Hosting Multipoint Calls on Polycom® HDX® Series Systems

How Internal Multipoint Calls Work on Polycom HDX Series Systems and How to Optimize Internal Multipoint Experience

Introduction

Polycom® HDX® Series systems are capable of hosting an internal multipoint (MP) call[1]. Depending on the model and software version installed, an optional software license may be required to make full use of the MP feature.

All HDX Series models other than the HDX 6000 include Multipoint Trial feature, which allows a system without the Multipoint Option installed to host an MP call for demo purposes. The Multipoint Trial feature, which can be enabled under **Admin Settings > General Settings > Options**, allows a system to host MP call with up to 3 other sites (4-way MP call) for 5 minutes.

In order to achieve the best results from MP calls hosted by HDX Series systems, there are a number of things to consider. This paper discusses the options available and pros and cons of some of the configuration settings which can affect the user experience of an MP call.

[1] Polycom HDX 6000 systems are not capable of hosting MP calls. All other models are capable of hosting MP calls with MPplus Option Key installed.

Table of Contents

Introduction 1
Table of Contents 2
Glossary of Terms 3
History of MP calls on HDX Series Systems 4
Call Rate 5
Transcoding 6
Multipoint Mode 8
HD Continuous Presence 9
SD Continuous Presence 10
Monitor Configuration Considerations 11
Example 1: “Far” enabled on both monitors; “Near” enabled only on Monitor 2 11
Example 2: Both “Near” and “Far” enabled on both monitors 14
Example 3: “Near” enabled on both monitors; “Far” enabled only on Monitor 1 17
Summary 20
Appendix A: Events During MP Call Which Affect User Experience 21
Appendix B: Table of Tables 22

Polycom

Glossary of Terms

4CIF: 704x576, four times the CIF resolution.

4SIF: 704x480; four times the SIF resolution.

cascaded call: A multipoint call where two or more devices in the call are directly connected to multiple participants.

CIF: Common Intermediate Format; 352x288.

DBA: Dynamic Bandwidth Allocation, a method of constantly adjusting video bitrate in an attempt to reduce packet loss.

Force Video Mode: Polycom's proprietary method in which a system can force another system connected to a call to transmit H.264 Baseline Profile video in ¼ 720p or 1/9 720p resolution. It is currently supported with HDX Series systems and RealPresence® Group Series systems.

LPR: Lost Packet Recovery, Polycom's proprietary method of masking packet loss in RTP by encapsulating redundant data in the RTP stream.

MP call: Internal multipoint call conference hosted by a Polycom HDX Series system.

MP host: HDX Series system hosting an MP call.

remote system: A system connected to the MP call that is not the MP host.

SD: Standard Definition. In the context of this document, 4CIF and 4SIF are considered as Standard Definition.

SIF: Source Input Format; 352x240.

video bitrate: A rate at which video is being encoded and decoded.

History of MP calls on HDX Series Systems

The MP capability currently available on HDX Series systems were first introduced on the HDX 9000 series with Release 2.0.0. The same capability was extended to other HDX models with Release 2.5.0.

When optimized, HDX 9006, HDX 9004, HDX 9002, HDX 8000 HD, HDX 4500, and HDX 4000 HD systems are capable of hosting an MP call where the MP host transmits video in continuous presence layout in HD (720p) to the sites connected to the call. HDX 9001, HDX 7000 Series, and HDX 4000 systems are capable of hosting MP calls where the MP host transmits video in continuous presence layout in SD (4SIF or 4CIF) under optimal system configuration and circumstances.

HDX 6000 is the only model in the HDX Series platform incapable of hosting an MP call.

It is important to note, however, that HD or SD resolution in an MP call can only be achieved when viewing the continuous presence layout. There are other factors that can prevent HD or SD video to be displayed even when viewing video in continuous presence.

The factors which affect the quality of video in an MP call hosted by an HDX Series system are discussed below.

Call Rate

The number of sites connected to the HDX system hosting the MP call dictates the maximum call rate for each of the connections in the call. Table 1 shows the maximum call rate that can be used on each HDX Series model.

