Cisco on Cisco Best Practices
Streaming Video for High-Impact Business Communications

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Executive Overview

A crucial business initiative for Cisco Systems is to be the leader in data, voice, and video solutions. Another is to demonstrate leadership in Internet capabilities that provide a competitive edge, increase employee productivity, and reduce costs. To gain these leadership positions and meet the associated business objectives and benefits, Cisco has implemented measurable, Internet-based business solutions across its own enterprise for more than five years.

E-commerce, customer support, and employee self-service were among the first Internet applications successfully implemented at Cisco in the mid-1990s, offering a significant return on investment. Virtual manufacturing and virtual financial close applications continued to transform Cisco's business processes. The latest set of Internet applications, broadly grouped as "IP network-based communications," offer additional opportunities for reducing training and travel costs, improving employee productivity, and empowering employees to create and receive immediate information in rich video formats to maintain Cisco's competitive edge.

Evolving IP Network-Based Communications Solutions

IP network-based communications can be defined as the electronic exchange of information, thoughts, or messages between individuals or communities of interest. The most typical IP network-based communications applications include corporate communication, e-learning, and e-collaboration solutions. These applications continue to evolve as high-speed, broadband network connections—capable of carrying bandwidth-intensive digitized data—open the door for more sophisticated multimedia interactions. User expectations also contribute to the evolution of these self-service tools. As more employees rely on these solutions to enhance their productivity and reduce costs, they raise the bar in terms of usability, interaction, and quality.

Initial IP network-based communications efforts at Cisco, for example, began as thousands of predominately text-based, static Web pages that were difficult to find, track, and update. Today, much of Cisco's IP network-based communications efforts include rich video-based content delivered live or accessed on demand by users right from their desktops. PowerPoint presentations or Flash memory demonstrations accompany many of these video offerings. This multimedia content provides a much more engaging method of relaying information and knowledge than just a static Web page. It is also a more cost-effective alternative than sending thousands of employees to instructor-led courses or flying a team of presenters to multiple sites for a product launch. The ability to tag rich media assets also eases searching, tracking, and updating content. Video on demand (VoD) provides the added flexibility of anytime, anywhere viewing to accommodate the hectic schedules of 21st-century employees.

Attaining Business Results with Streaming Video

Over the years, Cisco has fine-tuned the processes for creating, managing, and delivering high-quality, live, or on-demand streaming-video content directly to employees, working onsite or at home. Today, the use of IP network-based streaming video flourishes throughout the organization. On average, Cisco hosts 40-50 live streaming broadcasts for about 11,250 viewers per month and creates 300-400 new VoD offerings per month, which are viewed about 89,000 times each month. The bottom line: By implementing IP solutions to meet key business objectives, Cisco saves millions of dollars every year.

Cisco customers and prospects often ask, “How did you do it?” or perhaps more importantly, “How can *we* do it?” The primary purpose of this white paper is to answer these questions and assist anyone interested in integrating IP video as a network-based communications solution. It describes the processes that Cisco has in place to effectively use its internal Cisco Media Network architecture to create live and on-demand video content, publish and manage media assets, and globally deliver video-based content for multiple business communication and learning needs over the Cisco intranet. This white paper also outlines existing Cisco business and technical support systems that help ensure the successful creation and broad use of video content across the enterprise. It concludes with a look at what is next in this rapidly evolving medium. Tim- should we include something here on the VoD Solutions offering?

Streaming Video Content Creation

Video of the Past

Using video for a variety of communication and learning applications is not a new concept. For decades, video has been an effective communication vehicle for a widely dispersed audience, freeing presenters from the need to deliver the same information over and over again. Yet the challenges and limitations were evident: steep production and broadcasting costs, the time and expense of physically storing, tracking, and mailing videotapes to multiple geographic locations, and the difficulty of delivering immediate, real-time communication.

Today’s Video

Video is now generating much more excitement as a corporate communication vehicle because of the availability of tools that enable businesses to cost-effectively create digital video assets and deliver them over an IP-based corporate intranet in real time or on demand. An added benefit of streaming video is the ability to search for specific video content, track usage/effectiveness, and more easily maintain the timeliness of information as a company’s competitive advantage. The burdened cost per broadcast within Cisco has gone from approximately $200,000 per broadcast to $5,000 per broadcast over 7 years by switching to an IP-based system.

Video Content Sources

Video content can be created from live events or staged productions. Cisco derives valuable video content from live events such as executive communications broadcasts, training programs, product launches, sales meetings, and virtually any other type of business meeting. Video content is also created from one-on-one staged presentations in front of a video camera in a studio. Both live and staged presentations at Cisco can be viewed later on demand. In either case, it is beneficial to ease the content creation process with the appropriate preproduction planning and considerations.

Network Considerations Prior to Implementing Streaming Video

Perhaps the most important prerequisite for effectively using streaming video as a standard communication vehicle is a solid network infrastructure. An end-to-end IP network serves as the foundation for delivering high-quality video to users and storing media assets for easy search and retrieval.

The Cisco intranet is based on Cisco AVVID (Architecture for Voice, Video and Integrated Data)—the industry's only enterprise-wide, standards-based network architecture. Cisco AVVID defines a framework for building and evolving networks that support Internet business solutions, and this architecture provides a road map for combining business and technology strategies. The inherent quality of service (QoS), multicast features, and use of standards-based protocols in all Cisco products ensure higher performance, interoperability, easier management, and integration with new technologies.

It is also important to have a proficient network support staff that can properly configure network infrastructure components, determine the necessary redundant and backup WAN connections, and investigate WAN connectivity alternatives, such as satellite transmission services dedicated to video broadcast streams as the primary, inter-site transmission medium.

Although Cisco uses the same underlying infrastructure for all its communication needs, there are different requirements for live and on-demand streaming video in terms of management and transport. The following sections detail how Cisco has addressed and continues to address the unique requirements of each method.

Preproduction Planning

Practical preproduction planning tips adopted as best practices at Cisco can be found in Table 1. These tips are based on six years of experience with live video broadcasting and the use of the Cisco IP/TV® Solution, a turnkey video streaming system.

