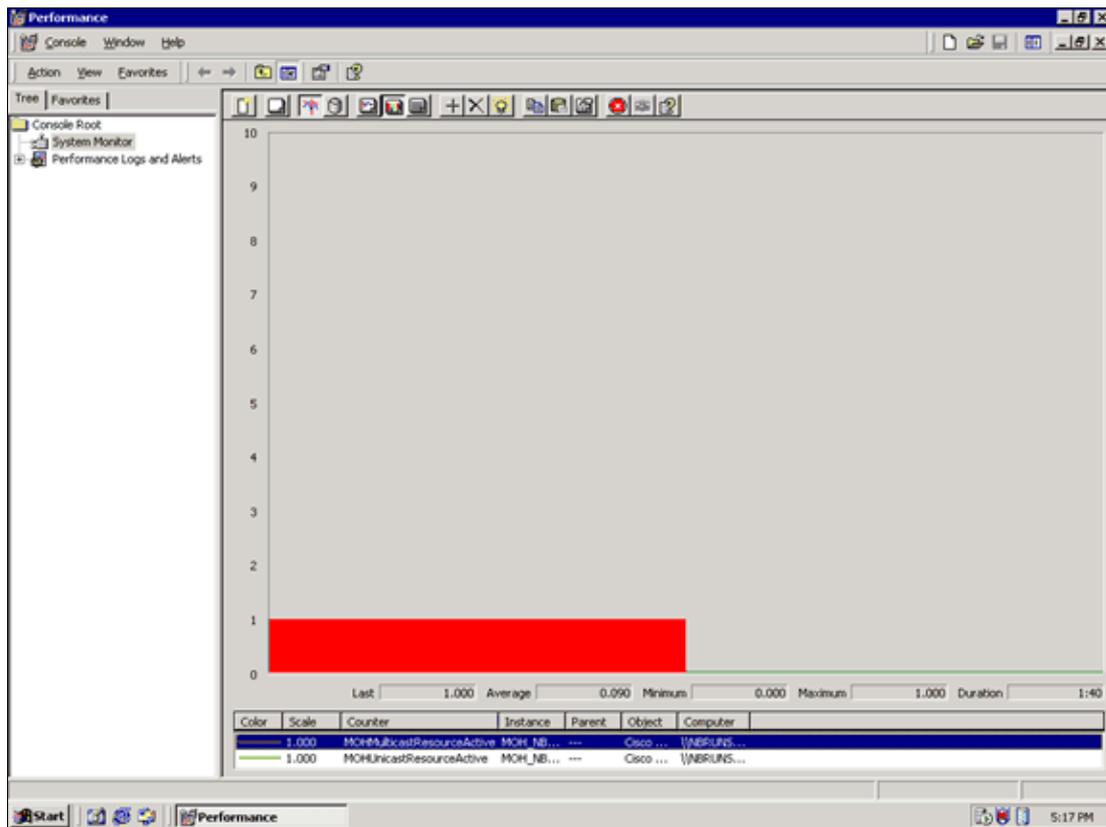


Test Cisco CallManager

Once the Cisco CallManager configuration has been completed, and before any MoH configuration is done on the Cisco IOS gateway, it is recommended that you verify the Cisco CallManager configuration. Even with a Cisco IOS MoH resource present, the Cisco CallManager MoH configuration that has just been put together must work. If it does not work, then it will also not work later when the Cisco IOS MoH resource is introduced. The only difference between the current design, and the final design with Cisco IOS MoH added, is that Cisco CallManager and not Cisco IOS is streaming the multicast MoH RTP packets.

If the WAN is multicast enabled, then the ultimate test to validate the configuration is to place a remote IP phone and/or gateway on hold. If the WAN is not multicast enabled, then it is not possible for the Cisco CallManager MoH server to stream MoH to the remote device and you hear silence at the device because CCM is multicasting the stream but the stream is not able to reach the device. In this case, the second best test is to place an IP phone on the same subnet as the Cisco CallManager MoH server and verify that MoH can be heard. Since the phone and MoH server are on the same subnet, no multicast routing capabilities in the network are required.

Use the MoH perfmon counters to verify that the MoH you are hearing is provided by multicast and not unicast. Since unicast MoH is enabled by default, it is easy to mistakenly conclude that multicast MoH is working when in fact it is not. Monitor the MOHMulticastResourceActive and MOHUnicastResourceActive counters under the Cisco MoH Device performance object. The multicast counter must be the one that increments in order for Cisco IOS MoH to later work.