Table 1: Number of Sites Connected to the MP Host and Maximum Call Rate Per Site

MP Host Model	Number of Sites Connected to the MP Host[2]						
	1	2	3	4	5	6	7
HDX 9006	6044	1920	1344				
HDX 9004	4096	3072	1920	1472	1024	1024	1024
HDX 9002	4096	3072	1920				
HDX 9001	4096	3072	1920				
HDX 8000 HD HW Version B	6044	1920	1344				
HDX 8000 HD HW Version A	4096	1920	1472				
HDX 7000 HD HW Version D	1920	1920	1344				
HDX 7000 HD HW Version C	1920	1920	1344				
HDX 7000 HD HW Version B	1920	1920	1344				
HDX 7000 HD HW Version A	1920	1920	1344				
HDX 7000	1920	1920	1344				
HDX 6000 HD	1920						
HDX 4500	1920	1920	1344				
HDX 4000 HD HW Version C	1920	1920	1344				
HDX 4000 HD HW Version B	4096	1920	1344				
HDX 4000 HD HW Version A	4096	1920	1344				
HDX 4000	4096	1920	1344				

[2] The maximum call rate and the number of connections that can be hosted depend on whether the appropriate MPplus option key and Line Rate option key are installed.

Transcoding

Transcoding is a feature which enables the HDX system hosting the MP call to connect other endpoints using different video protocols, resolutions, and bitrate. Transcoding is disabled by default on HDX Series systems, but can be enabled under **Admin Settings > Network > Call Preference**.[3]

With transcoding disabled, systems will connect to the MP host using the video protocol that's supported by all systems connected to the MP call (including the host). If all systems connected support H.264, H.264 will be used. However, if any one of the systems connected to the call does not support H.264, then all endpoints will connect to the MP host using H.263 or H.261, depending on what is the highest common video protocol supported by all the systems.

The following rules are applied to the conference by the MP host when transcoding is disabled:

- All systems are connected to the MP call using the same video protocol.
- All systems transmit video to the MP host using the same encoding rate (video bitrate).
- The MP host transmits video to all systems using the same encoding rate (video bitrate).
- All systems transmit video to the MP host using the same resolution.

With transcoding enabled, none of these rules apply. Transcoding forces the MP host to treat each connection independently, not being affected by other connections. Each connection can be established using a different call rate and video bitrate.

With transcoding enabled, the MP host can connect to one endpoint with H.264 and another endpoint which does not support H.264 with H.263. In this example, the advantage of using transcoding is that it allows the system which supports H.264, a protocol that is typically more optimal than H.263, to connect to the MP host using H.264. With transcoding disabled, all endpoints will connect to the MP host with the protocol that is common to all the systems; in this example, the system that is capable of H.264 will connect to the MP host using H.263.

The major side-effect of having transcoding enabled in an MP call hosted by the HDX Series system is that it forces all connections to have a maximum video resolution of SIF or CIF in both directions of the call once the second endpoint connects to the MP host. The **Transcoding** configuration setting does not affect point-to-point calls.

MP calls with transcoding disabled can achieve a much better video resolutions when H.264[4] is being used as the video protocol on all systems in the call. Table 2 provides the maximum supported resolutions in H.264 Baseline Profile that HDX Series systems can receive when hosting MP calls. The maximum resolution of video being transmitted from the MP host depends on the resolution of video being received from its connections and whether or not the video being transmitted by the host is in full screen or continuous presence. This is discussed further in "HD Continuous Presence" and "SD Continuous Presence" sections below.

[3] The Transcoding configuration setting must be changed before the first call is established. If the configuration is changed after the call is already connected, the actual change in transcoding behavior will not take place when additional sites are added into the conference.

[4] H.264 High Profile is not supported in MP calls hosted by an HDX Series system.

Enabling the **Transcoding** configuration is recommended only if connecting to legacy endpoints which do not support video in H.264 or endpoints which are incapable of receiving H.264 video in 4SIF or 4CIF.

