Product Overview

This chapter provides a brief introduction to the Cisco TV Content Delivery System Release 2.0 for a Real Time Streaming Protocol (RTSP) environment. For information on an Interactive Services Architecture (ISA) environment, see the Cisco TV CDS 2.0 ISA Software Configuration Guide. See the “Related Documentation” section on page xiv for links to documentation online. This chapter covers the following major topics:

- Overview, page 1-1
- Content Delivery System Architecture, page 1-4

Overview

The Cisco TV Content Delivery System (CDS) is a distributed network of Content Delivery Engines (CDEs) running Content Delivery Applications (CDAs) that collaborate with each other to deliver personalized entertainment and interactive media to subscribers.

The Cisco TV CDS has a variety of mechanisms to accelerate the distribution and delivery of content. The CDS interoperates with electronic program guides (EPGs), set-top boxes (STBs), and backoffice applications, offering an end-to-end solution for video delivery systems.

The Cisco TV CDS functionality can be separated into four areas:

- Ingest
- Storage
- Streaming
- Management

Each CDE in the CDS contributes to one or more of these functions as determined by the CDAs running on it. Table 1-1 describes the relationship between the CDA names and the names the TV Content Delivery System Manager (CDSM) uses.

<table>
<thead>
<tr>
<th>CDA Name</th>
<th>Functionalities</th>
<th>CDSM Device Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vault</td>
<td>Ingest and storage</td>
<td>Vault</td>
</tr>
<tr>
<td>TV Streamer</td>
<td>Content caching, personalization, and streaming to STBs</td>
<td>Streamer</td>
</tr>
</tbody>
</table>
**Table 1-1  CDA Mapping to Functionality and CDSM (continued)**

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<th>CDA Name</th>
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<th>CDSM Device Name</th>
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<tr>
<td>TV MediaX Suite</td>
<td>Aids content ingest workflow and scheduling tasks for both asset-based and real-time content</td>
<td>CDSM</td>
</tr>
<tr>
<td>TV Content Delivery System Manager</td>
<td>Management</td>
<td>CDSM</td>
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</tbody>
</table>

Figure 1-1 illustrates how a TV CDS network can be deployed. A business management system (BMS), commonly called a backoffice, enables service providers to deploy on-demand services using VOD servers, networks, billing systems and other system components. The asset management system (AMS) manages the content on headend and node servers, while the BMS handles functions related to pitching and catching. Sometimes there is some overlap of functionality between the BMS and the AMS.

**Figure 1-1  High-Level System View of Content Delivery System**

The Cisco TV CDS solution has three major elements:

- A Vault array consisting of one or more Vault servers. The Vault array is responsible for ingest and reliable storage of video on demand (VOD) content. The number of Vault servers in the Vault array is driven by the amount of content that the system offers and the degree of redundancy.

- One or more Streamer arrays each consisting of one or more Streamer servers. The Streamer array is responsible for the personalization and streaming of content in response to user requests. The number of Streamer servers and Streamer arrays is determined by the number of streams deployed and by the topology that best suits your individual network and redundancy requirements.

- A CDSM server. The Content Delivery System Manager is used to manage the Vault and Streamer servers, collect event logs, and provide reporting tools.

*Note*  In smaller systems, the Integrated Streamer-Vault (ISV) server can be used, where the Vault and Streamer functionalities exist in one ISV server.
TV CDS Software

The Cisco TV CDS kernel software, known as the CServer, creates a logical network that pools, load balances, and coordinates the physical resources of the CDEs, so that the whole network operates and is managed as if it is a single resource.

The CServer facilitates the rapid movement of content between Vaults and Streamers while keeping required bandwidth to a minimum. To accomplish this, the Cisco TV CDS software uses a proprietary protocol, the Cache Control Protocol (CCP), across the Gigabit Ethernet networks. All content is held reliably on the Vault servers and a large amount, but not all, of the content is also contained on the Streamer servers. Cisco CCP, a multilayered caching architecture, along with associated software algorithms ensures that content segments are delivered only to the Streamers where there is demand for that content. The TV CDS software monitors the frequency of subscriber demand and places content appropriately in either the serving Streamer’s dynamic random access memory (DRAM) or disk cache.

Content is delivered across the network in response to cache-fill calls from the Streamers in an opportunistic manner, depending on the availability of bandwidth; delivery can be faster than real-time delivery where bandwidth allows. The TV CDS software that ensures content on the Streamer servers is always the most popular content; that is, the content requested by the largest number of subscribers. User requests are generally served from the Streamer’s cache. Requests for content that are not already in the Streamer’s local cache are pulled from the Vault, cached on the Streamer, and streamed to the subscriber. Wherever the content is stored relative to the point of playout, all content appears as if it is local to the Streamer and the streaming of any content is nearly instantaneous.

Each Streamer array runs a load distribution protocol among its members to ensure that new streams are distributed to the “best” Streamer in the array. The “best” Streamer is the Streamer that has the requested content in the highest-performing cache resource (DRAM or disk) or that has the most unused capacity. In this way, new Streamers are brought into operation hitlessly—because once a new server is in service, fresh streams are automatically allocated to it. Furthermore, the cache capacity of the array is the sum of the caches of all Streamers in the array, which provides the most optimal system operation and the highest cache-hit rate.