Cisco CallManager 4.0 Configuration and Troubleshooting

Cisco CallManager Configuration

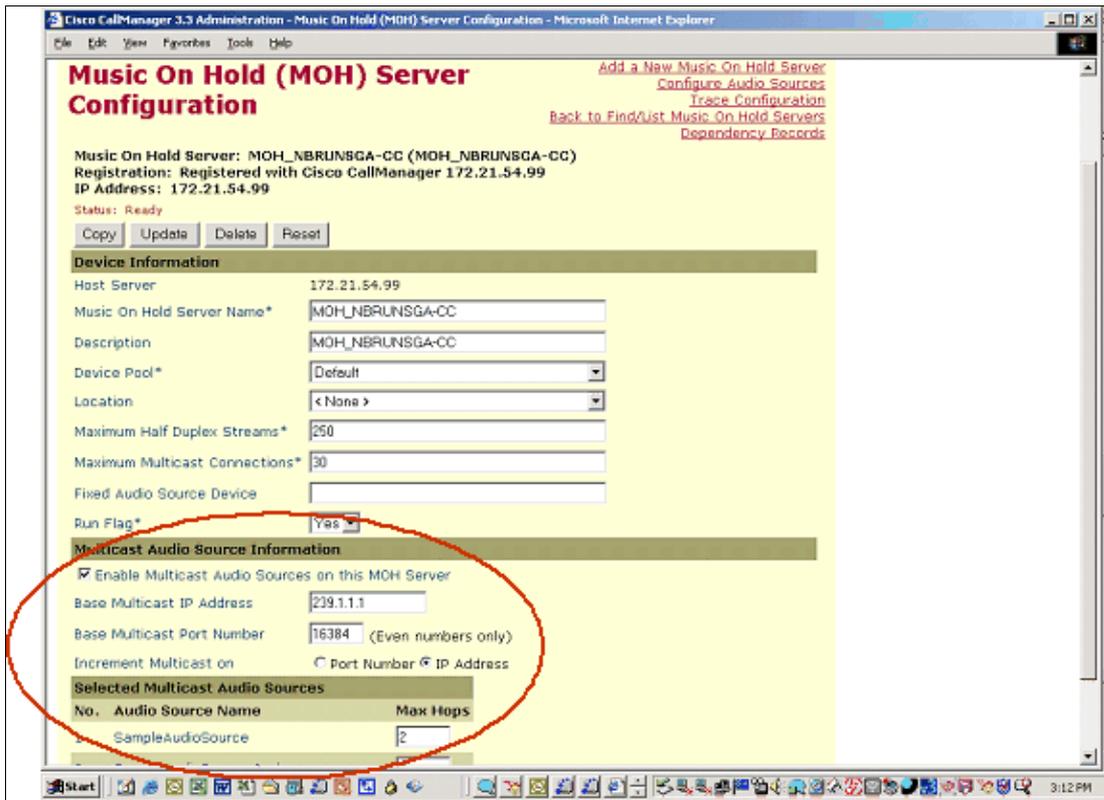
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Multicast Enabling the Cisco CallManager MoH Server

From the Cisco CallManager administration page, go to the **Service** menu, select **Media Resource** and then **Music On Hold server**.

On the MoH server configuration, check the **Enable Multicast Audio Sources on this MOH Server** box.

Note: This MoH server can still unicast MoH. Its capabilities are just being expanded to include multicast MoH. Specify a base for the IP multicast address and port numbers. For example, IP address 239.1.1.1 and port 16384.



