Recommendations and Practices for Content Caching

HCS TECHNOLOGY GROUP

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Contents

Preface

The purpose of this document is to supply guidance and solutions around content caching to improve the user experience. This includes coaching and mentoring the technical staff on core concepts, configuration, content cache deployment options, and verification and troubleshooting steps.

What is Content Caching?
Content caching speeds up the downloading of software distributed by Apple and of data in users' iCloud accounts by caching content that local Mac computers, iOS and iPadOS devices, and tvOS devices have already downloaded. When you turn on content caching on your Mac, content caching stores local copies of items so downloads are faster for connected clients.

Content types supported by the content caching service*:

macOS

- macOS updates and Internet Recovery images (macOS 10.13.5 or later)
- System firmware and recovery updates
- macOS installers downloaded from the App Store or softwareupdate --fetch-full installer
- Apps and app updates from the Mac App Store
- GarageBand downloadable content
- iCloud data caching (photos and documents)
- Apple Books content
- Xcode downloadable components such as simulators (Xcode 10.2 or later)
- Rosetta
- Aerial screen savers and wallpaper
- Apple intelligence models

iOS, 7 and later, iPadOS, tvOS, visionOS, and Apple TV

- iOS and iPadOSOS updates (over the air)
- Apple TV updates (over the air) Aerial screen savers on Apple TV
- Apple TV screensavers (tvOS 12.2 or later)
- iOS and iPadOS apps, Apple TV apps, and app updates.
- On-demand resources support for iOS 10 and later, iPadOS, and tvOS 10 and later.
- iCloud data caching (photos and documents) for iOS 9 and later and iPadOS
- iTunes U course materials from the iOS App Store and Apple Books, as well as uploaded instructor materials such as audio, video, iWork, and iBooks Author files
- Apple Books content
- Certain mobile assets, such as Siri high quality voices, language dictionaries, and more
- Schoolwork content, including file attachments and multimedia files added to assignments
- Apple intelligence models

watchOS

- watchOS apps and app updates
- iCloud data caching

* This list is subject to change. The following Apple support article always contains the most up-to-date list:
https://support.apple.com/en-us/102860

Hardware Recommendations

- Mac computer with Apple Silicon and a solid-state drive (SSD)
- Gigabit Ethernet (10Gb Ethernet strongly recommended if capable) For more information go to: https://support.apple.com/en-us/HT208405
- 16 GB RAM or more
- Adequate storage for cache type (Shared Content vs iCloud Content)
- SSD strongly recommended

How does content caching work?
After you turn on content caching on a Mac, it keeps a copy of all supported content that local networked devices (called clients) download devices (called clients) on the local network can download.

For example, when the first client on your network downloads an App Store app, the content cache keeps a copy of the app. When the next client on the network connects to the App Store to download the app, the client downloads the app from the content cache rather than from the App Store.

Because your clients' connection to the local network is normally much faster than the connection to the internet, the second client (and all subsequent clients) download apps much faster. You also preserve internet bandwidth.

Service Registration & Discovery
When you first turn on the content caching service on your Mac, and every 55 minutes after that, the content cache service sends a registration request to Apple at icdn-registration.apple.com. The registration request includes the content caching service public IP address, private IP address, and the subnet ranges that it is open to serving. Note that TCP ports 80 and 443 need to be opened on your network firewall and/or filter for registration to succeed.

After the content cache has successfully registered, when a client requests a cacheable asset, the client sends a request to Apple for the asset. The request includes the client's public IP address and private IP address. If Apple finds a match for a content caching service that's registered at the same public IP address, Apple returns a list of potentially available content caches to that client. The client then sends a request for an asset directly to the content cache. If there's no reply from a local content cache, the client automatically downloads the asset directly from Apple.

Best Practices
- Allow all Apple push notifications
- Don't use manual proxy settings
- Don't proxy client requests to content caches
- Bypass proxy authentication for content caches
- Specify a TCP port for caching
- Manage inter-site caching traffic
- Block rogue cache registration

Section 1: Prepare for Content Caching

Content caching is primarily affected by two main factors: connectivity and hardware configurations. In order to get the best performance out of your content caching setup, Apple recommends that you take precise steps and gather the appropriate information.