The CServer is responsible for the following:

- Storing content
- Streaming content
- Managing bandwidth usage for ingests
- Managing bandwidth usage for streaming
- Mirroring content among Vault servers
- Making decisions on content retention on Streamer servers

On top of the CServer, and taking advantage of the services it offers, a variety of applications deliver individual personalized entertainment services. Cisco currently offers the following applications:

- TV Streamer delivering VOD and network personal video recorder (nPVR) services
- TV MediaX Suite for simplifying ingest and workflow scheduling tasks for asset-based and real-time content

In a full TV CDS network, the Vault, TV Streamer, and CDSM are required. The TV MediaX Suite is an optional CDA. In a smaller TV CDS network, the ISV can be used in place of the Vault and TV Streamer.
TV Streamer CDA

The TV Streamer CDA is used for VOD delivery systems. TV Streamers are responsible for personalizing content and playing that content out under subscriber control.

TV MediaX Suite CDA

The TV MediaX Suite CDA offers a set of tools that simplify content ingest workflow and scheduling tasks for both asset-based and real-time content. The TV MediaX Suite CDA consists of the following features:

- Publisher—Coordinates the ingest of pre-encrypted content.
- Scheduler—Schedules real-time content or imports the schedule from an EPG.

Content Delivery System Architecture

Vaults and Streamers have different but important functions that are required for the TV CDS software to run efficiently. The Integrated Streamer-Vault (ISV) server combines the functionality of both the Vault and Streamer for smaller networks. The Content Delivery System Manager provides a browser-based user interface for configuration, monitoring, maintenance, and reports of the TV Content Delivery System solution. Figure 1-2 shows the different elements of the TV Content Delivery System.

![High-Level View of the Content Delivery System](image)

Table 1-2 describes the system elements shown in Figure 1-2.
Table 1-2  High-Level Description of the TV Content Delivery System

<table>
<thead>
<tr>
<th>Content Delivery System Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CServer</td>
<td>The CServer is the kernel software that handles bandwidth management, storage decisions, and Lightweight Stream Control (LSC) and stream processing on the TV Content Delivery System.</td>
</tr>
<tr>
<td>Database</td>
<td>The database stores information about the system including current states of all ingests and streams, configuration settings, and system statistics. Some database elements are global among all servers and some are local. For example, statistics are stored on the local server and the Content Delivery System Manager only. States about stream objects are replicated on all Streamer servers. The Content Delivery System Manager stores a superset of all database elements.</td>
</tr>
</tbody>
</table>
| Management                      | There are two types of management:  
  - Content Delivery System Manager—Browser-based user interface.  
  - SNMP agent—Network Management System (NMS) interface. |
| Storage                         | There are three levels of storage (or cache):  
  - All content is stored on the Vault server, as well as mirrored to other Vaults.  
  - Currently requested content, or popular content, is stored in the Streamer’s random access memory (RAM).  
  - Recently requested content, or popular content, is stored on the Streamer’s hard drive. |
| Event Collection                | The Content Delivery System Manager collects logged events for reporting purposes as well as third-party applications |
| Reports                         | The Content Delivery System Manager provides a reporting tool to aid performance trending and analysis of streams, popular content, bandwidth usage, and more. |

Vault

The Vault server ingests content delivered over a standard interface (for example, using FTP to receive content from a catcher), performs whatever processing is required (for example, generating trick-play files), and stores the processed content reliably on disk. A Vault array consists of a scalable number of Vault servers that divide the responsibility for ingest and storage among the members of the array. Vault servers can be collocated or distributed to multiple locations across an IP or Ethernet network. Each Vault server can simultaneously ingest up to 200 channels of MPEG-2 transport stream (TS) content and store up to 6000 hours of MPEG-2 TS standard definition content with two mirrored copies of the content and one to two trick files.

Streamer

A Streamer server receives content from the Vault and delivers that content to subscribers. Streamers can be of different capacity, depending on the needs of the network, and have different applications, depending on the type of content being delivered. Currently, the highest-capacity Streamer can
simultaneously stream approximately 2500 streams of MPEG-2 TS standard definition VOD. Streamers can be collocated with Vaults or distributed to remote locations. The Streamer array is responsible for the personalization and streaming of content in response to user requests. The Streamer can have one or more of the following applications:

- TV Streamer
- TV MediaX Suite

**Integrated Streamer-Vault**

The Integrated Streamer-Vault (ISV) server offers the functionality of both a Vault and Streamer in one server in either a 2U or 4U CDE.

The ISV server ingests content delivered over a standard interface, performs whatever processing is required, and stores the processed content reliably on disk. An ISV array consists of a scalable number of ISV servers that divide the responsibility for ingest, storage, and streaming among the members of the array.