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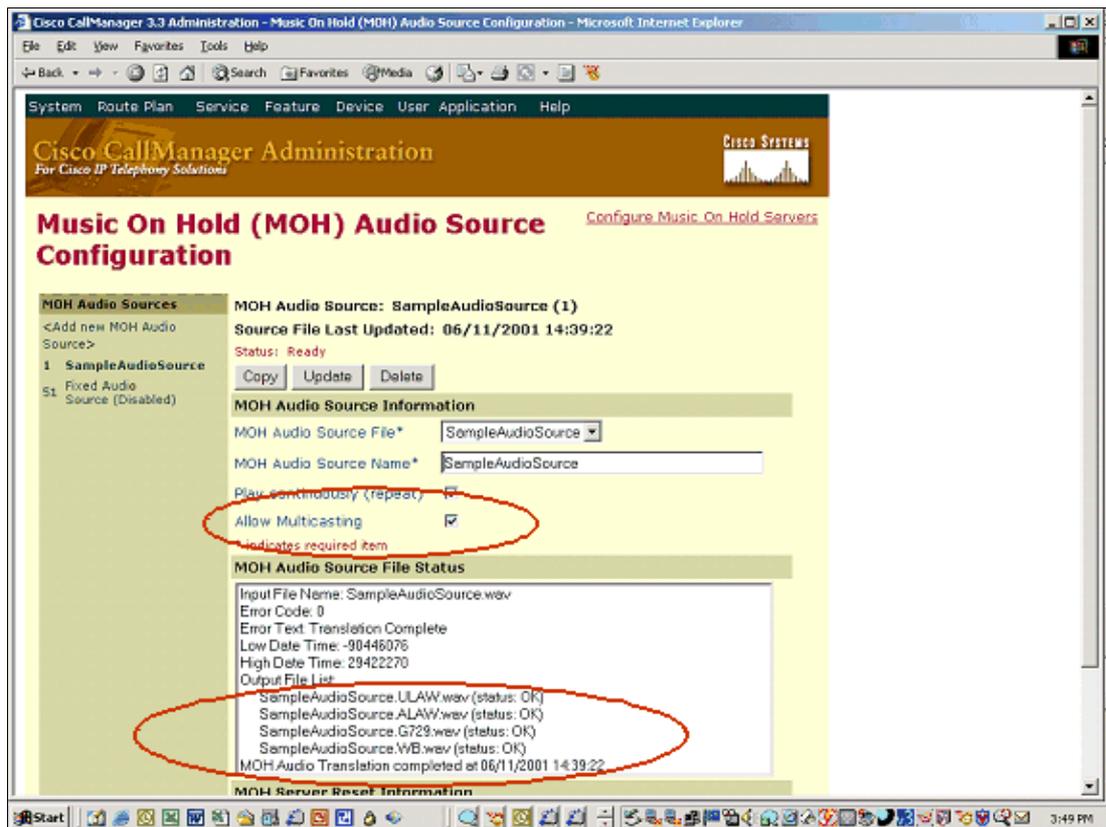
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On the MoH audio source configuration, select **audio source 1**. Check the **Allow Multicasting** box to allow this audio source to be used for multicast MoH.

Note: This audio source can still be used simultaneously for unicast MoH.

It is important to realize that only a single audio source can be used throughout the network when Cisco IOS MoH is used. Even if you have 500 sites and only one site is using Cisco IOS MoH, you are subject to this restriction. All devices must be configured to use the same audio source for user and network hold. This is because Cisco IOS MoH can only stream audio to a single multicast address. Hence, all devices must be configured to use an audio source that corresponds to the IP address and port used by Cisco IOS MoH. The simplest way to achieve this is to not configure a specific Network Hold MoH Audio Source or User Hold MoH Audio Source, as all devices then use audio source 1 by default.



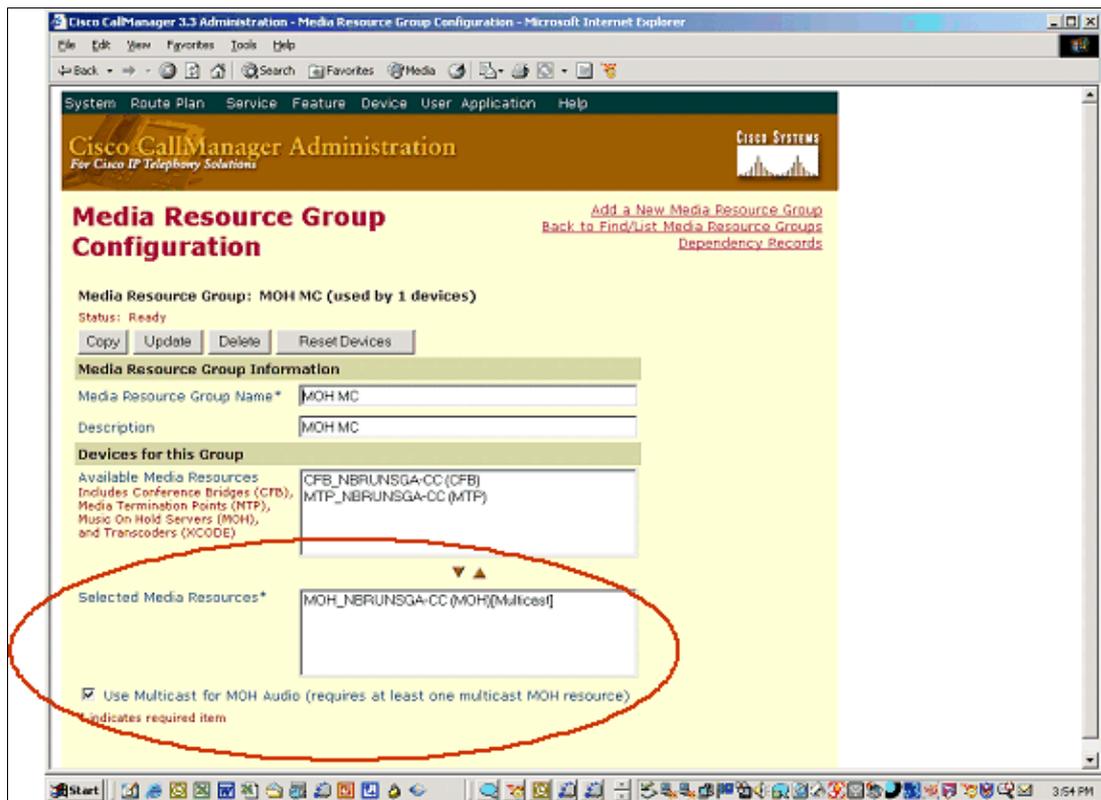
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From the Cisco CallManager administration page, go to the **Service** menu, select **Media Resource** and then **Media Resource Group**.