Table 1: Preproduction Best Practices Adopted by Cisco

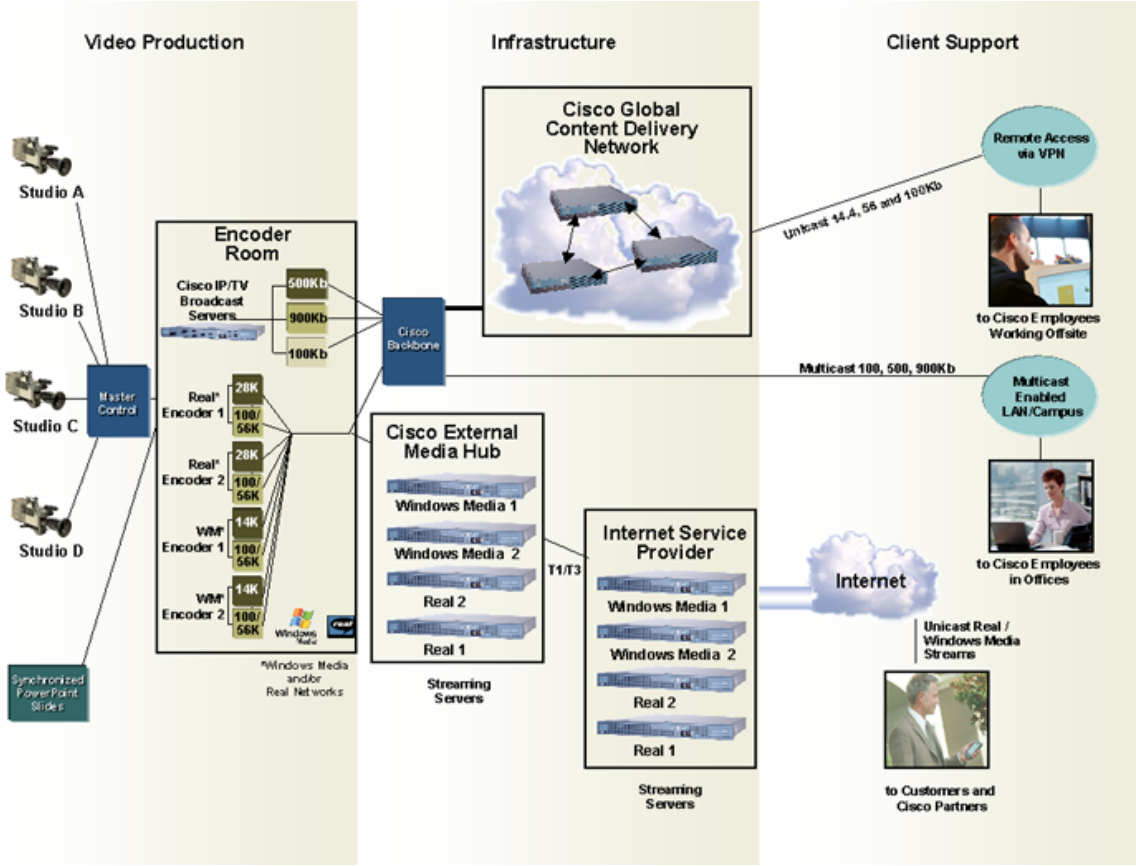
Content authoring guidelines
1. Take a decentralized approach to content creation. Use subject matter experts throughout the company.
2. Create text font size and graphic standards based on broadcast viewing requirements (that is, 24 pt or larger) and keep the number of colors and fonts to a minimum.
3. Limit each slide to a few major points (6–8 lines) and avoid detailed diagrams and organization charts.
4. Structure content around the following basic outline: Tell the audience what you are going to tell them (set the context), tell the audience what you want to tell them (give the information), and tell the audience what you have told them (review).
Meeting preparation and planning guidelines
1. Know what the goals and objectives of the meeting are for both the presenters and the participants.
2. Plan the event announcements, viewing instructions, and registration well in advance of the broadcast date, and send several reminders after the initial announcement. Include clear instructions on how to access the event.
3. Plan the event so that it keeps moving without long pauses during the broadcast.
4. To break up presentations, include periodic, moderated Q&A sessions and provide an offline Q&A moderator who will manage audience call-ins and speaker questions.
5. Script and rehearse presentations, including the Q&A moderation and the use of mixed media (video and slides). Make presenters conscious of unnecessary mannerisms such as walking around or stretching and restrict physical presentation methods to occasional hand gestures.
6. Review presentation content accuracy *prior* to the live event to ensure a quality presentation.
7. Create and maintain presentation facilities—including adequate technical support and presentation room logistics—for

groups of viewers who prefer to meet in a conference room and view streaming videos or on-demand videos together.
8. Before broadcasting the live presentation, provide a test stream at least three hours prior to the event so that any unforeseen connection problems can be identified and fixed prior to the planned presentation.
General filming considerations
1. Hire professional video production crews to achieve the best video and audio quality for major events.
2. For more casual, day-to-day broadcasts, it is best to use a high-quality camera such as DVCpro, DVcam, BetaCamSP, Digital Hi8, or Hi8 to videotape the presenters.
3. Concentrate on close-up shots of the presenter in front of a medium-gray background.
4. Use one static camera set on a wide shot of the slide projector screen to record the slide changes.
5. Give each presenter a wireless or dedicated microphone.
6. If the broadcast will be reused as a VoD module, inform the production crew prior to the event so that particular VoD requirements are anticipated, planned for, and provided during the streaming video.
Lighting tips
1. The standard lighting setup used in a studio works best. This includes key lights that primarily define the appearance of a presenter, fill lights to partially remove shadows, back lights to illuminate the back of subjects to separate them from the background, and background lights to illuminate the front of the background area to add depth to scene elements. Avoid overlighting an area.
2. The necessary lighting for a production is determined by the size of the area, studio, or set. Between two and four lights are adequate for the average production. In larger areas, portable four-point lighting is usually sufficient. Four-point lighting consists of one key light and three small fill lights to reduce shadows.
Wardrobe guidelines
1. Because video cameras have limitations dealing with color and brightness, presenters should avoid extremely dark colors such as black, navy blue, dark brown, or bright red. They should also avoid a stark white shirt/blouse unless wearing a jacket. Off-whites and pastel colors are preferable. Grays, greens, medium and light blues, and medium browns and tans are the best colors for video.
2. Men should stay away from small stripes, herringbone, and plaid patterns in their shirts and ties and avoid shiny pins, buttons, and tie bars. Women should also avoid tiny complicated patterns. Jackets and blouses are preferred over dresses, and subtle stones are better than shiny metal jewelry.

Live Streaming Video Production

Using Cisco IP/TV products, Cisco simultaneously produces IP multicast video streams and unicast video streams, as illustrated in Figure 1.

Figure 1. Overview of Cisco's Live Streaming Video Architecture Using Both Multicast and Unicast Video Streams



Multicast transmissions send a single, high-quality video stream to thousands of viewers without overloading the network. These transmissions serve employees at their desktops in Cisco offices, which are connected to the Cisco corporate intranet.

Unicast streams are sent from a single source to a single destination. These point-to-point streams serve Cisco employees connecting to Cisco's corporate intranet from remote locations via virtual private network (VPN) connections, typically a home office. When Cisco wants to reach external partners and customers, unicast streams can be accessed via various company public Web sites at http://www.cisco.com. To avoid overloading its corporate intranet with these unicast streams, Cisco uses Internet service providers (ISPs) to distribute unicast traffic, as described later in this paper.

Almost every live streaming video is accompanied by an online slide presentation. For an IP multicast broadcast, a Cisco IP/TV Slidecast Server enables presenters to capture screen information from their Microsoft PowerPoint slides for transmission over a network. For a unicast broadcast, other encoder tools

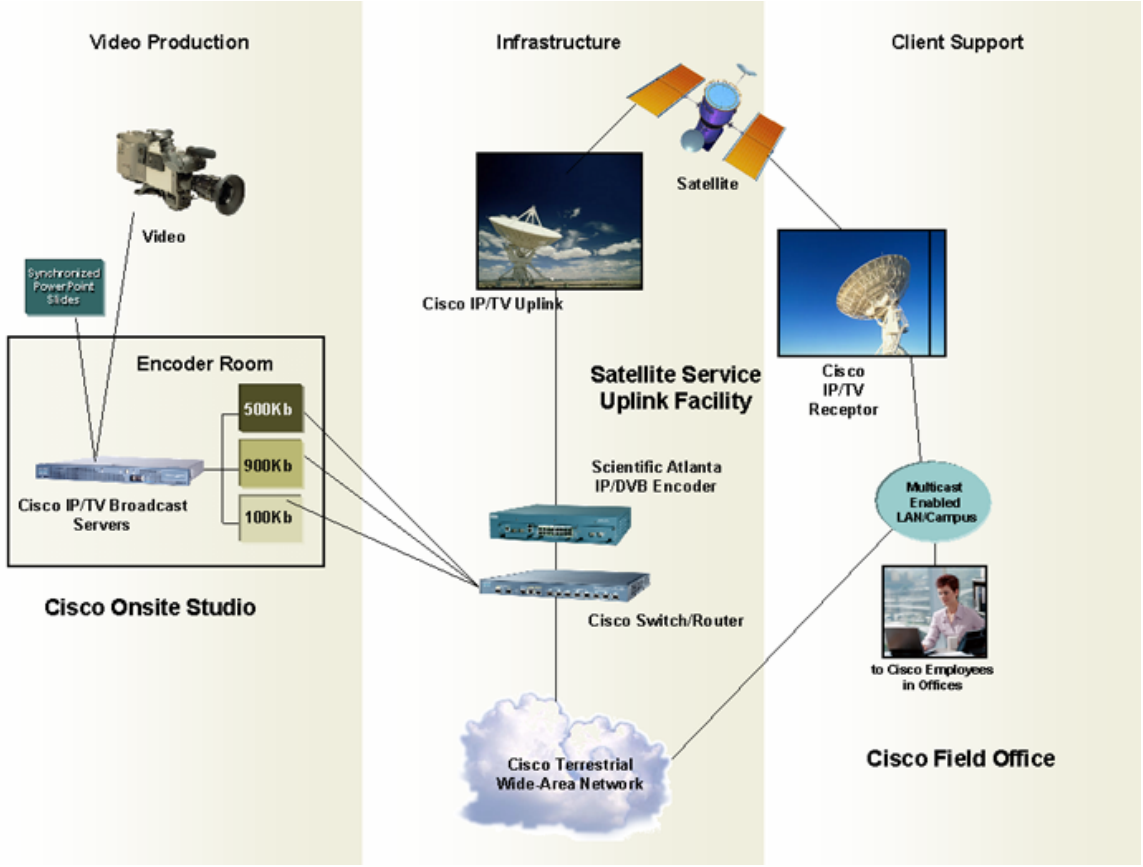
enable the inclusion of Microsoft PowerPoint slides with the live video streams. Cisco Systems currently uses similar encoding tools for unicast streaming video, including products from IVT (http://www.ivtweb.com). More details are available in the following section.