Table 2: Maximum Resolution of Video Received by MP Host Per Site with Transcoding Disabled

MP Host Model	Number of Sites Connected to the MP Host[5] [6]						
	1	2	3	4	5	6	7
HDX 9006	1080p	640x368	640x368				
HDX 9004	720p	640x368	640x368	432x240	432x240	432x240	432x240
HDX 9002	720p	640x368	640x368				
HDX 9001	4CIF/4SIF	CIF/SIF	CIF/SIF				
HDX 8000 HD HW Version B	1080p	640x368	640x368				
HDX 8000 HD HW Version A	720p	640x368	640x368				
HDX 7000 HD HW Version D	1080p	CIF/SIF	CIF/SIF				
HDX 7000 HD HW Version C	1080p	CIF/SIF	CIF/SIF				
HDX 7000 HD HW Version B	720p	CIF/SIF	CIF/SIF				
HDX 7000 HD HW Version A	720p	CIF/SIF	CIF/SIF				
HDX 7000	4CIF/4SIF	CIF/SIF	CIF/SIF				
HDX 6000 HD	1080p						
HDX 4500	1080p	640x368	640x368				
HDX 4000 HD HW Version C	1080p	640x368	640x368				
HDX 4000 HD HW Version B	720p	640x368	640x368				
HDX 4000 HD HW Version A	720p	640x368	640x368				
HDX 4000	4CIF/4SIF	CIF/SIF	CIF/SIF				

[5] The maximum resolution also depends on the call rate of each connection; therefore, other restrictions may apply if the appropriate Line Rate option key is not installed.
[6] If the MP call is cascaded, the highest-achievable resolution is SIF/CIF and is forced to use Full Screen mode.

Multipoint Mode

Configurable under **Admin Settings > Monitors > Multipoint Setup**, the **Multipoint Mode** setting configured on the MP host dictates how the video is rendered during the MP call.

Table 3: Multipoint Modes

Multipoint Mode[7]	Description
Auto	The view switches between continuous presence and full screen, depending on the interaction between the sites. If multiple sites are talking at the same time, continuous presence is used. If one site speaks uninterrupted, the site appears in presentation mode.
Discussion	Multiple sites are displayed in continuous presence. The current speaker's video is highlighted.
Presentation	The speaker sees continuous presence while the other sites see the speaker in full screen
Full Screen	The site that is speaking is shown in full screen to all other sites. The current speaker sees the previous speaker.

Note that the Multipoint Mode changes the video layout as displayed on the systems connected to the MP call. It does not change the resolution of the video being transmitted from each of the systems to the MP host; the maximum resolution of video which the MP host can receive remains as indicated in Table 2 if transcoding is disabled; it will be SIF or CIF with transcoding enabled.

The change in **Multipoint Mode** configuration can be made while the system is hosting an MP call; the change will take effect immediately.

For additional information on **Multipoint Mode** options, refer to *Administrator's Guide for Polycom HDX Systems*.

[7] If an MP call is cascaded, the MP host will be forced to use full screen layout no matter how Multipoint Mode is configured on the system hosting the MP call.

HD Continuous Presence

HDX 9006, HDX 9004, HDX 9002, HDX 8000 HD, HDX 4500, and HDX 4000 HD systems are capable of hosting MP calls in HD (720p) if the following conditions are met:

- Transcoding is disabled on the MP host.
- The call is not cascaded.
- The call rate is high enough to support 720p at 30fps (832kbps for Polycom HDX Series and RealPresence Group Series systems).
- The video encoding rate on the MP host must be high enough to support 720p at 30fps.
- Systems connected to the MP call must be capable of decoding H.264 Baseline Profile video in 720p resolution at that call rate.
- Systems connected to a 3-way or 4-way MP call must transmit video in H.264 Baseline Profile at ¼ 720p resolution (640x368 or 640x360) to the MP system.
- Systems connected to a 5-way, 6-way, 7-way, or 8-way MP call hosted by the HDX 9004 system must transmit video in H.264 Baseline Profile at 1/9 720p resolution (432x240).
- On an HDX 9004 system hosting a 7-way or 8-way MP call, AES cannot be enabled in more than 5 of the connections.