**Content Delivery System Manager**

The Content Delivery System Manager (CDSM) is a browser-based user interface accessible by means of a web browser program and designed to manage a TV CDS network. The CDSM provides centralized management functions for the TV CDS, including configuration, monitoring, troubleshooting, reporting, and maintenance. The CDSM has three configuration and monitoring levels: system, array, and server. System-wide configuration affects all servers in the TV CDS. The array-level configuration affects all the servers of the specified array, and the server-level configuration applies changes to a specific server.

The CDSM offers a drill-down approach to find the status of any stream or ingest point, or the physical status of any piece of hardware.

The CDSM reporting helps operators manage all aspects of the TV CDS. Information on stream traffic, content statistics, and server data are gathered from all servers in the network and correlated automatically, showing at a glance the status of the network and reporting on statistics such as content popularity, stream usage, and bandwidth usage for each service group.

*Figure 1-3* shows the system monitoring page of the CDSM.
Resiliency and Redundancy

The TV Content Delivery System is designed with no single point of failure. The TV Content Delivery System incorporates redundancy at several levels within the architecture. These levels of redundancy eliminate any customer impact from potential failures of Vault disks, Vault servers, Streamer disks, Streamer servers, ISV servers, Ethernet connections, processors, and power supplies.

Each server constantly monitors the state of its peers. The TV CDS unique resource pooling and auto-failover techniques allow all servers in the network to actively contribute to satisfying storage and streaming demand at all times. If a server fails, the load is instantaneously redistributed among the surviving servers, ensuring continuity of service.

Vault Disk Redundancy

The Vault server protects content through full 1:N redundancy. If a disk fails, the data is available from a redundant server, spreading the load and optimizing the bandwidth. Additionally, the regeneration of the redundant content utilizes the bandwidth of the whole Vault array rather than just the disk bandwidth available inside a particular server, significantly reducing the rebuild window. The need to replace the failed drive is not time critical in the least, making quarterly replacement of any failed Vault drives feasible.

Mirroring

The primary method to protect the content against loss due to hardware failure is mirroring. Content is stored on a Vault and, based on the policy, it is mirrored to other locations in the Vault array. The number of mirrored copies is configurable. There are two types of mirroring:

- Remote mirroring
- Local mirroring
When remote mirroring is used, copies of the content are mirrored to drives on other Vaults, based on the number of Vault mirror copies configured.

When local mirroring is used, copies of the content are mirrored across all the available drives on the same Vault, so that the content can be recovered from another drive if one of the drives fails.

Local mirroring is not turned on by default, and is generally only used when there is a single Vault in a system.

### Vault Server Resiliency

The Cisco TV CDS can handle the loss of an entire Vault server without impacting the subscriber. The communication with the backoffice suite is performed by a Vault server, designated as the Vault master. If the Vault master fails, one of the remaining slave Vault servers in the Vault array transparently takes over as the master. The remaining Vaults detect the loss of a Vault server, run a check of all stored content, and regenerate redundant content that was affected by the lost Vault server. This regeneration runs in the background utilizing spare system bandwidth that is not consumed by subscriber load, resulting in the shortest possible regeneration window possible without compromising performance to the subscriber.

### Vault Master

The Vault master, designated by a virtual IP address on its management interface, is used as the representative of the Vault array to the backoffice and handles the ingest of new content.

### Streamer Disk Redundancy

The disks in the Streamer are not used for full content storage like most VOD implementations. Rather, the Streamer disks are part of the TV CDS multilevel caching architecture. If a disk is lost on a Streamer, the only impact is a marginal loss of caching capability for the system. Any content that was cached on that Streamer disk is retrieved again from the Vault. The RAM on the Streamer has enough content cached for streaming to the subscriber, so that this refetch of content from the Vault occurs without impacting the subscribers. For example, for a Streamer array of five Streamers with sixteen hard drives each, a lost drive only reduces the total caching capability by less than 1.25 percent. The need to replace the failed drive is not time critical in the least, making quarterly replacement of any failed Streamer drives feasible.

### Streamer Server Resiliency

The Cisco TV CDS architecture allows for failed Streamer servers as well. If any Streamer server fails, the communication to the backoffice is transparently handed off to another Streamer. With the TV CDS software, if a Streamer server fails the other Streamers recognize that failure and continue streaming to that subscriber.

### Ethernet Link Resiliency

All Ethernet links used within the Cisco TV CDS architecture incorporate link failure detection with automatic failover. This includes interconnection between the Vault array and the Streamer array for cache-fill, and the Ethernet links that carry the subscriber streams to the transport networks.
Scalability

The Cisco TV CDS has separated streaming and storage, which enables a cable operator to add storage without affecting streaming counts and conversely to add streaming without affecting storage. This flexibility allows cable operators to grow according to the needs of customers and to scale the system on an as-needed basis. For example, if more storage is required, the cable operator adds a Vault server without taking the system offline, and in Layer 2 networks the new device is automatically discovered within the architecture and the new resources are automatically utilized by the system. If additional streaming is required, the content provider either purchases more streaming licenses within the current servers, or a Streamer server is added to the system without taking the system offline.