If someone misses a live streaming video scheduled at a certain time, an on-demand version of the broadcast can be available as early as 24 hours later to ensure that employees around the globe receive timely, consistent messages, regardless of their location or schedule. More details of on-demand video production follow later in this paper.

Overview of Cisco's Multicast Production Flow

Live streaming video events at Cisco provide the invaluable opportunity to communicate consistent messages to all employees or a specific group of employees, while also opening interaction between presenters and the audience. The Cisco IP/TV Question Manager feature enables viewers to submit a question to the presenter via a text box at any time during a broadcast. The presenter can choose to answer these questions as they come in or during a specified Q&A session. Answers also can be posted to the entire audience for public viewing. Figure 2 shows a brief behind-the-scenes look at what makes this communication possible at Cisco.

Figure 2: Cisco relies on an IP satellite network service to augment the corporate WAN to accommodate bandwidth-intensive video files.



Cisco's Infrastructure

IP multicasting utilizes both the Cisco WAN infrastructure and an IP satellite network service for transmission. The IP satellite network augments the WAN in Europe, North America, and South America, currently providing a more cost-effective transmission medium for high-quality multimedia than installing high-speed WAN connections in those areas. Cisco is constantly reexamining its transport options as higher-speed lines become available at lower price points.

Cisco IP/TV Technology

The company uses its own Cisco IP/TV product as the application to deliver high-quality, live streaming-video multicast programming over the Cisco intranet. The Cisco IP/TV Control Server is the policy manager that communicates scheduling information and desired video encoding formats to the Cisco IP/TV broadcast servers. It also generates a program listing and handles network and device configuration and management. It manages the slide synchronization discussed earlier and enables administrators to monitor the usage and quality of streams delivered throughout the multicast network via the Cisco IP/TV StreamWatch monitoring tool.

Multicast Encoding

The Cisco IP/TV Broadcast Server encodes and transmits a video stream according to the directions received from the Cisco IP/TV Control Server. The broadcast servers multicast live or prerecorded programs from devices such as video cameras, VCRs, DVDs, satellite and cable feeds, or prerecorded Windows Media, AVI, MP3, and MPEG files. In the Cisco Media Network, broadcast servers encode three different streams for each multicast broadcast: a 900-kbps accessible via a satellite WAN connection, a 500-kbps stream, and a 100-kbps stream accessible via a terrestrial WAN connection.

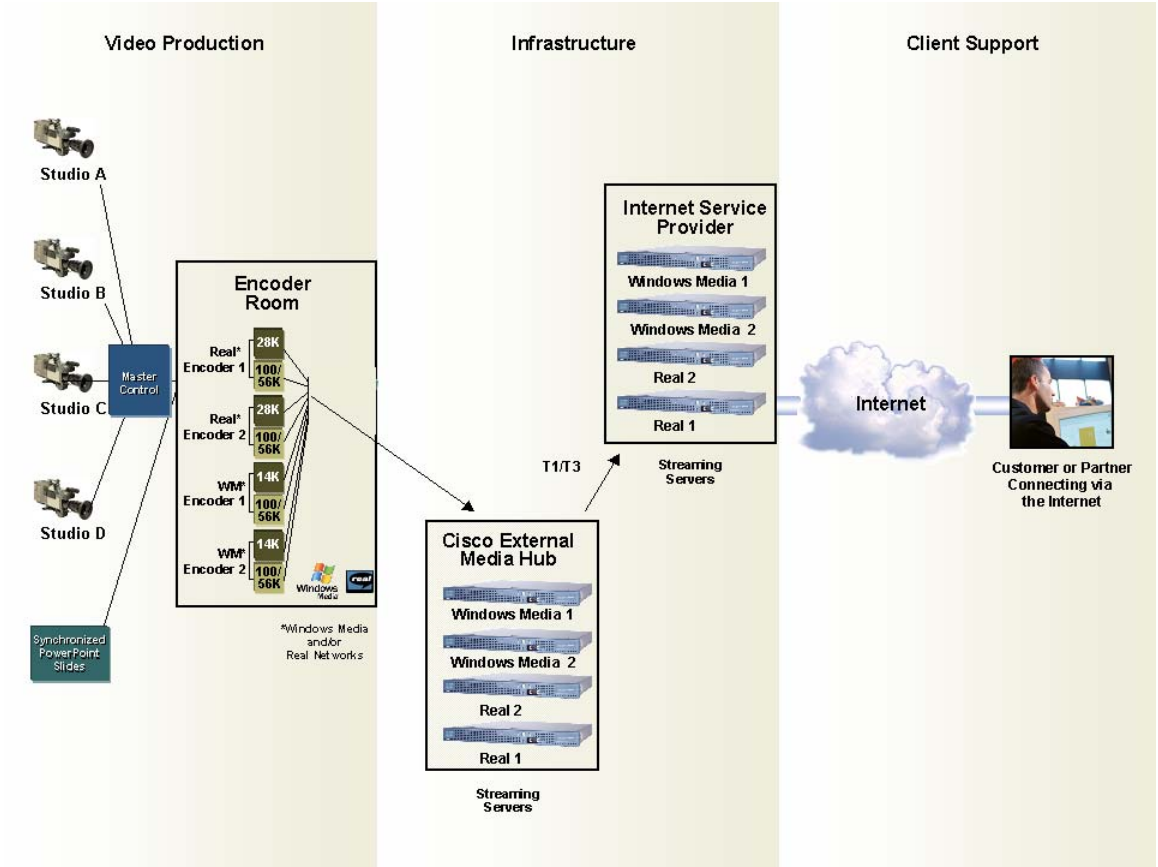
Overview of Cisco's Unicast Production Flow

To reach employees, customers, and channel partners who need access to video-based content but are not located in a Cisco office, Cisco also broadcasts video via unicast streams. These streams are supported by two different implementations within the Cisco Media Network.

Unicast Streaming Video for Partners and Customers

Figure 3 depicts the architecture for streaming video content to Internet-connected viewers such as Cisco partners and customers. Cisco supplies multiple rate streams comprising multiple encoded streams, including a 14-kbps Windows Media audio stream, a 56-, 100-, or 300-kbps Windows Media video stream, a 28-kbps Real Audio 8 stream, and a 56-, 100-, or 300-kbps Real Video 8 stream. These encoded streams are directed from the encoder to a set of Windows Media and Real streaming-video servers called the Cisco External Media Hub. These streams are then directed via a high-speed connection to a global ISP. The ISP then provides nearest proximity, worldwide streaming video to partners and customers.