Note that not all HD-capable systems are capable of transmitting ¼ 720p or 1/9 720p video. Some systems may choose to transmit 2SIF, SIF or CIF instead of these resolutions. When this occurs, HD Continuous Presence cannot be achieved[8]. The HDX Series system hosting an MP call can force other HDX Series systems and RealPresence® Group Series systems to send these resolutions using a proprietary method known as Force Video Mode.

In an HD Continuous Presence (HDCP) call, continuous presence video is transmitted in 720p. Video in full screen is transmitted at ¼ 720p or 1/9 720p depending on the number of calls being hosted by the MP host.

To get the most out of HD Continuous Presence, Polycom recommends that **Multipoint Mode** is configured for **Discussion** on the MP host. Discussion mode will enable all sites connected to the MP host to receive the highest possible video resolution (720p) throughout the HD Continuous Presence call.

[8] SD Continuous Presence MP call can still be achieved in this case.

SD Continuous Presence

All multipoint-enabled HDX Series systems are capable of hosting MP calls in SD (4SIF or 4CIF) if the following conditions are met:

- Transcoding is disabled on the MP host.
- The call is not cascaded.
- All sites connected in the call must support receiving H.264 Baseline Profile in 4SIF or 4SIF at 30fps at the connected call rate.
- All sites connected to the call must transmit H.264 Baseline Profile in SIF or CIF at 30fps.

In an SD Continuous Presence (SDCP) call, continuous presence video is transmitted in either 4SIF or 4CIF. Video in full screen is transmitted in SIF or CIF format. Discussion mode will enable all sites connected to the MP host to receive the highest possible video resolution (4SIF or 4CIF) throughout the SD Continuous Presence call.

In order to get the most out of SD Continuous Presence, Polycom recommends that **Multipoint Mode** is configured for **Discussion** on the MP host. Discussion mode will enable all sites connected to the MP host to receive the highest possible video resolution (4SIF or 4CIF) throughout the SD Continuous Presence call.

Monitor Configuration Considerations

No matter how many systems are connected to the HDX Series system hosting an MP call, each of the remote sites will only receive one people video stream that's either in full screen or continuous presence. The video received from the MP host will be displayed on the monitor configured to display the far-end video.

The HDX Series system hosting the MP call, however, receives people video from every system connected to the MP call. Even if the **Multipoint Mode** is configured for **Discussion**, the hosting system can be configured to display each of the sites in full screen on its local monitors.

Displaying one of the far sites in full screen in an MP call, however, may not be ideal, as the video received from the far site in any MP call is in ¼ 720p resolution at best. In an SD Continuous Presence call, the video received from the far-end system is in SIF (352x240) or CIF (352x288), either of which is ideal when videwed on an HD video display in full screen.

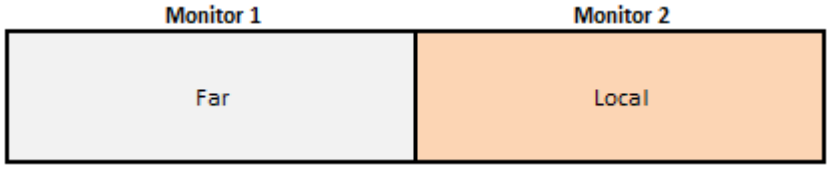
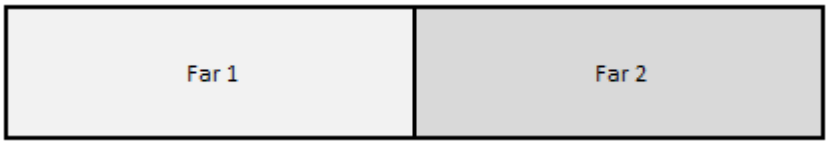
Below are a few examples of possible monitor configurations and how the video is rendered on a 2-monitor system, with **Multipoint Mode** configured for **Discussion**. For each configuration example, the expected video output as an MP host and also as a remote site connected to the MP call are provided.

