Terminals, Gatekeepers, Gateways & MCUs

Overview:

The purpose of this paper is to explain in greater detail the functions of the four main H.323 network components; H.323 Terminals, Gatekeepers, Gateways and Multipoint Control Units (MCUs) when used in conjunction with standards based Video Conferencing systems. It is intended to provide an overview of these products and broaden their appeal by giving brief examples of their usage. However, the key to a successful implementation of a Video over IP installation is the effective management of the network resources.

It is assumed that the reader has a general knowledge of Video Conferencing systems and the standards involved. However, the following technical papers are available to provide more information on these topics:

- ***How do I choose a Video Conferencing system?***
- ***Video Conferencing Standards and Terminology.***
- ***Global Dialling Scheme (GDS) for Schools VideoConferencing.***
- ***H.323 Dial Plan and Service Codes used by Gatekeepers etc.***
- ***IP Ports and Protocols used by H.323 Devices.***
- ***Cost Efficient ISDN Conferencing, including Multipoint Access.***
- ***H.221 Framing used in ISDN Conferences.***

H.323 Terminals:

H.323 Terminals are the endpoints on the LAN that provide real-time two way communications. The H.323 standard states that all H.323 Terminals must support voice, with video and data being optional. Hence the basic form of an H.323 Terminal is the IP Phone; however most H.323 Terminals are ***Video Conferencing Systems***. The H.323 standard specifies what modes must be supported so that all these endpoints can work together. H.323 Terminals must support H.245 protocol to control channel usage and capabilities; Q.931 protocol for call setup and signalling; RAS (Registration/Admission/Status) protocol to communicate with the Gatekeeper and RTP/RTCP protocol to sequence audio and video packets.

When initiating an H.323 Video Conference, we need some means of identifying the User or H.323 Endpoint that we wish to conference with. The thought of having to remember IP addresses is daunting enough; but the use of DHCP to dynamically allocate the IP address of an endpoint means that this method is impractical. Hence the concept of a Dial Plan and the use of an H.323 User Number registered to a Gatekeeper.

A Dial Plan is simply a method of allocating a unique number to an H.323 Endpoint. This number is referred to as the H.323 User Number and when registered with a Gatekeeper, we have a means of translating this User Number into an IP address.

The H.323 User Number is often loosely referred to as the ***E.164 Number***.

Gatekeepers:

Although the H.323 standard describes the Gatekeeper, as an optional component, it is in practice an essential tool for defining and controlling how voice and video communications are managed over the IP network. Gatekeepers are responsible for providing address

translation between an endpoints current IP address and its various H.323 aliases, call control and routing services to H.323 endpoints, system management and security policies. These services provided by the Gatekeeper in communicating between H.323 endpoints are defined in RAS.

Gatekeepers provide the *intelligence* for delivering new IP services and applications. They allow network administrators to configure, monitor and manage the activities of registered endpoints, set policies and control network resources such as bandwidth usage within their H.323 zone. Registered endpoints can be H.323 Terminals, Gateways or MCU's.

Only one Gatekeeper can manage a H.323 zone, but this zone could include several Gateways and MCU's. Since a zone is defined and managed by only one Gatekeeper, endpoints such as Gateways and MCU's that also have a built-in Gatekeeper must provide a means for disabling this functionality. This ensures that multiple H.323 endpoints that contain a Gatekeeper can all be configured into the same zone. The RADVISION ***SCOPIA$_{100}$ 12/24 Series*** combines Gateway and MCU functionality in one box and includes a separate basic Gatekeeper that can be disabled; this allows the zone to be controlled by a more powerful Gatekeeper such as the ***ECS*** -Enhanced Communications Server or utilise the ***PBX*** like features of the Media Xchange Manager.