Figure 3: Unicast Streaming Video for Internet-Connected Customers and Partners



Unicast Streaming Video for Remote VPN-Connected Employees

Cisco also deploys unicast streaming video for employees accessing the corporate intranet via secure VPN connections to watch a streaming video. As depicted in Figure 4, the current Cisco VoD content delivery network (CDN) provides unicast pull-splitting technology. This enables VoD servers to pull a live stream from a source-streaming server in a daisy-chain manner and then provide that stream to locally connected clients. The pull-splitting technology allows the VoD servers to supply live streaming video in addition to on-demand content. Viewers connect to a local VPN concentrator via the Internet and are directed to the nearest streaming VoD server.

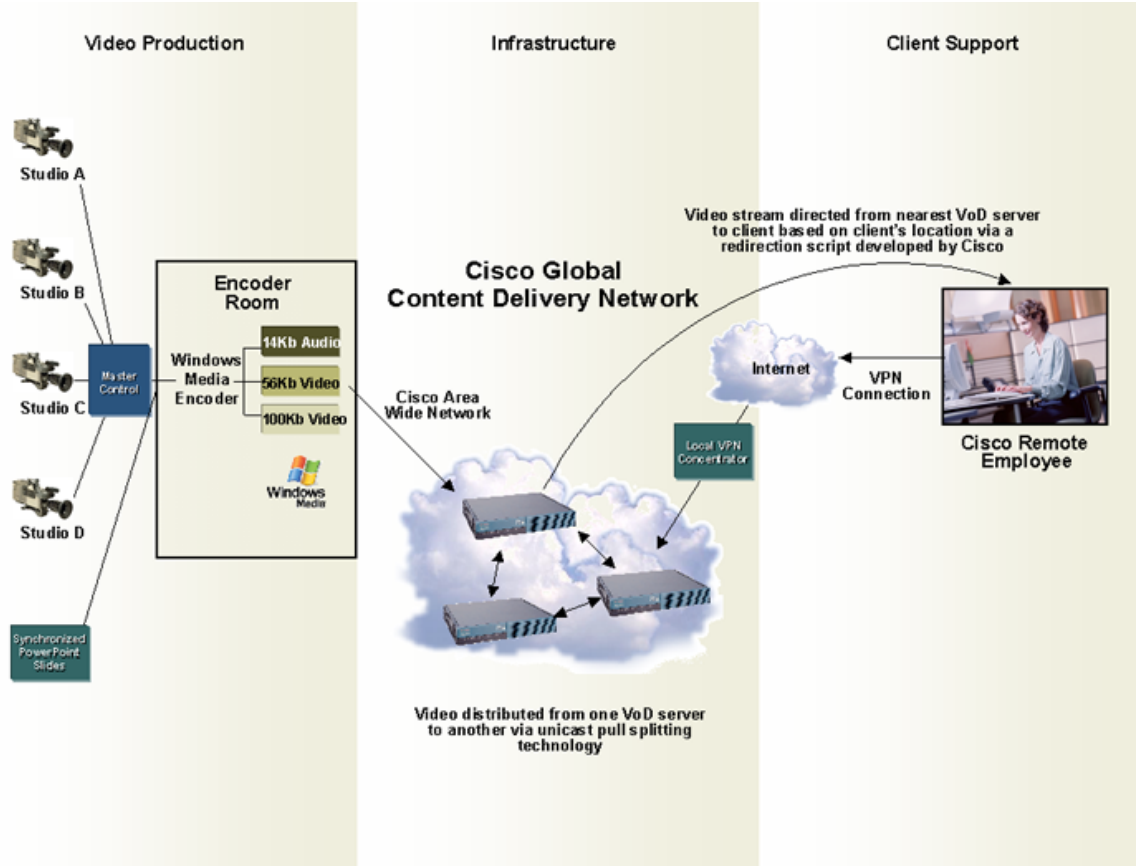
The originating video stream is encoded into two unicast streams. The first unicast stream is sent at two bit rates: 100-kbps and 56-kbps. The supporting Cisco Live Media Template Web page automatically detects which stream is appropriate for the viewer's bandwidth and adjusts accordingly. The second unicast stream is a 14-kbps audio stream appropriate for employees using a lower-speed dialup connection.

Unicast Encoding

Additional encoders are currently deployed that take the original live video stream and create separate unicast streams. Cisco currently uses various encoder products, including several from IVT (http://www.ivtweb.com) to encode these unicast streams. IVT is a member of the Cisco AVVID

partner program, an interoperability testing and comarketing program that enables customers to implement verified e-business solutions.

Figure 4: Unicast Streaming Video for Remote VPN-Connected Employees



Live Global Channels Architecture

To support live unicast video streaming from multiple studios around the world, Cisco deploys a video channel architecture for employees and external partners and customers. Video streams originating from various global locations are directed via the corporate intranet to a media hub in San Jose, California, for streaming to the ISP. This channel architecture provides easier management and support for multiple streaming sources. It also enables Cisco to target broadcasts to specific regions.

Cisco Live Media Template

Each client accesses these unicast streams via a Web-based interface called the Cisco Live Media Template (LMT), as depicted in Figure 5. The Cisco LMT provides a standard look and feel in both Netscape and Internet Explorer Versions 4.0 or higher. The interface is a dynamic JavaServer Pages (JSP) application that generates xHTML. Cisco LMT currently links to a redirection JSP application that detects if the viewer is remote or on the Cisco intranet. If the viewer is remote, the application redirects the viewer to a local unicast live video stream. If the viewer is on the Cisco intranet, then the application returns a

message asking the viewer to watch the broadcast using the Cisco IP/TV application via a multicast stream. In the future, all interfaces independent of this type of stream will be offered via the Cisco LMT.

Figure 5: Cisco LMT

Unicast broadcasts take advantage of other feature-rich production tools that enable:

- Simultaneous support of Windows Media and Real streams
- Easy access to a dedicated Web page with links to streams at various speeds (14.4-kbps audio only, 56- and 100-kbps audio/video)
- Ability to advance PowerPoint slides synchronously with live stream
- Cisco IP/TV Question Manager functionality for audience interaction
- Archiving of audio/video and slide flips for conversion to VoD
- Reporting functionality (number of streams, duration a client watched a particular program, IP address, and so on)
- Single interface to simultaneously control multiple encoders (Windows, Real, and so on)
- Conversion of PowerPoint slides to high-quality JPEG files and automatic posting to internal Web servers
- Channel architecture to manage and support broadcast streams

Example of a Typical Cisco Streaming-Video Broadcast

Offering both multicast and unicast video-streaming options is critical to broaden the reach of Cisco employee broadcasts and to adequately serve Cisco's mobile population. Most employees are equipped with a laptop to transition seamlessly between an onsite office to an offsite location, typically a home office. Following is an example of how Cisco broadcasts its quarterly company meeting in real time, using both multicast and unicast video streams to share the information from the meeting.

Infrastructure for Multiple Audio and Video Streams

Cisco office users require the production end to support one Cisco IP/TV Broadcast Server to multicast one 900-kbps video stream, one Cisco IP/TV Broadcast Server to multicast a 500-kbps video stream, and one Cisco IP/TV Broadcast Server to multicast a 100-kbps video stream (refer back to Figure 1). One Cisco IP/TV Control Server is also required to take the source audio and video signals from the camera and split them into four signals so that each Cisco IP/TV Broadcast Server can transmit a different video stream. In addition, as mentioned earlier, separate encoders are also used to create the various unicast streams that are offered via separate streaming servers to VPN-connected employees and Cisco partners and customers accessing via the Internet.

Backup

Because these broadcasts are live, the Cisco Media Network now includes a second, redundant server to back up each of the Cisco IP/TV broadcast servers. This brings the total number of Cisco IP/TV broadcast servers per streaming video to eight. Though not required, Cisco recommends these backup servers for each multicast and unicast video stream. If a broadcast server fails, a properly configured backup broadcast server can take over seamlessly, avoiding the risk of losing the transmission while attempting to bring up another system in real time.

