Deploying Enterprise Content Delivery Networks
Session NCM-205

ECDN Motivation

- Scalable platform for managing, distributing, and serving high-quality streaming media over existing network infrastructure
- Enable use of “TV-quality” video in web presentations
Why Is This Interesting?

- Huge demand
  Multi-billion dollar market for video as a communications medium
- Increasing demand
  Driven by ease of web integration
- Current approaches insufficient

VHS Tapes + Overnight Shipping

- Expensive
- No integration with web content
- Increases complexity of content management
Centralized Streaming Servers

- Simplifies content management
- Integrates with web content
- Bandwidth bottleneck at streaming servers due to *serving* content

Centralized + Streaming Caches

- Integrates with web content
- Complicates content management
- Bandwidth bottleneck at streaming servers due to *distributing* content
Current Approaches

• Practical constraints imply low-bandwidth streams
  Small picture, high compression, low frame rate
• Content management story?

Agenda

• ECDN Technology
• ECDN Deployment
• Customer Examples
ECDN Technology

Motivation

• Serve high-bandwidth streaming media (high-quality video) over the existing network infrastructure
• High QoS/bandwidth requirements
Basic Idea

- High QoS/bandwidth easiest to provide at edge of network
- Pre-position content at edge, serve from there
- Single entry point for requests
  - Content URLs are client-independent
  - Clients automatically directed to nearby servers

Hard Problem # 1

- How to do content distribution?
  - Video files are very large
  - Naive distribution schemes can easily lead to severe network congestion
Hard Problem # 2

• How to do content routing?
  QoS/bandwidth requirements imply need for precise routing
  Need to interoperate with firewalls, NATs, proxies

System Elements

• CDM
  Admin interface
  Content routing
  Content distribution

• CR
  Content routing

• CE
  Content distribution
  Content delivery
System Concepts

• Content items
• Channels
  Distribution/subscription groups
• Network bandwidth
• Coverage zones

Basic Operation

1. HTTP Request
2. HTTP Redirect
3. HTTP Request
4. CE-Served Content
How It All Works

- Tree building
- Metadata replication
- Content replication/distribution
- Content routing
- Content delivery

Tree Building

- TBP: **Tree-Building Protocol**
  Implemented on top of HTTP/1.x
  Used to self-organize CE’s into routing hierarchies
Routing Hierarchies

- Logical trees with CDM as root, CE’s as nodes and leaves
- Used for metadata and content replication

Routing Hierarchy Example

- Routing hierarchy topology respects network topology
- Keep tree edges as “short” as possible
- Avoid having numerous tree edges cross any given network link
TBP Overview

• Build routing hierarchies through periodic “reregistration” process
  - CE’s disconnect from tree
  - Navigate tree, find new place to connect
  - Reconnect themselves to tree

• Routing hierarchies adapt to changing network conditions

TBP Navigation Details I

• Start with current = root
• Send registration request to current
  - Response contains list of current’s immediate descendants
• Probe current + children
  - Determine which is “closest”
TBP Navigation Details II

- If current is closest, become child of current and terminate
- If a child of current is closest, set current = child and start over

TBP Navigation Example

Register with CDM
Probe CDM and Children
CE#1 Is Closest
Register with CE#1
Probe CE#1 and Children
CE#1 Is Closest
Become Child of CE#1
TBP Navigation Details III

- Probes are 1 kbyte HTTP round-trips
  - Rate is throttled
  - Measured values are cached
  - Round-trip times affected by replication bandwidth at target box

Multiple Routing Hierarchies

- Each CDM/CE belongs to multiple routing hierarchies
  - One for each subscribed channel
  - One for administration/configuration
- TBP builds separate trees for each
Disabling Tree Building

• TBP enabled by default (recommended setting)

• Automatic tree building can be disabled on a per-device basis
  - Devices become immediate descendants of CDM in routing hierarchies
  - Devices don’t participate in full TBP

• Appropriate for large “star topology” networks

Metadata Replication

• MRP: Metadata Replication Protocol
  - Implemented on top of HTTP/1.x

• Manages distributed database of metadata and configuration information
  - Content, channels, policies, etc.