Collect Network Information:

- A list of WAN IP(s) for initial caching service sites.
- A list of LAN IP ranges we will configure each content caching Mac.
- A list of internal static IP(s) and DNS/router information for initial caching Mac computers.
  - If a network topology diagram or visual overview is available, it should be collected.
- Confirmation from your network administrator that the identified caching service IP hosts will be exempt from SSL inspection or proxy rules for caching.
  - This includes network sercurity agents or other tools that might interfere with caching per resources below:
- Identify the process/contact person to get a DNS record published/updated in your external DNS when using multiple WAN IP(s) at any one site/internet route.
  - Confirm if you use BIND or Windows DNS TXT record format.

Test the environment:

- Possess in-hand at least one (1) test iOS or iPadOS and one (1) Mac computer.
  - Use Mac Evaluation Utility (MEU) on a content cache and inspect the report.
    - ◊ MEU is available through the AppleSeed for IT program in the resources below. You will need a Managed Apple Account to log in.
- Run the following command using the terminal on the content cache and inspect the output
  - `dig txt _applcache._tcp.yourdomain.com`
    - ◊ Replace yourdomain.com with your domain and verify all WAN IP(s) for each location are returned.
- Run the following terminal command on any Mac client on your internal network and inspect the output:
  - `AssetCacheLocatorUtil`
- If enrolled in your MDM already, verify someone will be available to adjust/change/remove settings or policies in the MDM for the content cache.

Best Practices

- Allow all Apple push notifications.
- Don't use manual proxy settings.
- Don't use a proxy to accept client requests and pass them to content caches.
- Bypass proxy authentication for content caches.
- Specify a TCP port for caching.
- Manage intersite caching traffic.
- Block rogue cache registration by enforcing the MDM restriction "Prevent content caching" on all Mac computers.

Additional Information for Review:

- Apple Mac Evaluation Utility via AppleSeed for IT - Resources
  https://beta.apple.com/for-it

- Use Apple products on enterprise networks
  https://support.apple.com/en-us/101555

- Intro and planning for setup of content caching
  - https://support.apple.com/guide/deployment/intro-to-content-caching-depde72e125f/web
  - https://support.apple.com/guide/deployment/set-up-content-caching-depe9b5c1aab/web
  - https://support.apple.com/guide/mac-help/set-up-content-caching-on-mac-mchl3b6c3720/mac
  - https://support.apple.com/guide/deployment/advanced-content-caching-settings-depc8f669b20/web
  - https://support.apple.com/guide/deployment/use-dns-txt-records-depe6ded0780/web

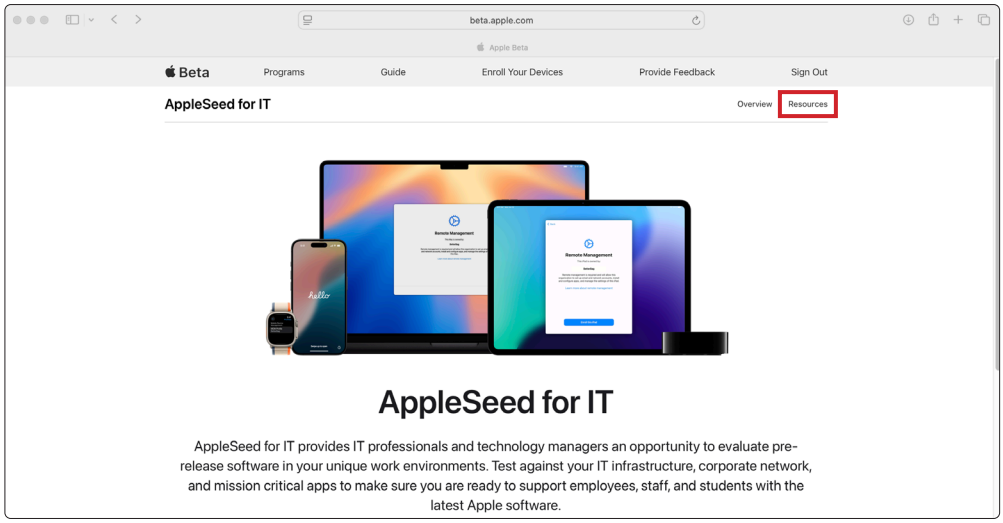
- Content types supported by content caching in macOS, iOS, iPadOS, tvOS, and visionOS
  https://support.apple.com/en-us/102860