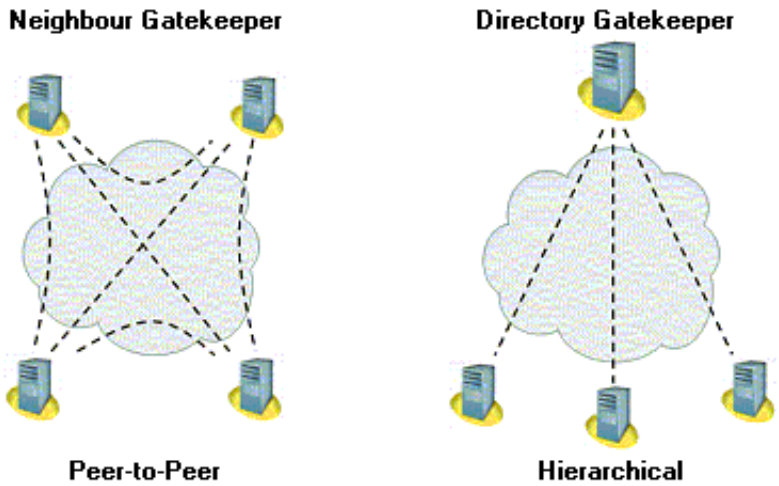
With media networks becoming more and more complex, the ability for the administrator to effectively manage and control their usage becomes crucial. To address these issues, Emblaze-VCON have introduced Media Xchange Manager, ***MXM***. From a remote console, the administrator can now perform centralised management functions such as configure endpoints, monitor the status and availability of endpoints, control and limit bandwidth usage and more. MXM automatically generates Call Detail Reports, CDR; which can be used for network planning or billing purposes. With video telephony services such as Call Forward, Call Transfer and Call Pickup, MXM provides the functions that make Video Conferencing as simple as making a telephone call. Furthermore, ***MXM*** includes an H.323 Gatekeeper.

Interconnected Gatekeeper Zones:

As stated earlier, the Gatekeeper defines the zone and manages the registered endpoints within. To call an endpoint within the same zone, we simply dial that endpoints H.323 User Number. But what happens when we want to call an endpoint that is located in another zone? Well, we then also need to know the zone where that endpoint is registered. Each Gatekeeper on the same network is identified by a unique number, its Zone Number. To call an endpoint in a different zone, we prefix that endpoints H.323 User Number with its Zone Number and dial this extended number.

The telephone analogy to the Gatekeeper Zone Number is the STD code for the local exchange. If we want to telephone a person locally, we just dial their local number, but if we want to telephone somebody further afield, we need to prefix their local number with their STD code.

Behind the scenes, all the Gatekeepers on the network must know how they are related to eachother. The diagram below shows the two different relationships in which Gatekeepers can be networked and interoperate together.



When Gatekeepers are arranged in a single tier 'Peer-to-Peer' manner with no particular hierarchical structure, they are termed as being Neighbour Gatekeepers. This would typically be on a corporate network within a multi-site company who has a Gatekeeper at each site. Each Gatekeeper manages its own site (Zone), with inter-zone communications routed directly between zones and controlled on an individual basis specifically defined by the direct relationship between each Gatekeeper.

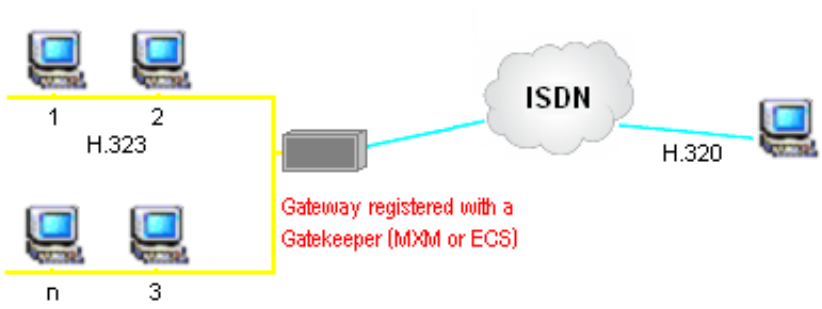
When the Gatekeepers are arranged in a multi-tier manner with a hierarchical structure, they are termed as being Directory Gatekeepers (DGK). This would typically be within a large scale deployment such as the national schools network. Whilst each Gatekeeper still manages its own zone, inter-zone communications are routed indirectly on a Parent-Child basis between zones.

A Directory Gatekeeper only knows its Parent and Child Gatekeepers. If the Gatekeeper does not know the Zone of the dialled number, it routes the call to its Parent DGK, which then searches its database to see if the Zone known. If not known, this Parent routes the call to its Parent and so on until it eventually reaches a Parent DGK that has a Child DGK that matches the Zone. The call is then routed down through each Child DGK tier until it reaches the specific endpoint.