Publicity and Registration

From the user standpoint, the live streaming-video information is publicized via a variety of venues, including e-mail, electronic newsletters, Web pages, or simply by word of mouth. A full schedule is also posted on the Cisco broadcast calendar found on the Cisco Media Network site. The electronic publicity methods typically include a hyperlinked URL that a user can click on to access the broadcast at the specified time. Because some of the live events are part of defined training courses, these broadcasts are registered in the Cisco Learning Management System and users must register to attend.

Cisco Office Users

Employees planning to watch the broadcast from a Cisco office that accesses the corporate intranet can use the Cisco IP/TV application installed on their desktop. By opening the Cisco IP/TV Viewer, employees can search daily, weekly, or monthly programming information, watch the program, or select a stream. The image size of the video, as seen through a Cisco IP/TV Viewer, is 320 x 240 pixels. Employees can test their reception prior to the event because there is always a program or test stream being broadcast.

Cisco Remote Users

Employees working from a remote location via a DSL, cable modem, ISDN, or dialup connection use a standard Web browser to view broadcasts. With VPN access to the Cisco corporate intranet, they can also access Cisco's internal broadcast calendar found on the Cisco Media Network Web site and click on the program they are interested in. This opens a window with details on how to watch the program and enables them to click on the link "*Watch using your Web browser*" in the *Remote Users* box. The video stream takes about 30 seconds to display. The Cisco Media Network site offers a VoD for remote users to test their ability to watch broadcasts and learn more about the environment. The site also includes troubleshooting tips for remote users, as well as contact information for the internal Cisco Global Technical Response Center (TRC).

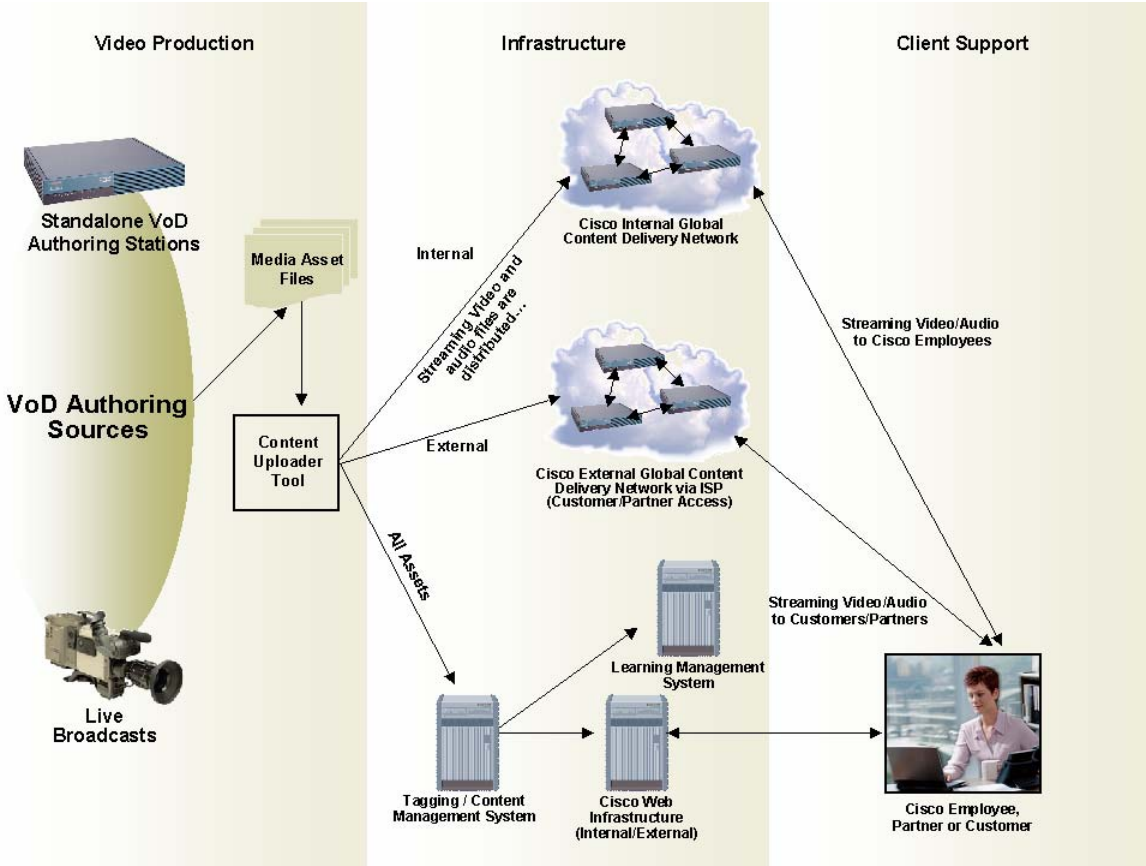
Public Remote Users

Public users usually find out about live Cisco broadcasts via e-mail or targeted messages on Cisco's public Web site, http://www.cisco.com.

VoD Production

Cisco uses several methods to capture and manage VoD assets. Valuable information can be captured from a streaming video, from a scheduled video shoot in Cisco's onsite studios, from a virtual classroom, or from a more informal offline production authoring tool, as shown in Figure 6.

Figure 6: Overview of the VoD Production Process



Capturing VoDs from Live Streaming Video

All Cisco live streaming videos are now automatically captured and archived in the onsite studio while programs are streaming to the audience. Immediately after the broadcast, these captured video assets are converted to VoDs. This capability offers tremendous cost savings by eliminating the estimated $2000 U.S. per-hour cost of video production once spent on hiring an outside vendor to reencode a video into a VoD format. It also retains the timeliness of the program by eliminating the weeklong wait previously endured while vendors transferred videotaped versions of Cisco programs to VoD. VoDs created from streaming videos can be available as soon as 24 hours after a streaming video, depending on the urgency of the content.

Creating VoD Content in Cisco's Onsite Studio

After a decision to proceed with a VoD production has been made, content owners consider their audiences when organizing the content to ensure retention of the information presented, and they often break up the information into smaller presentations to best convey the message or instructions. This helps create an organized "agenda" that should include the type and number of presentations required, as well as who the speakers are for each presentation.

With an agenda in mind, VoD content owners at Cisco must fill out an online Video on Demand Request Form to initiate VoD production with a live crew. The content owners are also the primary contacts for the project manager, as well as the liaisons/coordinators between the presenter(s) and the required processes and documentation.

A Cisco Media Network project manager then contacts the VoD content owner when the request has been processed. The project manager provides further details about the production process and answers any questions the project manager has.

The VoD content owner is responsible for providing the following items to the Cisco Media Network project manager before the event occurs to ensure a timely production and posting of the content:

- An agenda with each presenter's name and title in the order that the presenter will appear in the event
- PowerPoint slides for each presenter at least 24 hours before the recording session
- A completed Media Locator Tagging Form used to organize, categorize, and identify information associated with the produced VoD

The typical turnaround time for VoD productions without transcription is now three business days if no modifications are needed. VoD productions with transcription require 12 business days, if all transcripts are reviewed and returned according to schedule.

Offline VoD Production

Several approved and licensed tools that do not require outside vendor involvement are available to automatically produce media assets such as VoDs.

Cisco provides VoD self-authoring workstations in quiet areas or converted offices around the globe. These workstations allow subject matter experts to quickly produce more "casual" VoDs at little or no cost.

Figure 7: Self Authoring Tool

The authoring station includes a Windows NT Workstation with a video camera, lighting, and microphone attached. With the PowerPoint plug-in included, a subject matter expert using the authoring station can easily add video and audio to the PowerPoint slides. The authoring station creates a series of files that are then automatically pushed to the publishing server for conversion to Cisco standard format VoD assets. For additional details on Cisco's authoring process, see Table 2.