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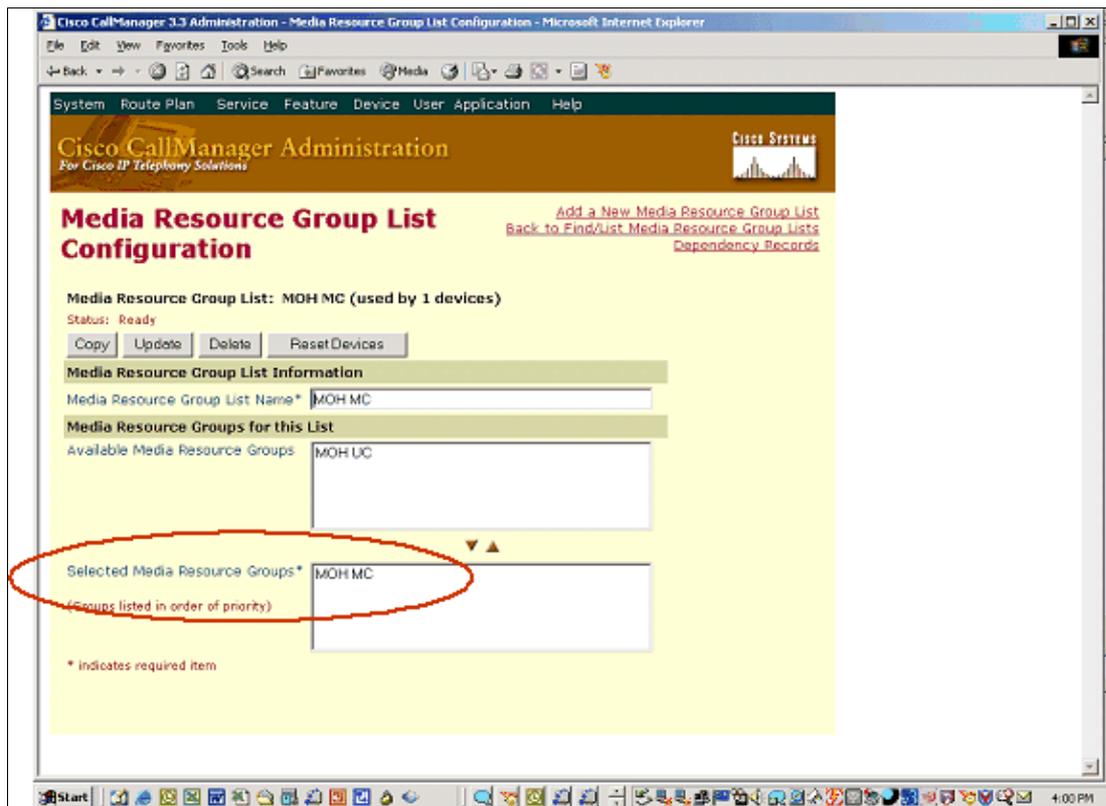
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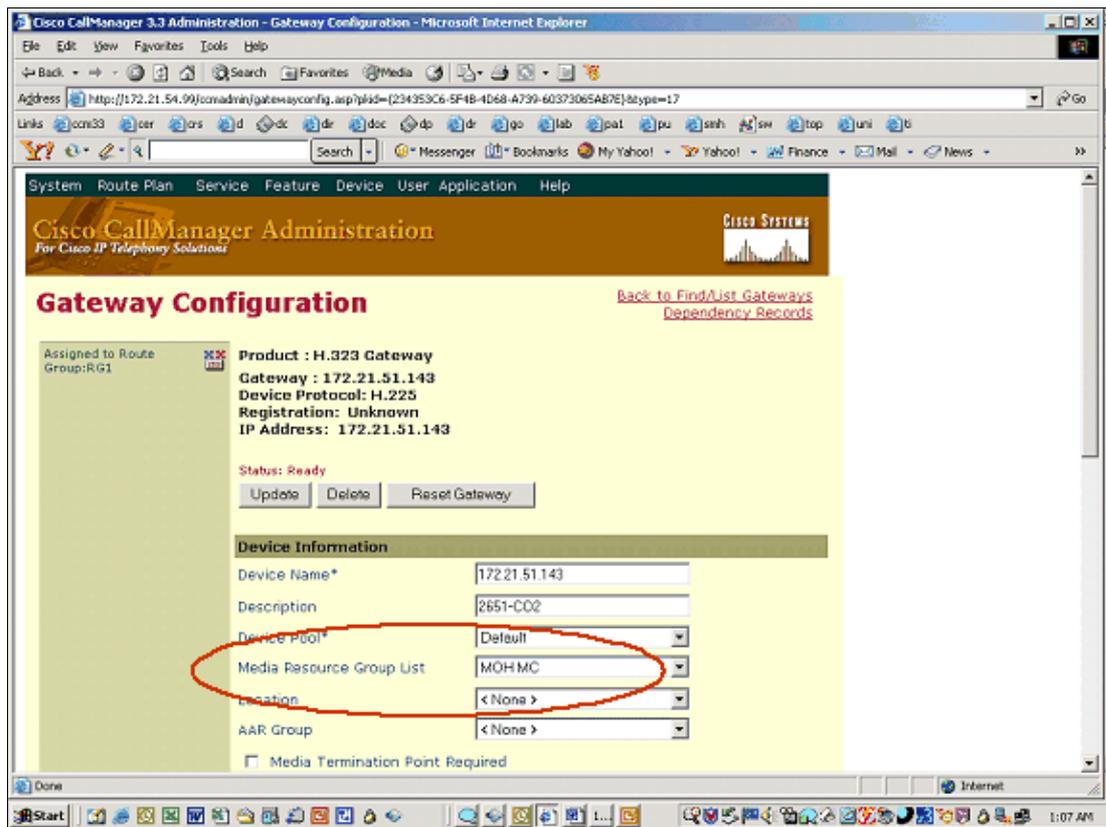
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When a device is placed on hold, the MRGL controls from where MoH RTP packets are sourced. In this case, you want the branch gateway and IP phones in the branch to source MoH packets from the local Cisco IOS MoH resource. Therefore, the above MRGL must be attached to both the branch gateway and branch phones. This screen capture shows the multicast MRGL attached to the branch gateway. The MRGL can also be applied indirectly to the phones and gateway if you apply it to their device pool instead.