Gateways:

H.320 and H.323 systems can interoperate with the use of a Gateway. Essentially, the Gateway provides translation between circuit-switched networks ISDN and packet-based networks LAN, enabling the endpoints to communicate. To do this, it must translate between the H.225 to H.221 transmission formats and between the H.245 to H.242 communications control protocols. The Gateway also has to transcode between the various audio and video codecs used between the LAN and ISDN devices.

Most Gateways have multiple BRI connections and can support several conferences simultaneously. For example, a Quad BRI Gateway, such as the RADVISION ***SCOPIA$_{100}$ B40*** can simultaneously support either four conferences at 128Kbps, two at 256Kbps or one at 384Kbps and one at 128Kbps. Furthermore, the SCOPIA$_{100}$ P20 has two PRI interfaces and can support up to 60 concurrent voice calls.



H.320 (ISDN) Gateway <> H.323 (IP)

Most Gateways work in conjunction with, or include a Gatekeeper functionality. A real world H.323 implementation of a Gateway working in conjunction with a Gatekeeper is in a Multimedia Call Centre were needs-based call routing and a variety of other automatic call distribution features are used.

Dedicated Multipoint Control Units (MCUs):

To allow three or more participants into a conference, most H.323 systems usually require a Multipoint Conference Server (MCS). This is also referred to as an H.323 Multipoint Control Unit (H.323 MCU). This is not the same as an H.320 MCU; hence it is important to be clear about what you mean when using the term MCU; see section below on H.320 MCU.

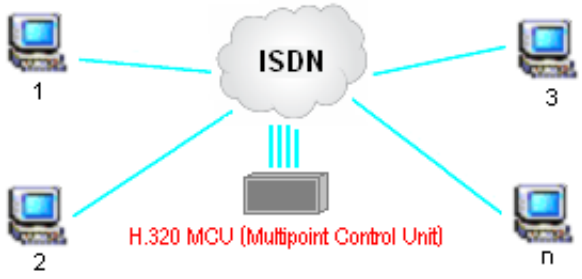
H.323 Multipoint Conference

The H.323 MCU's basic function is to maintain all the audio, video, data and control streams between all the participants in the conference. Whilst most H.323 MCU's, such as the RADVISION ***SCOPIA$_{100}$ 12/24 Series*** are hardware based, Emblaze-VCON have introduced the VCON Conference Bridge, ***VCBPro*** as an option to MXM that provides a basic software MCU capable of

allowing Ad-Hoc Conferencing in both Continuous Presence or Voice-Activated Switching modes.

The main components of an H.323 MCU are the multipoint controller MC and the optional multipoint processor MP. The MC is the conference controller and handles H.245 negotiations between all terminals to determine common capabilities for audio and video processing. The MC also controls conference resources such as multicasting. Most H.323 systems support IP multicast and use this to send just one audio and one video stream to the other participants. The MC does not actually deal directly with any of the audio, video and data streams. This is left to the MP, which does all the audio mixing, data distribution and video switching/mixing of the bits. It also provides the conversion between different codecs and bit rates. Both the MC and MP functions can exist in one unit or as part of other H.323 components. Most H.323 MCU's work in conjunction with, or include a Gatekeeper functionality.

H.320 conferences are essentially a point-to-point connection and need to use an H.320 MCU to link and manage all the ISDN lines in order to hold a conference with three or more participants.



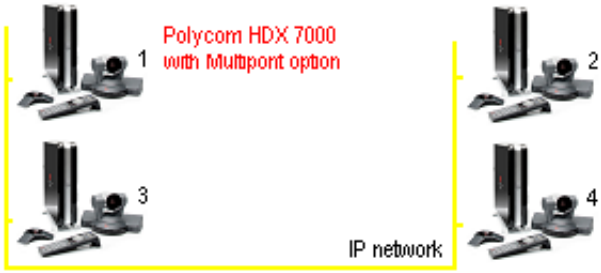
H.320 Multipoint Conference

The H.320 MCU's basic function is to maintain the communications between all the participants in the conference. H.320 MCU's are hardware based as they need to connect to all of the ISDN lines from each participant. For example, to manage a conference between four H.320 systems, each at 384Kbps (3xBRI), the H.320 MCU needs to connect the twelve BRI's. This is typically done as 24 x 64Kbps channels within a Primary Rate Interface, (PRI).

Note that an H.320 MCU is not the same as an H.323 MCU!