Table 2: Cisco's Self Authoring Process

Step	Action items
Get training	Watch an online demonstration of the self authoring tool. Review an online online user's guide that addresses many commonly asked questions.
Schedule time on the exchange workstation	Because Cisco owns a limited number of self authoring workstations, content creators must schedule time on a station by filling out an online form .
Give the presentation	It is important for presenters to look their best for the camera, as noted in the Preproduction Planning Tips in Table 1. To help make presentations run smoothly, content owners should run through their presentation a few times before using the workstation to gain a better idea of its length.
Assemble and upload media assets	Cisco has created a plug-in for the workstation that integrates the capabilities of the Cisco CUT. The plug-in eliminates many manual operations and automates the process of assembling and uploading the assets as described in the "Content Publishing and Management" section of this paper.

Camtasia

Another “do-it-yourself VoD production tool” used by Cisco employees, Camtasia (http://www.camtasia.com) is a desktop capture utility that can record software or Web-site demonstrations and tutorials. Camtasia can capture graphics and mouse movements as they are demonstrated with the presenter's audio narration. The presentation is saved as a video file that can be edited and converted into a format compatible with Cisco standards.

Desktop Alternatives

If time and resources are particularly constrained, employees can create an audio or video on demand using tools such as IVT MediaPlatform Studio (http://www.ivtweb.com)—to add just audio to a PowerPoint presentation. The MediaPlatform Studio plug-in for PowerPoint enables presenters to create and edit their own AoD or VoD, conforming to Cisco standards, right from their desktop. This provides a quick, simple method of augmenting the limitations of a bulleted presentation that needs further explanation.

Cisco works with many third-party, best-of-breed vendors.

How Cisco Justified an Onsite Studio

Companies do not have to begin with a sophisticated onsite broadcast studio to reap the benefits of using video to support business goals and needs. Building an onsite broadcast and production facility can be costly. Yet as the concept of using video to enhance communication, collaboration, and learning gained momentum at Cisco—and as the tools and processes for creating video became easily accessible to users—the volume of video production increased rapidly.

The return on investment (ROI) for building an onsite studio became very apparent. Cisco’s current volume of producing 40-50 live streaming videos and 300-400 VoD modules per month will enable the company to realize a quick 12- to 14-month ROI for its recently constructed state-of-the-art studio located in San Jose, California (refer to Figure 8). The company will actually save millions of dollars in production costs after the facility pays for itself, because most employees can now bypass the expense of outsourcing vendors and facilities when creating audio or video to enhance their IP network video-based communication and e-learning content. Video content also provides a cost-effective alternative to travel and training expenses.

Additional savings are derived from the ability to more efficiently coordinate outside vendors. Cisco used to pay professional camera crews on a “per-event” basis, including fees for a full day of work setting up their equipment prior to a broadcast. Now that all the equipment is already in place, Cisco can move to a per-diem video production crew expense model and produce up to four shorter, focused broadcasts per day. Employees eager to cut their equipment or vendor fees to zero must simply:

Comply with Cisco standards and established formats

Reserve the studio on a day when a video production crew is already scheduled to be onsite

To schedule studio time, employees go to the Internal Cisco Media Network Web site to check availability and to fill out the appropriate request form. The Cisco Media Network team expects content providers to provide sponsorship for each show, supply the content expertise, and cooperate with other content providers.

The studio satisfies all in-house broadcast and production needs in San Jose, where 80 percent of Cisco's VoD and Cisco IP/TV output is produced today. Because of the significant cost savings Cisco will realize from this studio, another studio—based on this studio design and functionality—has been created in the United Kingdom. Key features of Cisco's onsite studio are listed in Table 3.

Table 3: Key Features of Cisco's Onsite Studio

	Number	Primary use/features
Broadcast control rooms	4	Each broadcast control room (A, B, C, and D) has an adjacent production room, Studios A, B, C, and D.
Production rooms (studios)	4	Studio A, the largest of the four with a 35- by 45-foot production room, is fully equipped with all the capabilities of a professional TV studio. Three smaller studios (B, C, and D) are customized for smaller broadcasts with two to three presenters. The adjacent production rooms to Control Rooms B, C, and D are about half the size of the Control A production room, at 18 by 20 feet each. Generally, all four production rooms feature similar equipment: cameras with standard-definition lenses, each room featuring multicamera setups. The production studios for Control Rooms C and D also house robotic cameras. Featured throughout the entire facility for communication purposes are several audio products, including rack-mount receivers, body-pack transmitters, and wireless and microphone products.
Master Control Center	1	The heart of the system is rooted in the Master Control Center, a 20- by 20-foot room that features 10 racks of equipment to tie all operational aspects of the entire facility together. The primary core consists of routing and switching systems, which address Serial Digital Interface (SDI) and National Television System Committee (NTSC) video, plus Advanced Encryption Standard (AES) and analog audio. All electronics for the entire facility live in this space. This includes all processors for the various production switchers found in all four broadcast control rooms, plus a variety of distribution, test, and measurement equipment.
Videotape Operations Center	1	The Videotape Operations Center, complete with Betacam, Digital Betacam, DVCam, and VHS systems, is also found in the Master Control Center. The primary control room of the facility features a large production switcher as the centerpiece of the room amid a wealth of associated production equipment,

		including a digital effects system, a computer graphics system, and a still-store. All the Cisco IP/TV products for multicast and unicast streaming, as well as an intercom matrix for comprehensive facility communication, are found in an adjacent server room.
Compression Lab	1	The studio also includes a compression lab where employees can edit their raw video or complete Macromedia Flash memory base work. A broadcast in any of the studios can be routed to a computer in the compression lab to digitize it. Employees can also do postproduction work on the broadcast there and then export it as a VoD without the need to redigitize the content.
Server Room	1	All the Cisco IP/TV products for multicast and unicast streaming, as well as an intercom matrix for comprehensive facility communication, are found adjacent to the Master Control Room.

Content Publishing and Management

After VoD media assets are recorded and processed in specific formats using standard multimedia tools, the Cisco Media Network group typically publishes the content to the VoD network in three business days. These media assets are uploaded to VoD servers using the internally developed Cisco Content Upload Tool (CUT) and formatted into the Cisco Media Template for playback by end users. Content can be hosted inside or outside the Cisco firewall. To access published content, employees either click on advertised URLs or execute a key word search using Cisco's MediaLocator tool to identify and access appropriate VoD content.

Cisco Media Template

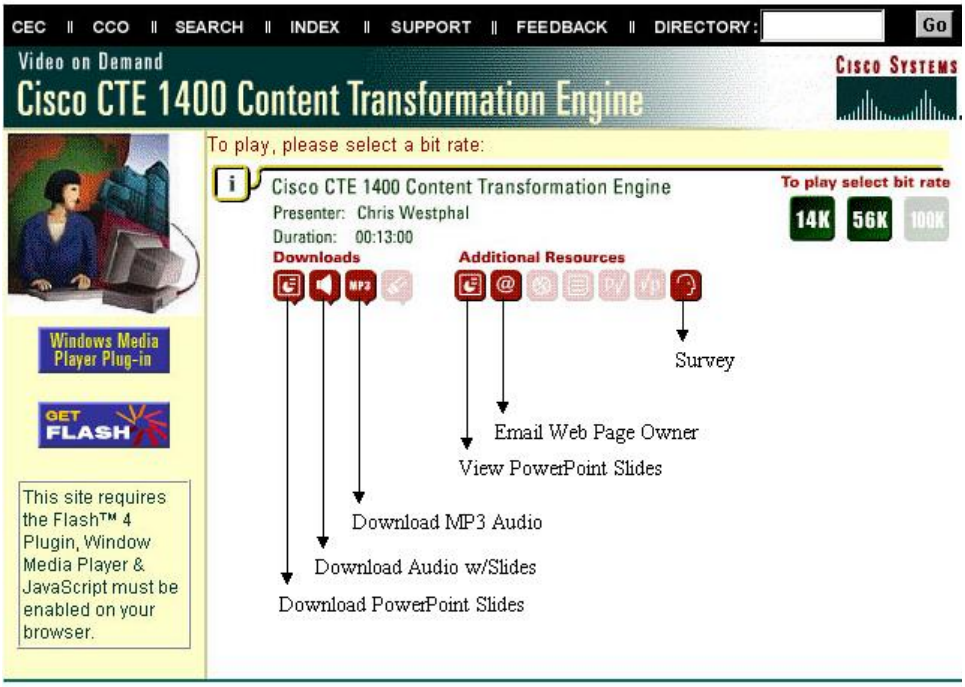
In order to standardize the development and delivery of VoD content, Cisco developed a VoD media template similar to the live media template discussed previously. Because most VoD content is derived from individual presentations comprising PowerPoint slides, the template is designed for this type of material.