- Apple Training - Content Caching
  https://it-training.apple.com/tutorials/deployment/dm070

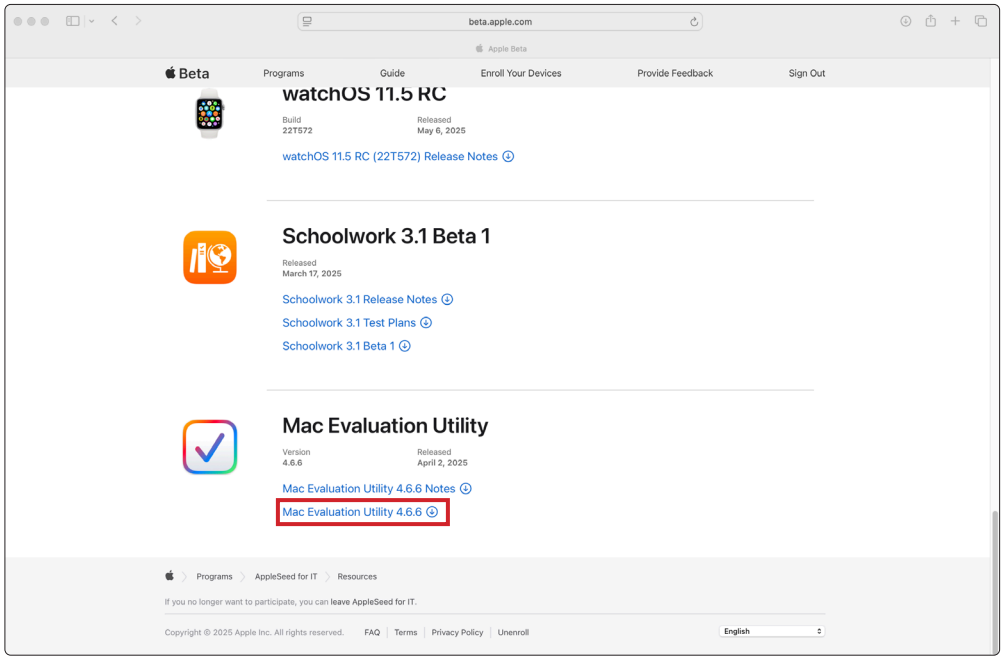
Section 2: Mac Evaluation Utility

Apple recommends using Mac Evaluation Utility (MEU) before setting up the content caching service. MEU will evaluate the Mac and its network infrastructure to ensure that content caching has access to necessary Apple services for proper functionality. You obtain MEU from AppleSeed for IT.

1. Open a web browser, and navigate to https://beta.apple.com/for-it
2. In the upper right corner, click sign-in, then sign in with a Managed Apple Account. By default, all roles in Apple Business Manager and Apple School Manager are allowed to participate in AppleSeed for IT.
3. Once signed in, click Resources.