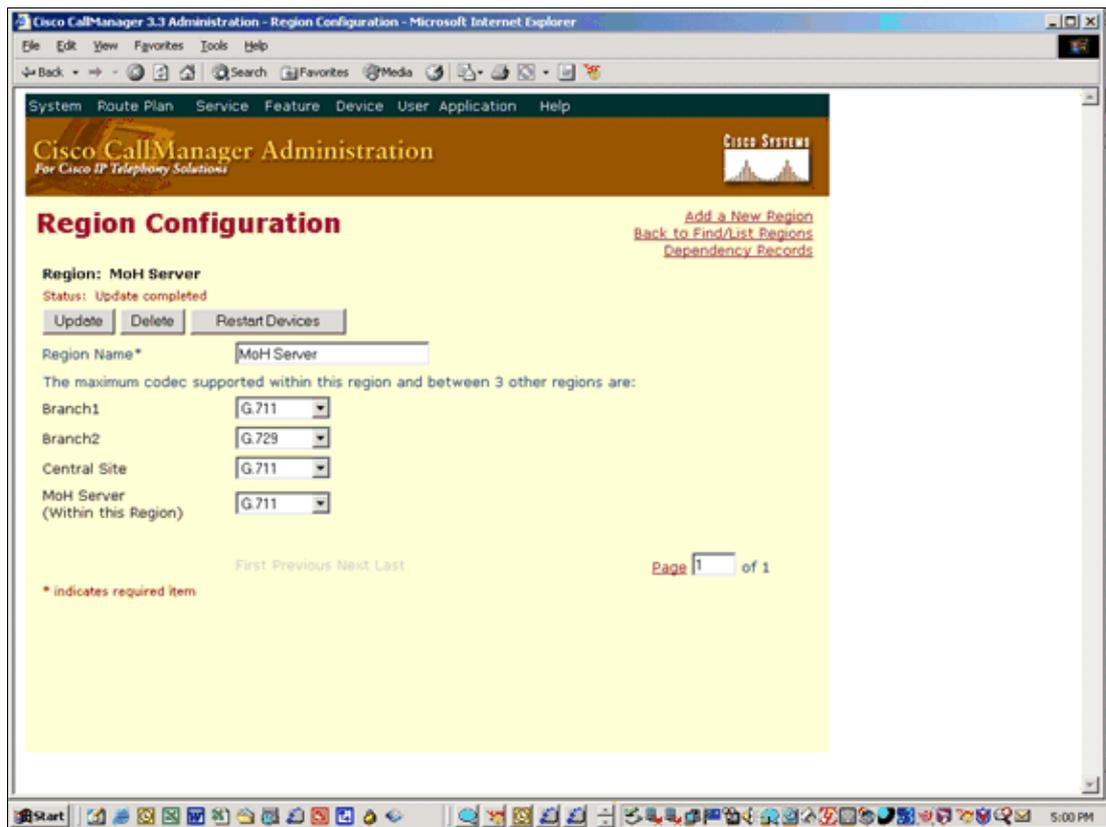


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Note: Observe the new feature of CCM 4.0 to configure "Video Call Bandwidth" also.