Example 1: "Far" enabled on both monitors; "Near" enabled only on Monitor 2

Table 4: Monitor Configuration for Example 1

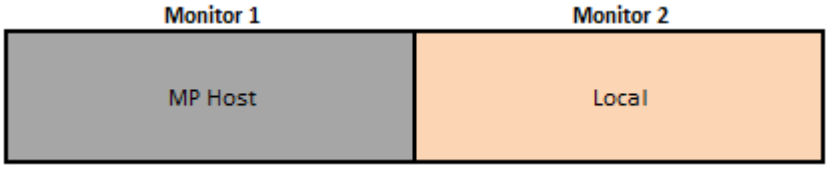
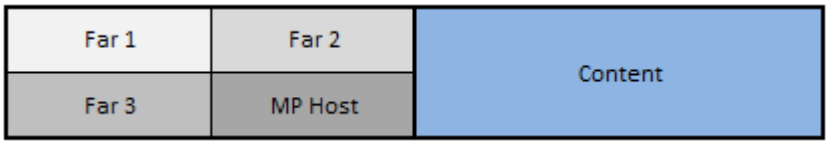
Monitor 1 Configuration	Monitor 2 Configuration
PIP: On Display Near Video: disabled Display Far Video: enabled Display Content: disabled Dual Monitor Emulation: disabled	Display Near Video: enabled Display Far Video: enabled Display Content: enabled

Table 5: Video Layout for Example 1 while Hosting MP Call

Type of Call	Local Video Layout
Point-to-Point Call, No Content	
Point-to-Point Call, With Content	
3-way MP Call, No Content	
3-way MP Call, With Content	
4-way MP Call, No Content	
4-Way MP Call, With Content	

Polycom

Table 6: Video Layout for Example 1 while Connected to MP Host

Type of Call	Local Video Layout
Point-to-Point Call, No Content	
Point-to-Point Call, With Content	
3-way MP Call, No Content	
3-way MP Call, With Content	
4-way MP Call, No Content	
4-Way MP Call, With Content	

Example 2: Both “Near” and “Far” enabled on both monitors

Table 7: Monitor Configuration for Example 2

Monitor 1 Configuration	Monitor 2 Configuration
PIP: On Display Near Video: enabled Display Far Video: enabled Display Content: disabled Dual Monitor Emulation: disabled	Display Near Video: enabled Display Far Video: enabled Display Content: enabled

Table 8: Video Layout for Example 2 while Hosting MP Call

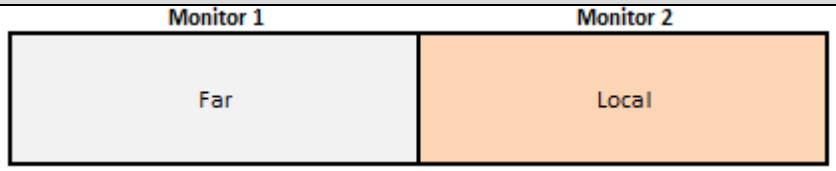
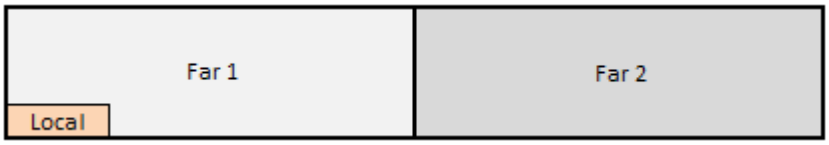
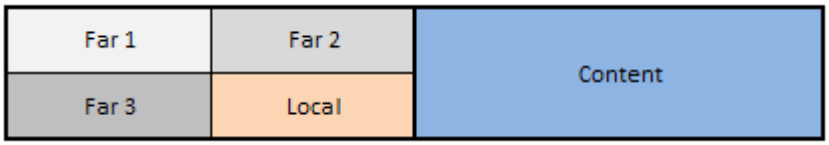
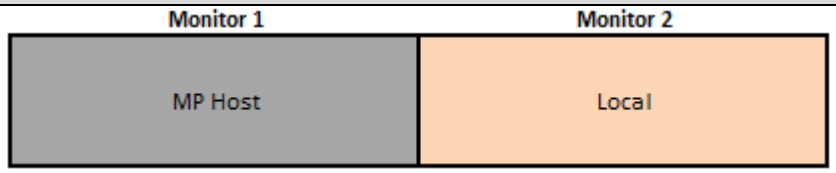
Type of Call	Local Video Layout
Point-to-Point Call, No Content	
Point-to-Point Call, With Content	
3-way MP Call, No Content	
3-way MP Call, With Content	
4-way MP Call, No Content	
4-Way MP Call, With Content	