• Periodic incremental updates between child and parent in routing hierarchy
Content Replication

- Two mechanisms
  - Hierarchical unicast, IP multicast
- Replication method selected on a per-channel basis
  - Eventual fallback to hierarchical unicast
- Bandwidth usage scheduled via CDM user interface

Hierarchical Unicast

- CRP: Content Replication Protocol
  - Implemented on top of HTTP/1.x
  - Use routing hierarchy for efficient content distribution
  - CE’s replicate content from immediate parent in routing hierarchy
IP Multicast

- Digital Fountain (DF) protocols
  - External DF server associated with CDM
  - DF client integrated onto CE's

Coverage Zones I

- Sets of IP addresses
- Content routing based on coverage zones
- Two coverage zones per CE
  - Preferred: addresses for which CE is known to be a good choice for providing service
  - Regular: addresses to which CE is willing to provide service, but does not know if it is the best CE for doing so
Coverage Zones II

- Default to local network
  Based on CE’s IP address and netmask
- Can override defaults via CDM user interface

Content Routing I

- TBP registration requests include coverage zone and liveness information from requesting CE
- CDM builds table of CE’s and their coverage zones
- Stale table entries are timed out
Content Routing II

• Content routing process
  Obtain IP address of requesting client
  Consult CE table to find matching coverage zone
  Generate HTTP redirect to said CE

NAT/Proxy Complications

• Content routing based on IP address of requesting client
• True IP address not available if request came through NAT/proxy
NAT/Proxy Example I

CDM Outside Firewall
Multiple Ce’s Inside Firewall
Which CE to Route Request to?

NAT/Proxy Solution

- Recognize NAT/proxy cases
- Designate primary CE for each
  All other CE’s inside NAT/proxy must be descendants of primary
- Redirect to primary
  Primary does add’l routing as necessary
NAT/Proxy Example II

1. CDM Redirects to Primary
2. Primary Redirects to CE

Content Router I

- Can route requests for content
- Situated with CDM “behind” content switch
- Up to three CR’s
Content Router II

• **Fault-tolerance**
  
  CR’s can route requests even if CDM is off-line

• **Scalability**
  
  Increased content routing throughput

Content Router III

• **Redundant routing hierarchies**
  
  One per channel per CR, rooted at CR
  
  Run TBP independently for each

• **CR handles content routing like CDM**
  
  CE + coverage zone table, etc.
Content Delivery: Network

- HTTP, Real, WMT
  Selected via URL options

Content Delivery: Video Out

- CE “AV” model includes NTSC/PAL video decoder
- Playback scheduled via CDM user interface
  Playlists, looping, random playback
ECDN Deployment

- Planning
- Installation
- Operations
Select CDM Model

- CDM-4630 (1 RU)
  1x 600 MHz CPU, 256 MB memory, 30 GB disk
- CDM-4650 (7 RU)
  2x 866 MHz CPU, 1 GB memory, 144 GB disk
  Redundant power, etc.
- Select based on amount of content, number of CE’s

What about CR’s?

- Fault tolerance at CDM
- Increased redirection throughput
- Requires use of content switch
  Cisco CSS-11k
CDM/CR Placement

- CDM and CR’s co-located behind content switch
- Good network connectivity
  - Handle requests for content
  - Source for content replication
  - Access to CDM user interface

CE Planning

- Capacity plan for expected users
  - Approx 2-3 dozen concurrent high-quality streams per CE
- Place CE’s close to expected users
  - Avoid serving content over critical or low-bandwidth network links
  - Placement may influence coverage zone settings
ECDN Installation

1. Install CDM
2. Install CR’s and content switch
   Add’l CR’s can be added later
3. Install CE’s
   Add’l CE’s can be added later

CDN Wizard I

• Windows application
• Provides bootstrap configuration information to ECDN devices
  Network settings, etc.
• Must be run on same network segment as device to be configured
CDN Wizard II