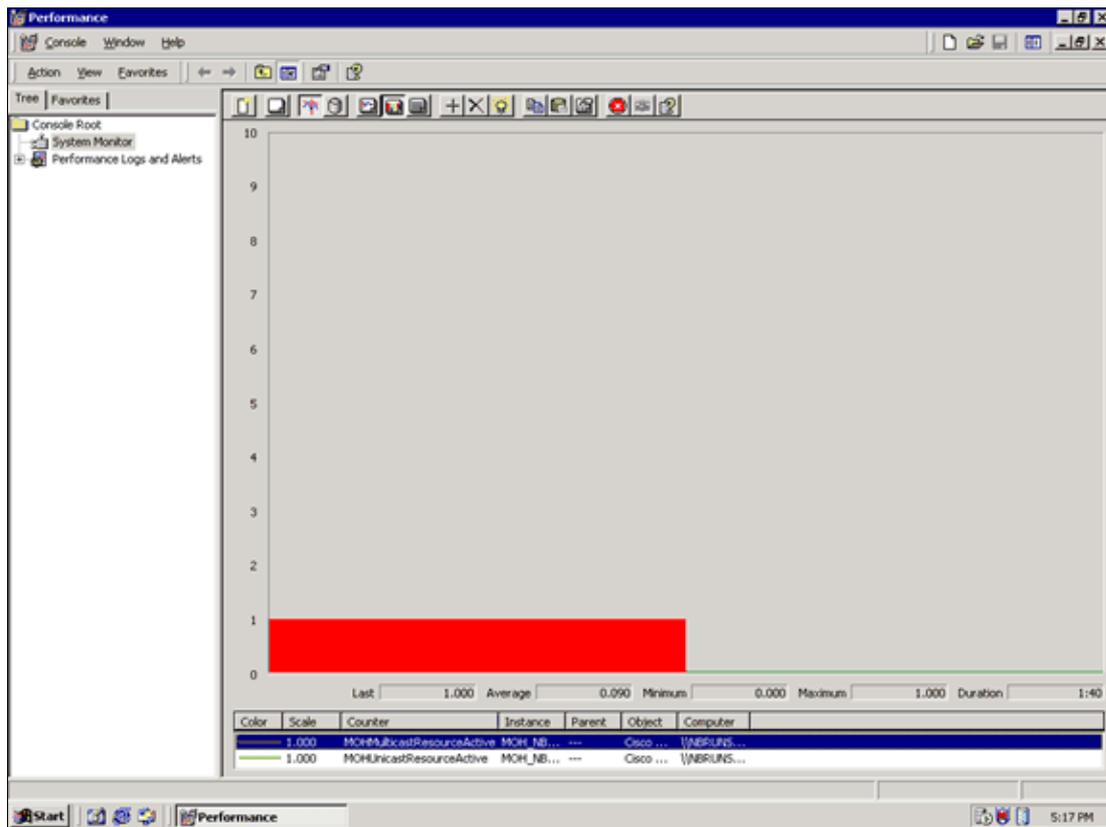


Test Cisco CallManager

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If the WAN is multicast enabled, then you can place a remote IP phone and/or gateway on hold as the ultimate test to validate the configuration. If the WAN is not multicast enabled, then it is not possible for the Cisco CallManager MoH server to stream MoH to the remote device and you hear silence at the device because Cisco CallManager is multicasting the stream but the stream is not able to reach the device. In this case, the second best test is to place an IP phone on the same subnet as the Cisco CallManager MoH server and verify that MoH can be heard. Since the phone and MoH server are on the same subnet, no multicast routing capabilities in the network are required.

Use the MoH perfmon counters to verify that the MoH you are hearing is provided through multicast and not unicast. Since unicast MoH is enabled by default, it is easy to mistakenly conclude that multicast MoH is working when in fact it is not. Monitor the MOHMulticastResourceActive and MOHUnicastResourceActive counters under the Cisco MoH Device performance object. The multicast counter must be the one that increments in order for Cisco IOS MoH to later work.