Table 9: Video Layout for Example 2 while Connected to MP Host

Type of Call	Local Video Layout
Point-to-Point Call, No Content	
Point-to-Point Call, With Content	
3-way MP Call, No Content	
3-way MP Call, With Content	
4-way MP Call, No Content	
4-Way MP Call, With Content	

Polycom

Example 3: "Near" enabled on both monitors; "Far" enabled only on Monitor 1

Table 10: Monitor Configuration for Example 3

Monitor 1 Configuration	Monitor 2 Configuration
PIP: On Display Near Video: enabled Display Far Video: enabled Display Content: disabled Dual Monitor Emulation: disabled	Display Near Video: enabled Display Far Video: disabled Display Content: enabled

This configuration can provide one of the best user-experience when hosting an MP call, since the far-end systems connected to the MP call will always appear as a part of continuous presence layout and will never be displayed in full screen. Furthermore, the user-experience while hosting an MP call is almost identical to that when connected to an MP host that has **Multipoint Mode** configured for **Discussion**.

Table 11: Video Layout for Example 3 while Hosting MP Call

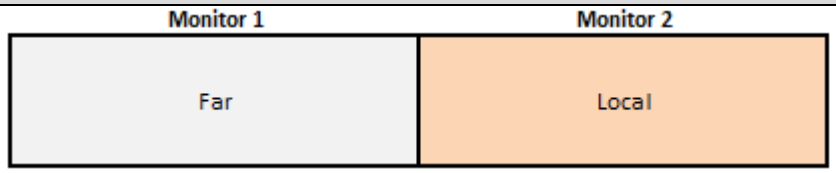
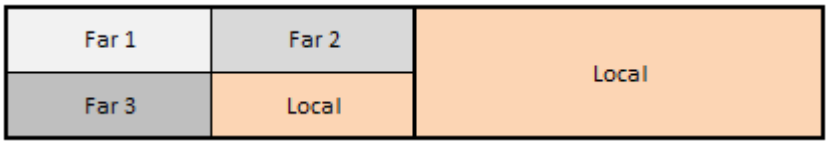
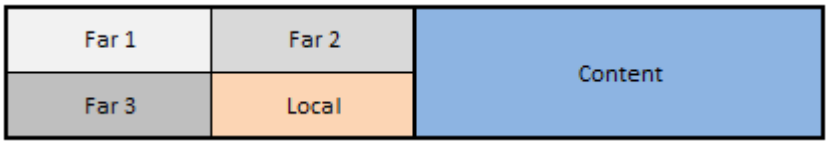
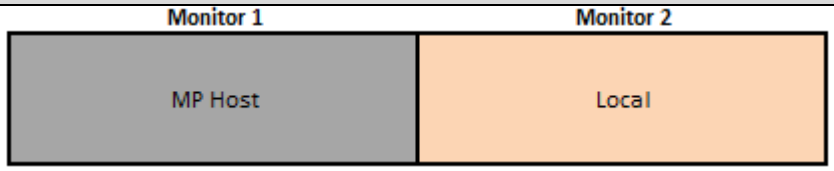
Type of Call	Local Video Layout
Point-to-Point Call, No Content	
Point-to-Point Call, With Content	
3-way MP Call, No Content	
3-way MP Call, With Content	
4-way MP Call, No Content	
4-Way MP Call, With Content	