The Cisco Media Template shown in Figure 9 works with the Cisco network infrastructure both internally and externally. Whether employees develop VoD offerings internally or through a vendor, they are encouraged to use this template for two primary reasons. The template not only offers a standard look and feel for end users, it also enables Cisco to easily reuse content for future applications.

The Cisco Media Template integrates the streaming video of the presenter synchronized with the presentation slides. A table of contents allows the viewer to jump to any segment of the presentation,

and an optional searchable transcript of the presentation can be added. The Cisco Media Template includes controls to pause and play the video, advance and synchronize slides, and e-mail questions.

Figure 8: A Cisco Employee's Typical Screen View Prior to Playing a VoD



Cisco AoD Template

The Cisco AoD template is identical to the VoD template except the video playback window is replaced by an animated graphic depicting audio playback. The template is appropriate for slow network connections or for content that lacks video.

Media Bar Template

VoD content is organized into lessons or offerings. Each offering can have multiple options for viewing or listening to the content and links to additional resources. These selections are grouped into a media bar template, pictured in Figure 10, which typically lists AoD (14-kpbs data rate) and VoD (56-kbps data rate) versions of the content. Accompanying PowerPoint slides can be viewed separately from the media bar or downloaded for future reference.

As an option, the AoD version can be downloaded as an MP3 version of the audio. These download options allow users to listen to content at a later date while traveling or while working in a location without adequate network connections for viewing streaming video.

Figure 10: The Media Bar Template

Content Upload Tool

To sustain production levels of approximately 300-400 VoDs per month, Cisco realized that it had to create automated tools to help content providers ease the entire process. The VoD, AoD, and media bar templates are all created using a Cisco internally developed production tool, the CUT. This tool automates the assembly of content assets into the templates, creates folders on the content and video servers, and uploads and posts VoD content from a desktop workstation to the Cisco internal CDN.

Although several commercial tools available today perform similar functions, the Cisco CUT was developed prior to the availability of these tools. The Cisco CUT continues to support Cisco's video communications infrastructure with automated tools that guide the content provider through a "painless" publishing process. Table 4 shows some of these automated options. [Tim – Insert VoD solutions here?]

Table 4: Cisco CUT Fields that Guide the User

14K, 56K, and 100K Audio and Video Encoding checkboxes	These checkboxes indicate the type of content that is to be created. The 14K and 56K checkboxes are checked by default.
MP3 checkbox	This checkbox gives content authors the option to upload MP3 file content.
Directory Containing All Required Files	This field is used to specify the directory path to all the files that are required to create the ASF and GIF files.
PowerPoint File	This is an optional field that offers users a downloadable PowerPoint file in zipped format.

"Gatekeeper" for Cisco VoD CDN

The Cisco CUT is the *only* entry point for publishing VoD content into the company's VoD CDN, and use of the Cisco CUT application requires access approval. Along with each offering, a content provider may have additional material related to the offering. This material may include MP3, PowerPoint, PDF, zip files, or Flash memory-based deliverables. The Cisco CUT assembles all these assets onto a staging server, which shows the content author how the VoD looks in an assembled fashion. This is a quality control step to ensure that all the components are present and synchronized before the VoD is published.

Metadata Tagging

Before a VoD can be pushed into production, each asset must be tagged to help users search for the asset, manage the versions, and track the use of the content to determine if it should be archived or deleted. From a user standpoint, the greatest benefit of metadata tagging is providing the ability to search for a specific video. The search tool allows learners to seek content based on numerous attributes such as subject matter, language, target job role, target theater, delivery type, target organization, and so on. All these metadata attributes must be tagged by the content provider and compiled into a media locator database in order to enable such robust search capabilities.

Media Uploader

After content is uploaded to the development environment, the media uploader feature of the Cisco CUT pushes the assembled assets from the development-staging server to production. In the future, the Cisco Media Uploader tool will integrate with a Cisco Content Delivery Manager (CDM) to upload and manage content within the internal Cisco Enterprise Content Delivery Network (ECDN).

VoD Archival Process

The purpose of Cisco's archival process is to manage VoD content that resides on the VoD CDN. With an established archival process in place, Cisco saves approximately US$1 million per year by avoiding investment of additional VoD disk space.

The hit activity of a VoD is reviewed 90 days after the day of upload. If the offering has received fewer than eight hits, an e-mail notification is sent to the Web page owner noting the intent to archive or delete it within the next two weeks. If a content owner wishes to extend the VoD, the owner must send an e-mail presenting a business justification for exclusion from the archival process. If approved by the business owners, an archival script does not delete the content at the scheduled time, but reviews the case again 90 days later.

Content Delivery

Overview of Cisco VoD Delivery Architecture

The foundation of Cisco VoD content is streaming video, which allows viewers to play video files over the Web without having to download them. However, streaming video requires much greater bandwidth demands than static Web pages. To provide streaming video, Cisco's accessed content pages actually reside on two different types of servers. The video is streamed from a dedicated video-streaming server

while the rest of the content, such as the text and page graphic elements, resides on a separate Web server. This architecture separates the Web server from the high-bandwidth access demands of the streaming video, thus providing faster access and better playback quality to the audience.

The Cisco VoD CDN

Because of the volume of content and the geographic distribution of Cisco offices, sending all requests for streaming video to one video server would present performance problems. To optimize each connection, Cisco initially developed a global VoD CDN with a distributed video server approach six years ago. This VoD CDN spans multiple geographical regions and countries, in areas such as the United States, Australia, China, Singapore, Japan, Korea, Belgium, the United Kingdom, the Netherlands, Germany, and France. Installation of these edge “appliances” requires minimal support from local IT resources.

The content on each video server is the same. A user receives the Web page content from Web servers in San Jose while the video is streamed from a local video server. For its video servers, Cisco currently uses Cisco. Today, Cisco’s internally developed CDN is evolving to include commercially available Cisco Content Delivery Network products such as the Cisco Content Engine and Content Distribution Manager. [We are partially on ACNS 4.2 now. We should be completely on Cisco CDN equipment in 3-6 months. So we can probably reference the Cisco CDN stuff now. Let me know if you want me to do this section.]