Cisco IOS Configuration and Troubleshooting

MoH Audio File in Flash

Copy the desired MoH audio file to Flash on the gateway. The MoH file can be in .wav or .au file format, but must contain 8-bit 8 kHz data, such as a-law or u-law data format. A known working MoH audio file (music-on-hold.au) is included in its-3.0.1.zip file and srst-3.0.zip file, which can be downloaded from the Software Download page (registered customers only) . Alternatively, copy one of the MoH files from C:\Program Files\Cisco\MOH on Cisco CallManager.

Configuration

Use the configuration presented here to enable MoH on a Cisco IOS gateway. The configuration required is identical for H.323 and MGCP. Both protocols work with Cisco IOS MoH.

```

ccm-manager music-on-hold

interface Loopback0
 ip address 10.1.1.1 255.255.255.255

interface FastEthernet0/0
 ip address 172.21.51.143 255.255.255.192

call-manager-fallback
 ip source-address 172.21.51.143 port 2000
 max-ephones 1
 max-dn 1
 moh music-on-hold.au
 multicast moh 239.1.1.1 port 16384 route 172.21.51.143 10.1.1.1

```

No multicast routing configuration is required on the gateway. For example, do not configure IP multicast-routing unless you need multicast routing for reasons other than Cisco IOS MoH. You should simply configure the gateway to act as a host running an application that streams multicast packets to the network. Specify a list of up to four interface IP addresses (172.21.51.143 and 10.1.1.1 in above example). The MoH component in Cisco IOS forces multicast packets out of these interfaces, regardless of whether the multicast component in Cisco IOS thinks that multicast packets should be forwarded out these interfaces or not.

A loopback interface must be configured and included in the list of IP addresses on the **multicast moh** command. Without this, no MoH is heard on plain old telephone service (POTS) ports on the gateway. This interface does not need to be the one bound to H.323 (h323-gateway voip bind) or to MGCP (mgcp bind).

At least one ephone and DN (max-ephones and max-dn) must be configured even if the gateway is not actually used for SRST. Without this, MoH streaming never starts.

Verify and Troubleshoot Basic Cisco IOS MoH Streaming

Once the configuration has been completed, the first task is to verify that MoH packets are being multicasted out of the interfaces that were configured with the **multicast moh** command. This can be verified with the **debug ephone moh** command. This **debug** output shows MoH being sent out Loopback 0 and FastEthernet0/0:

```
Mar1 4:46:40.616: MoH route If FastEthernet0/0 ETHERNET 172.21.51.143 via ARP
Mar1 4:46:40.616: MoH route If Loopback0 46 172.21.51.98 via 172.21.51.98
```

Basic MoH streaming can also be verified if you confirm that the output rates on the interfaces match one G.711 stream. For example, approximately 50 packets per second and 80 Kbps.

```
2651-CO2#
show interfaces fastEthernet 0/0 | include output rate
 30 second output rate 86000 bits/sec, 50 packets/sec
```

If MoH streaming is not functional, then issue the **show ephone summary** command to verify that Cisco IOS was able to successfully read the MoH audio file. If no file is loaded, or if the file type shows INVALID, then there is a problem. The file type should show either AU or WAVE. If an error exists, then it is possible that it could be caused by the order in which the configuration commands are entered. One option to try is to issue a **no call-manager-fallback** command and then paste the commands back in. Alternatively, reboot to see if this clears the error.

```
2651-CO2>show ephone summary | include type
File music-on-hold.au type AU Media_Payload_G711Ulaw64k 160 bytes

2651-CO2#show ephone summary | include type
File music-on-hold.au type INVALID Media_Payload_G711Ulaw64k 160 bytes651-
```

Verify and Troubleshoot IOS MoH to PSTN

Once basic streaming has been confirmed, a test call can be placed through the gateway to a POTS phone, and the POTS phone can be placed on hold by the IP phone.

If the PSTN caller on hold hears tone on hold (ToH) instead of MoH, then one can conclude that a configuration exists on the Cisco CallManager side. Cisco CallManager has failed to activate MoH and has used ToH as a last resort. In this case, use the troubleshooting guidelines described in the Cisco CallManager 3.3 or Cisco CallManager 4.0 sections of this document.

If the PSTN caller on hold hears complete silence, then one can conclude that the problem lies on the Cisco IOS or network side. In this case, Cisco CallManager has successfully completed the multicast MoH handshaking with the gateway, but the gateway has failed to pick up the locally generated multicast RTP stream. In this case issue the **show ccm-manager music-on-hold** command to troubleshoot as shown here:

```
2651-CO2#show ccm-manager music-on-hold
Current active multicast sessions : 1
Multicast      RTP port   Packets    Call   Codec   Incoming
Address        number    in/out     id     Codec   Interface
=====
239.1.1.1      16384    326/326    42    g711ulaw  Lo0
```

If no MoH streams are shown by this command, then Cisco CallManager has failed to provide the gateway with MoH. In this case you normally hear ToH instead. The typical cause for this is Cisco CallManager does not have an appropriate MoH resource available. This could be because the required codec has not been enabled on Cisco CallManager (check the service parameters). Or it could be because no MRGL has been assigned to the gateway, or if one has been assigned, then it has insufficient resources. Check the Event Viewer for error messages.