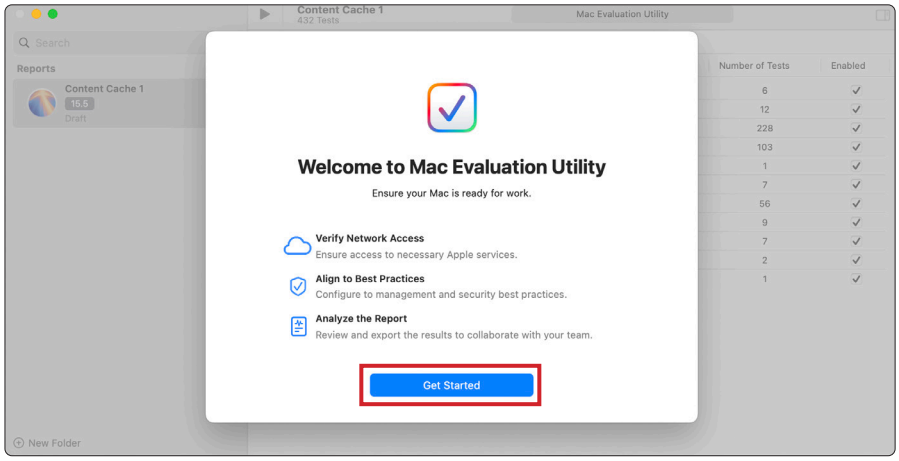


4. Scroll down to download Mac Evaluation Utility. Click Download (ⓘ).

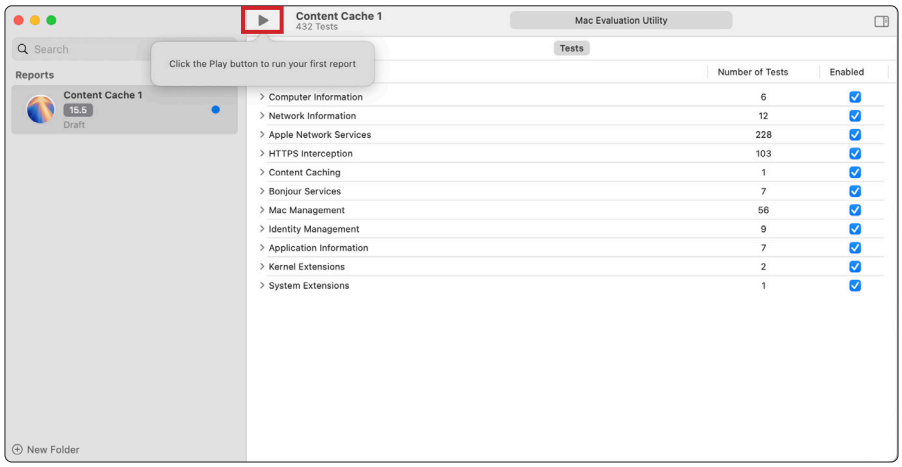


5. Once you have downloaded MEU, open the installer package, then open Mac Evaluation Utility from the Applications folder.

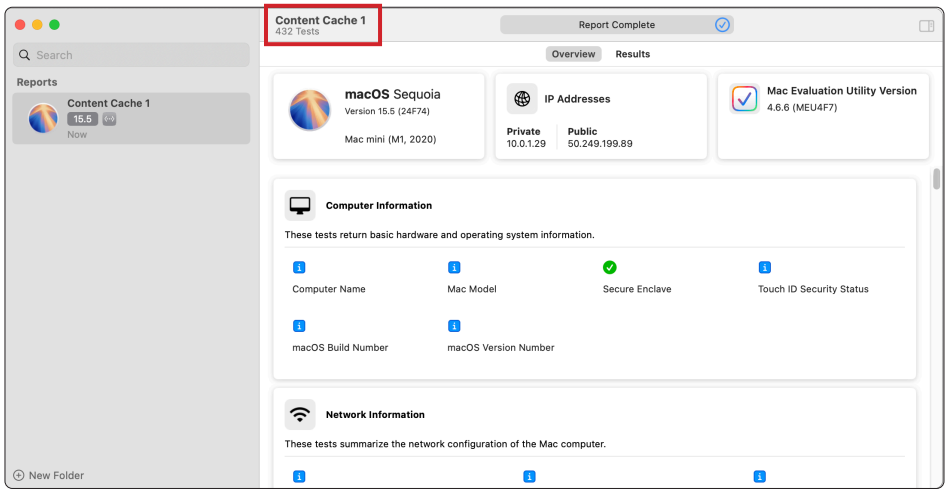
6. MEU will open and describe its functionality. Click Get Started.