Table 12: Video Layout for Example 3 while Connected to MP Host

Type of Call	Local Video Layout
Point-to-Point Call, No Content	
Point-to-Point Call, With Content	
3-way MP Call, No Content	
3-way MP Call, With Content	
4-way MP Call, No Content	
4-Way MP Call, With Content	

Summary

The following Polycom HDX Series systems are capable of hosting MP calls in HD:

- HDX 9006
- HDX 9004
- HDX 9002
- HDX 8000 HD
- HDX 4500
- HDX 4000 HD

MP calls in HD can only be achieved when transcoding is disabled on the MP host. Only video transmitted in continuous presence layout is in 720p. The video sent in full screen, whether from the MP host or to the MP host, is in a quarter of 720p resolution.

These HDX systems as well as HDX 7000 Series systems and HDX 4000 systems are capable of hosting MP calls in SD. The SD resolution can only be achieved when transcoding is disabled on the MP host. Only video transmitted in continuous presence layout is in SD resolution; video transmitted in full screen, whether from the MP host or to the MP host, is in CIF or SIF resolution.

There are other factors which can affect the availability of HD or SD video in an MP call hosted by the HDX Series systems which should be taken into considerations when setting up an HDX Series system for MP calls.

Appendix A: Events During MP Call Which Affect User Experience

Two of the key factors in achieving HD Continuous Presence are the following:

- The call rate is high enough to support 720p at 30fps (832kbps for Polycom HDX Series and RealPresence Group Series systems).
- The video encoding rate on the MP host must be high enough to support 720p at 30fps.

An MP call may successfully establish with HD Continuous Presence. However, while the call is ongoing, circumstances may arise where one or both of these requirements can no longer be met.

If one of the remote systems observed packet loss during the call, it may activate Dynamic Bandwidth Allocation (DBA) or Lost Packet Recover (LPR). Both DBA and LPR, if activated, are capable of reducing the video bitrate. If the video bitrate is reduced to the point where the 720p video at 30fps can no longer be sustained, the HD Continuous Presence call may downgrade itself to SD Continuous Presence.

For example, endpoints may be connected to an MP call at 832kbps. If one of the endpoints connected to the call has DBA enabled and observed some packet loss in the video RTP it was receiving from the host, DBA will throttle down the bandwidth used to transmit video from the MP host to the system. This may cause the MP host to be unable to sustain 720p video at 30fps.

The HDX Series systems do not typically perform a video mode change in the middle of a call. Even when the video encoding rate is not enough to achieve 720p at 30fps, the MP host will not instantaneously change video to a mode at which 30fps can be achieved, such as 4SIF. Until the video mode changes, however, the frame rate may become less than 30fps.

The HDX Series system re-evaluates its video mode as well as the call rate when any one of the following events takes place in the MP call:

- A new site is added to the MP call.
- A site is dropped from the MP call.
- Content video is transmitted in the MP call.
- Content video is stopped in the MP call.

At this time, if any of the requirements for sustaining HD Continuous Presence is determined to be not met, the call will drop to SD Continuous Conference.

Refer to *Analyzing Network Issues on Polycom HDX Series Systems and RealPresence Group Series Systems* on more information regarding DBA, LPR, and side-effects which may be induced by DBA and LPR.

Appendix B: Table of Tables

Table 1: Number of Sites Connected to the MP Host and Maximum Call Rate Per Site 5
Table 2: Maximum Resolution of Video Received by MP Host Per Site with Transcoding Disabled 7
Table 3: Multipoint Modes 8
Table 4: Monitor Configuration for Example 1 11
Table 5: Video Layout for Example 1 while Hosting MP Call 12
Table 6: Video Layout for Example 1 while Connected to MP Host 13
Table 7: Monitor Configuration for Example 2 14
Table 8: Video Layout for Example 2 while Hosting MP Call 15
Table 9: Video Layout for Example 2 while Connected to MP Host 16
Table 10: Monitor Configuration for Example 3 17
Table 11: Video Layout for Example 3 while Hosting MP Call 18
Table 12: Video Layout for Example 3 while Connected to MP Host 19