- Run CDN wizard, click ‘next’

CDN Wizard III

- Displays list of ECDN devices on local network segment
CDN Wizard IV

- Select desired device in list
  - Displayed by MAC address until device name has been provided
- Click ‘details’ to query settings
- Click ‘next’ to configure

CDM Installation I

- Physical installation
  - Location, power, network
  - Console if desired (but not necessary)
- Power up CDM
- Wait a few minutes
CDM Installation II

- Use CDN wizard to configure CDM
  Follow CDN wizard user interface
  Enter device name, network settings (static IP or DHCP), DNS servers, etc.
- Check settings, click on ‘finish’

CDM Installation III

- Monitor progress via CDN wizard
- Wait for ‘servers started successfully’
CDM Installation IV

- Factory default: CDM will obtain network settings via DHCP if available
- Be careful…

CDM Installation V

- CDM needs fixed IP address
  So client requests and other ECDN devices can locate CDM
- Use static IP or permanent DHCP lease
- Don’t use floating DHCP lease
CDM User Interface I

- Web-based interface
  http://<IP-or-FQDN-of-CDM>/
- Log in as ‘admin’, password ‘default’
  Don’t forget to change password

CDM User Interface II
Content Switch Installation I

• Physical installation
  Location, power, network

• Configure per user docs
  CDM and CR’s directly addressable
  Virtual IP address
  Load-balance connections to port 80 across CDM and CR’s

Content Switch Installation II

• Client requests go to virtual IP address
  Enter virtual IP address (or FQDN) into CDM user interface
  Causes media previewer URL’s to use virtual IP address (or FQDN)
CR Installation I

- Physical installation
  Location, power, network
  Console if desired (but not necessary)
- Power up CR
- Wait a few minutes

CR Installation II

- Use CDN wizard to configure CR
  Follow CDN wizard user interface, as with CDM
  Also need to enter FQDN or IP address of associated CDM
- Check settings, click on ‘finish’
CR Installation III

• CR needs fixed IP address
  So content switch and other ECDN devices can locate CR

• Use static IP or permanent DHCP lease

• Don’t use floating DHCP lease

CR Installation IV

• Monitor progress via CDN wizard

• Wait until CR enters ‘waiting for approval from CDM’ state
CR Installation V

- CDM must ‘approve’ CR before installation can proceed
- Go to CDM user interface, click on ‘device console’
- Device waiting for approval marked with a yellow warning triangle
CR Installation VII

- Click ‘edit’ for the device waiting for approval
- Brings up the ‘identification’ page for that device
- Click ‘approve’ checkbox
- Click ‘save changes’
CR Installation IX

- Back to CDN wizard, monitor progress
- Wait for ‘servers started successfully’

CR Installation X

- Confirm CR status in CDM user interface
  - Wait a few minutes
  - Go to CDM user interface, click on ‘device console’
  - New CR should be marked with a green light in the ‘online’ column
CE Installation I

- Physical installation
  Location, power, network
  Console if desired (but not necessary)
- Power up CE
- Wait a few minutes

CE Installation II

- CE does not need fixed IP address
- Same installation process as for CR
  Use CDN wizard to configure CE
  ‘Approve’ new CE in CDM user interface
  Monitor progress with CDN wizard
  Confirm status in CDM user interface
CE Installation III

• CDN wizard must run on same network segment as CE being installed

Import Content

• New content items get ‘imported’ into CDM
  Via ftp, drag-and-drop, or HTTP
  Edit content properties using media editor
Media Previewer

- Click on ‘previewer’ in CDM user interface
  Provides hyperlinks for previewing content
  URL’s can be cut-and-pasted into other web content that references content hosted by ECDN

Customer Examples
Customer Examples I

- Intel
  Engineering training
- Cookson electronics
  Partner training
- AmEx financial services
  VOD streaming in branch offices

Customer Examples II

- Hard Rock Café
  Video displays in restaurants
- St Georges Bank (Australia)
  Point of service advertising
  Branch office training
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