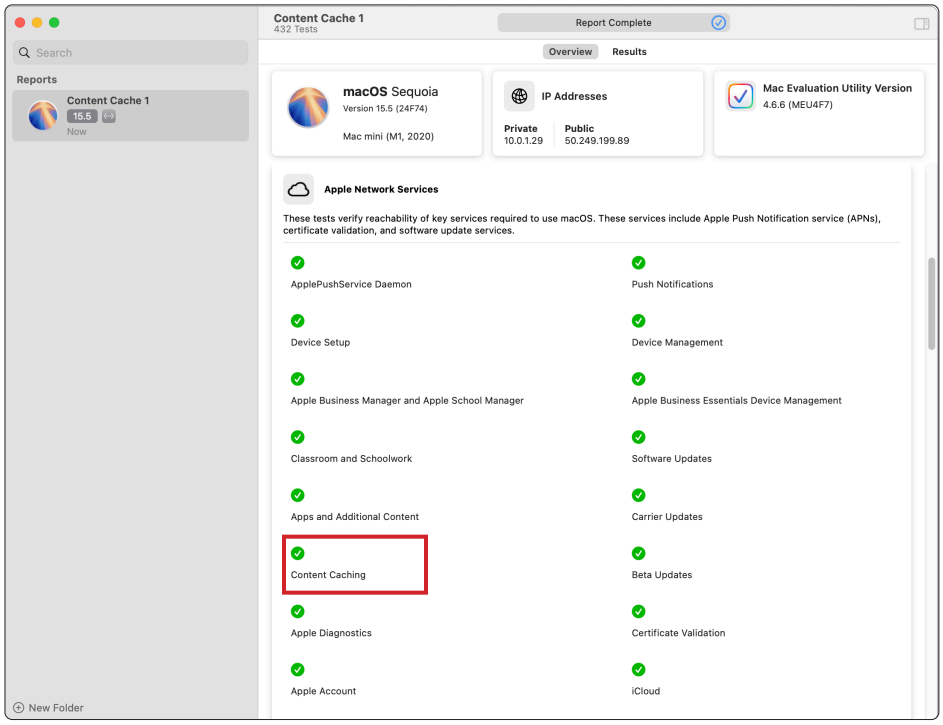
7. Leave the defaults selected. Click Play (▶) to run your first report.



8. Once the report is complete, you will see information on the 432 tests that have run.

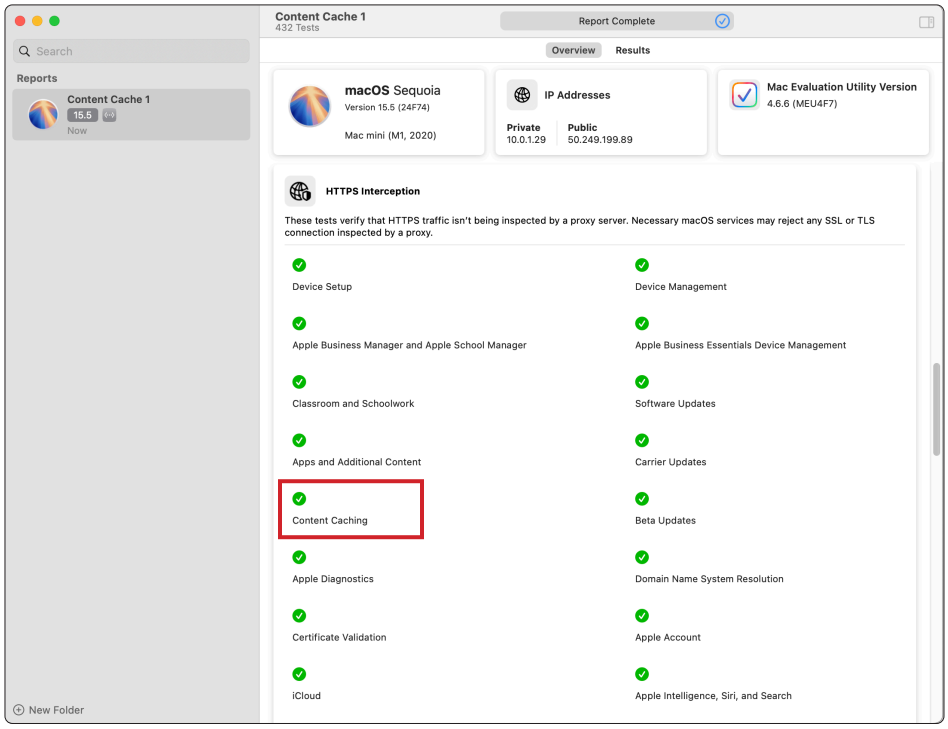


9. Scroll down in the report to Apple Network Services, then verify that Content Caching has a green checkmark (✓) next to it, indicating that access to Apple Network Services is functional.