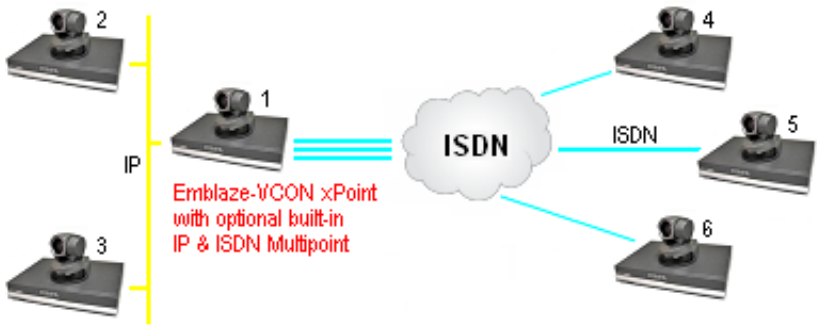
Endpoints with an Embedded MCU option:

An alternative to using a dedicated MCU for small conferences involving 3 or 6 participants is to equip one of the endpoints with an embedded multipoint capability. Both the Polycom ***HDX 7002XLP*** and Emblaze-VCON ***xPoint*** have embedded multipoint options that support themselves and the other sites in either a Voice-Activated or Continuous Presence session.



IP Connections using Built-in Multipoint

Furthermore, both of these systems have BRI or PRI ISDN connectivity options that when used in conjunction with their IP connectivity and multipoint capability, they allow mixed-mode operation between both ISDN and IP networks.



IP <> ISDN mixed connections using built-in Multipoint

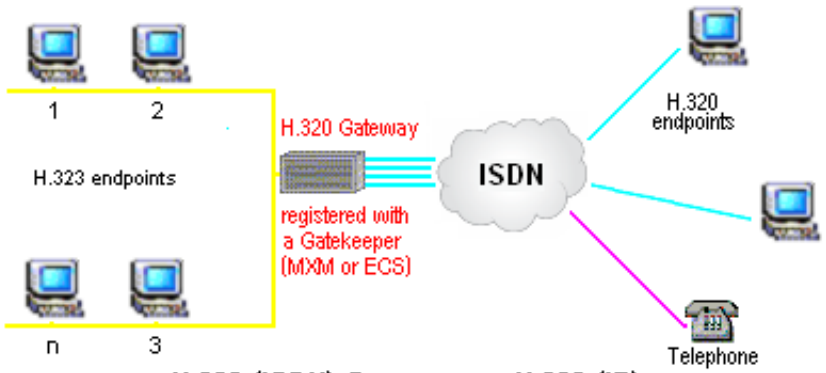
In a simplistic manner, they act like a Gateway bridging between the other ISDN and IP endpoints.

In general, dedicated MCU's support simultaneous sessions, more participants, higher bitrates, more screen layout options and more features than embedded MCU's found in some endpoints.

Using a Gateway and Gatekeeper:

The opportunities offered by using a Gateway in conjunction with a Gatekeeper are much more than just translation between a LAN and ISDN device. Most vendors Gateways have a built-in Gatekeeper as well as multiple BRI connections that allow several conferences to be held simultaneously.

By installing a Quad BRI Gateway with a Gatekeeper or registered with ***MXM***, a company could provide access to the outside world via eight ISDN lines paired as 4 BRI's. On this side of the Gateway, these BRI's can be grouped in various permutations to support calls at 64Kbps, 128Kbps, 256Kbps or 384Kbps. On the LAN side of the Gateway, access could be given to numerous H.323 Terminals located on the corporate network.



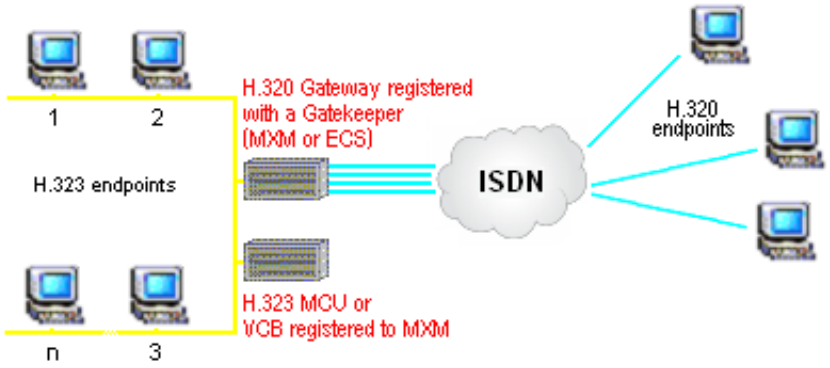
H.320 (ISDN) Gateway <> H.323 (IP)