The IP address and port number above is the MoH source that Cisco IOS has been directed to listen to by Cisco CallManager. Make sure that these match those configured in Cisco IOS MoH with the **multicast moh** command.

Verify that the in/out packet count increments.

The codec displayed reflects what Cisco CallManager has directed the Cisco IOS gateway to listen for. It must match the codec type of the audio file stored in Flash. For instance, it must be either G.711u-law or G.711a-law. If any other codec is shown, then review the region configuration on Cisco CallManager. The **music-on-hold.au** file is in G.711u-law format.

The Incoming Interface field shows where the gateway plans to receive the multicast MoH packets. An interface must be listed and it must be one of the interfaces included in the **multicast moh** command.

The **show ccm-manager music-on-hold** command shows only PSTN connections on hold. It does not show multicast streams going to IP phones on hold. When an IP phone is placed on hold, and the MoH is sourced from a Cisco IOS gateway, the MoH signaling is directly between Cisco CallManager and the IP phone. In this scenario, the Cisco IOS gateway plays no role other than to blindly stream multicast RTP packets to the IP phone.

Keep in mind that if you hear MoH, it does not necessarily mean that multicast Cisco IOS MoH is working as expected. If the PSTN caller hears MoH, but the **show ccm-manager music-on-hold** command shows no active multicast streams, then the MoH has come from a unicast. This can be confirmed if you check the MoH perfmon counters as discussed earlier.

If the problems persists, and H.323 is used, take a look at the **debug h245 asn1** command output to verify the H.323 handshaking between Cisco CallManager and the gateway. When the PSTN caller is placed on hold, Cisco CallManager sends an H.245 closeLogicalChannel, followed by an openLogicalChannel. Verify that the final openLogicalChannelAck from Cisco CallManager to the gateway contains the expected multicast IP address and port number. In this example, the IP address is EF010101 (239.1.1.1) and the port number is 16384:

```
*Mar  1 04:20:19.227: H245 MSC INCOMING PDU ::=
value MultimediaSystemControlMessage ::= response : openLogicalChannelAck :
```

```

{
  forwardLogicalChannelNumber 6
  forwardMultiplexAckParameters h2250LogicalChannelAckParameters :
  {
    sessionID 1
    mediaChannel unicastAddress : ipAddress :
    {
      network 'EF010101'H
      tsapIdentifier 16384
    }
    mediaControlChannel unicastAddress : ipAddress :
    {
      network 'EF010101'H
      tsapIdentifier 16385
    }
  }
}

```

This is also reflected by this **show** command:

```

2651-CO2#
show call active voice| include RemoteMedia
RemoteMediaIPAddress=239.1.1.1
RemoteMediaPort=16384

```

If the remote media IP address shows up as 0.0.0.0, then there is a good chance that you have encountered Cisco bug ID CSCdz00697 (registered customers only) .

Verify and Troubleshoot Cisco IOS MoH to IP Phone

When an IP phone is placed on hold, and the MoH is sourced from a Cisco IOS gateway, the MoH signaling takes place directly between Cisco CallManager and the IP phone. The Cisco IOS gateway has no other role than to blindly stream multicast RTP packets to the IP phone. Therefore, other than to verify that the IOS gateway is streaming multicast RTP packets out to the Ethernet interface where the IP phones reside, there is no other troubleshooting that can be performed on the gateway.

In order to verify that Cisco CallManager is correctly signaling the IP phone to listen for multicast MoH, place the IP phone on hold. Then check the MOHMulticastResourceActive and MOHUnicastResourceActive counters under the Cisco MoH Device performance object. The multicast counter must be the one that increments in order for Cisco IOS MoH to later work.

If MoH signaling looks OK, but no MoH is heard, connect a sniffer to the PC port on the back of the port. If the IP phone and Cisco IOS MoH gateway are connected to the same subnet, then multicast RTP packets should be seen here at all times, even when the IP phone is not placed on hold. If the IP phone and Cisco IOS MoH gateway are not connected to the same subnet, then multicast RTP packets are only seen when the IP phone is placed on hold and sends an Internet Group Management Protocol (IGMP) to join to the closest router.

Related Information

- [Configuring Additional Call Features](#)
- [Music On Hold Documentation](#)
- [Voice Technology Support](#)
- [Voice and IP Communications Product Support](#)
- [Voice, Telephony and Messaging TAC eLearning Solutions](#)

- **Recommended Reading: Troubleshooting Cisco IP Telephony**
 - **Technical Support – Cisco Systems**
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