This new ECDN will provide the network infrastructure components to ensure that every VoD asset created by Cisco is accessible at the highest quality levels possible to employees or partners, no matter where they are located in the world. Cisco ECDNs in general offer many benefits, including the ability to:

Intelligently and automatically distribute/store rich media

Provide fast, easy access to thousands of users

Enable simplified setup

Offer a low cost of ownership

Provide a high-impact learning/communications environment

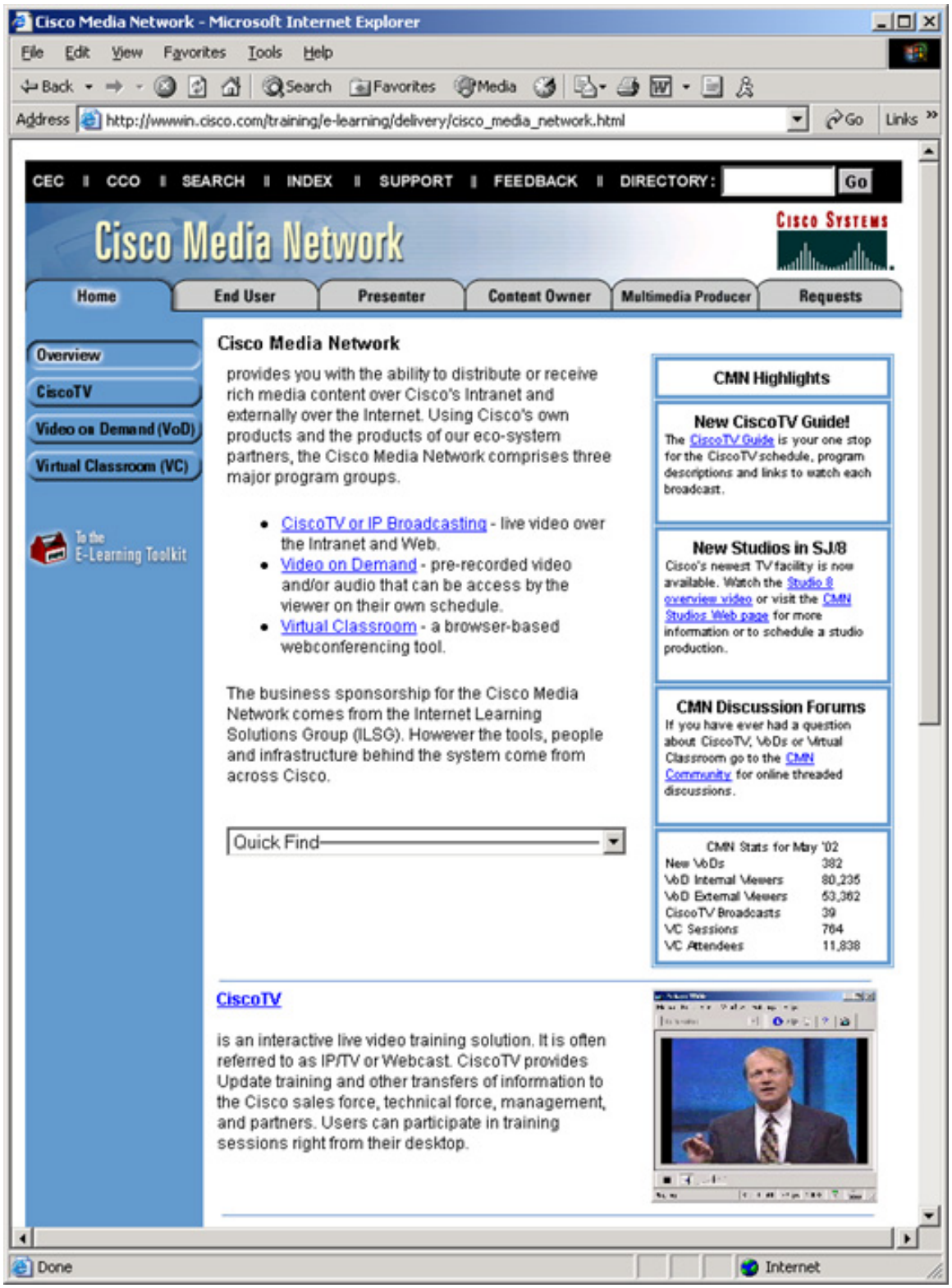
Serve as an infrastructure for other services/applications

Cisco Support Systems

Cisco Media Network

The internal Cisco Media Network Web site shown in Figure 11 provides all the information, documentation, resources, business processes, and tools needed to successfully create, distribute, or receive rich media content, as discussed throughout this paper. Tabs in the toolbar, which specify the various audiences involved, logically organize the information for end users, presenters, content owners, and multimedia producers. The successful proliferation of video to augment Cisco’s communication efforts throughout the enterprise can be attributed in large part to the strong user support that the Cisco Media Network offers through its human resources, onsite studio, and Web site.

Figure 10: Screen Shot of the Cisco Media Network Home Page



Using Cisco's own products as well as the products from its ecosystem partners, the Cisco Media Network comprises three major program groups: live IP broadcasts, VoD, and virtual classrooms.

The Cisco Global Technical Response Center

Cisco offers technical support for both office and remote employees viewing streaming videos. Analysts located in the Cisco Global Technical Response Center (GTRC) offices around the world receive streaming-video technical support training via a virtual classroom setup. This enables them to dial into an audio conference call moderated by a Cisco streaming-video expert and view the accompanying slides in a Web-based presentation via the Cisco corporate intranet. Analysts also have the opportunity to ask questions.

After the training, TRC analysts use two practical tools to address streaming-video problems from callers. Both of these tools can be implemented at companies of any size. The first tool is a document containing a comprehensive list of Frequently Asked Questions (FAQs) and the answers to those questions. When a Cisco employee calls in with a problem, the analyst can refer to the FAQ document to seek an answer. If an answer to a problem cannot be found in the FAQ document, the analyst can use the second tool, a decision tree, which provides a logical process for the analyst to troubleshoot the problem. By asking the caller simple *yes* and *no* questions in a certain order, the analyst eliminates all possible reasons for the caller's problem to uncover the actual reason for the problem.

Cisco also provides detailed service-level agreements (SLAs) for certain broadcast applications, a practice that is typical for larger companies. These SLAs outline the expectations and procedures required for both the GTRC and Cisco's IT to meet and exceed client service levels.

Moving Forward with Open Standards

The concept of streaming video over an IP multicast-enabled network is still in its infancy, and the technologies and processes that support IP-based video as a communication vehicle are transforming rapidly. The need to establish open standards in the streaming-video arena, as in any new technological field, is becoming more and more apparent.

Cisco is heavily involved with the Internet Streaming Media Alliance, Inc. (ISMA), a nonprofit corporation formed to provide a forum for the creation of specification(s) that define an interoperable implementation for streaming rich media (video, audio, and associated data) over IP networks. The alliance believes that in creating an interoperable approach for transporting and viewing streaming media, content creators, product developers, and service providers will have easier access to the expanding commercial and consumer markets for streaming-media services.

To date, the prohibitive costs associated with rolling out streaming-video services that support all current, disparate formats has kept many potential service providers and other adopters from taking full advantage of existing market opportunities. The emerging class of Internet appliances stands to benefit from a single standard because these devices often cannot afford to have multiple streaming-media players installed to view differently formatted video content from the Web.

The ISMA is actively developing MPEG-4 standards. MPEG-4 is an open-compression technology for

digital multimedia created by the Moving Picture Experts Group, which also forged MPEG-1 (interactive video on CD-ROM) and MPEG-2, the core compression technology underlying the transmission, storage, and display of digitized moving images and sound tracks. Featuring far greater compression than MPEG-2, MPEG-4 is the next logical step to bolster the quality of streaming video over the Internet.

The latest versions of all Cisco IP/TV products support MPEG-4, which is expected to become the accepted video coder-decoder (codec) standard in the same way that MP3 has become the dominant format for music on the Web. The format promises to send images using less data and network capacity, a scenario that will ultimately enable full-motion video over the Internet.

Although streaming video is mostly viewed on the Web today, open standards will pave the way for much more prolific use of streaming video across multiple devices, appliances, platforms, and computers. And as high-bandwidth access becomes more readily available around the world, one can assume that this rich communication medium will some day seem as commonplace as e-mail does today.

Additional Resources

For more information and updates on the various MPEG standards:

- The MPEG-4 Industry Forum site, http://www.m4if.org , which includes information for MPEG-4 patent holders
- The Third Generation Partnership Project, http://www.3gpp.org/, which is involved in the wireless area
- The home page of companies that promote MPEG-7, http://www.mpeg-industry.com/

For additional Cisco IT best practices, visit
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