Whilst the Gateway provides the physical links and translation between control and data formats, it is the Gatekeeper that establishes and manages the conference. The Gatekeeper manages the entire H.323 zone and all its registered endpoints. Furthermore, if the Gateway was registered with MXM, then the users could take advantage of additional services such as Simplified Outbound Dialling, whereby they simply dial 9+ISDN Number.

Using a Gateway, Gatekeeper and H.323 MCU:

The opportunities offered by using a Gateway in conjunction with a Gatekeeper and MCU are much more than just translation between a LAN and ISDN device. With the MCU adding the ability to hold a conference between three more participants, when used in conjunction with a Gateway, participants can be located on either a H.323 or H.320 endpoint. Furthermore, by using the Continuous Presence feature, participants can see more than just who is speaking. The actual number of participants viewable in a Continuous Presence conference is a function of the MCU used and maybe subject to network constraints. The Continuous Presence feature within the

SCOPIA$_{100}$ 12/24 enables the simultaneous display of up to 16 conference participants in a variety of layouts.



H.320 Gateway, Gatekeeper & MCU

When an H.323 endpoint registers with the Gatekeeper, it registers its IP address; its H.323 User Number and maybe an H.323 Alias as means of identification. As the Gateway provides services to H.323 Terminals in terms of outbound calls to H.320 Terminals or Telephones, when it registers with the Gatekeeper, it registers the services it supports. In the above example, the Gatekeeper has to manage 3 different calling routes; LAN to LAN; LAN to WAN and WAN to LAN.

How Calls are Established using Gatekeepers, Gateways and dedicated MCUs:

In the LAN to LAN situation, the Gatekeeper can locate the correct H.323 Terminal by translating its H.323 User Number or Alias into its IP address without any Gateway interaction.

In the LAN to WAN situation, when the Gatekeeper receives a service request, it recognises this as belonging to the Gateway and returns the IP address of the Gateway to the calling H.323 Terminal. The H.323 Terminal can now call the Gateway with the service code and the ISDN numbers for the H.320 Terminal. The Gateway determines the required service from the service code and calls the ISDN numbers of the H.320 Terminal. When connected, the Gateway calls the H.323 Terminal and completes the connection.

In the WAN to LAN situation, when the Gateway receives a service request, it has to forward it to the correct H.323 Terminal. This is achieved by using one of the Gateways *incoming call routing methods*; these typically being Multiple Subscriber Numbering, MSN; Terminal Control Strings, TCS-4; Interactive Voice Response, IVR or Default Extension.

With MSN, a group of phone numbers are assigned to the ISDN line. When each H.323 Terminal registers with the Gatekeeper, it is assigned to one of these phone numbers. Hence, when the H.320 Terminal calls the MSN number, it is routed through the Gateway to the H.323 Terminal after the Gatekeeper has translated the MSN number into the corresponding IP address.

TCS-4 is a special routing method for H.320 Terminals to call H.323 Terminals via a Gateway when MSN is not available. With TCS-4, the H.323 Terminal is identified using its H.323 User Number registered with the Gatekeeper. When the H.320 Terminal calls the Gateways ISDN number followed by a ***deliminator*** and the H.323 User Number, it is routed through the Gateway to the H.323 Terminal after the Gatekeeper has translated the H.323 User Number into the corresponding IP address.

IVR is a commonly used automated call answering system that presents a voice menu and allowing users to respond using Dual Tone Multi-Frequency DTMF signals entered via a keypad/keyboard. When an incoming call from an H.320 Terminal activates the IVR system, the Gateway establishes a connection and playbacks the ***IVR audio recording*** that prompts the user to identify the required H.323 Terminal by its H.323 User Number. The H.320 Terminal user then enters the H.323 User Number using DTMF signals. The IVR system interprets the DTMF signals and forwards the H.323 User Number to the Gatekeeper that translates it into the corresponding IP address.

Any H.323 Terminal can be defined as the Default Extension, which basically allows any call not routed by any other method to be forwarded to this endpoint.