NOTE: Although the Content Caching shows up in the MEU report with a green check, It's important to know that Cloud proxy agents like Zscaler, Cisco Umbrella, and GlobalProtect often relay traffic through shared WAN IPs, masking the actual source. For Apple content caching to work, cache lookup requests must come from the true WAN IP the cache is registered to. These requests should be exempt from proxy routing, and proxy agents should never be installed on the caching Mac.

10. Scroll down further to HTTPS Interception, then verify that Content Caching has a green checkmark (✅) next to it, which indicates that HTTPS traffic isn't being inspected by a proxy server.



11. You may export the report by choosing File > Export Report.

Section 3: Content Caching Configuration - Configuration for Simple Networks

In the context of content caching, a simple network can be defined as a network that uses a single WAN IP address. Peers can be used in a simple network without additional configuration.

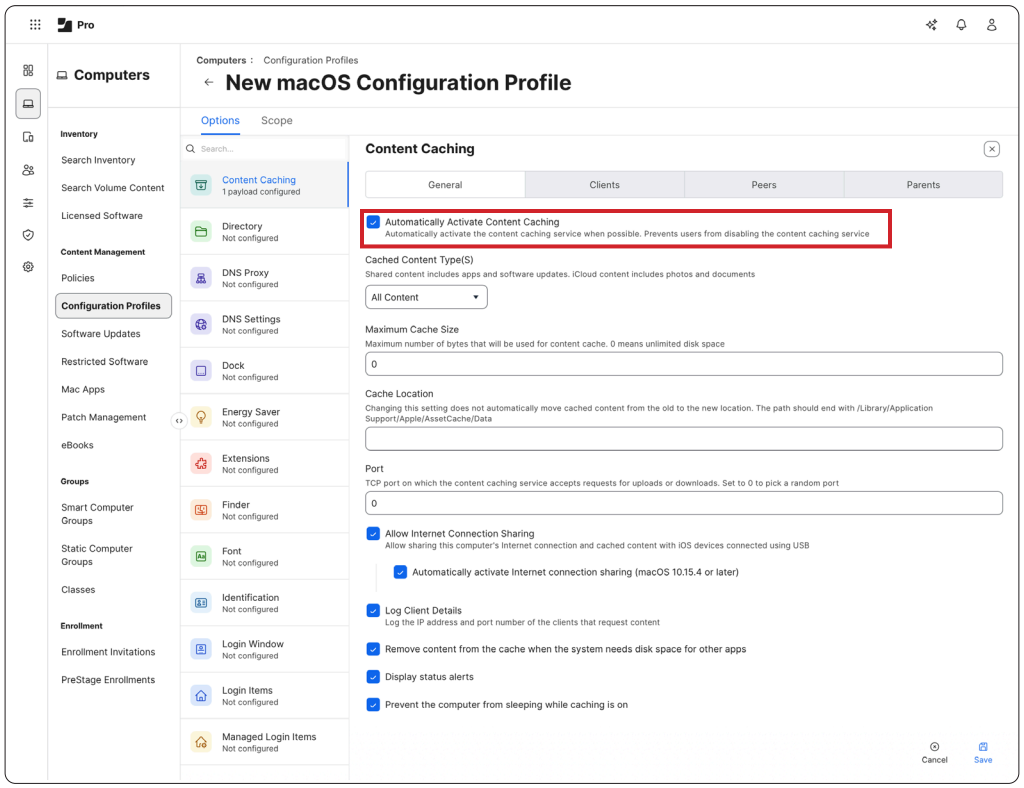
You can manually configure content caching by accessing the Content Caching settings found under System Settings > General > Sharing on macOS. However, a mobile device management (MDM) solution gives you the ability to use configuration profiles to configure and maintain content caching. In addition, there are settings that are not configurable in the user interface (UI) of Content Caching settings, such as the cache location and TCP port. Configuration Profiles allow you to be more efficient in configuring content caches, and to scale your solution. This guide uses Jamf Pro as a reference MDM solution.

General Settings for content caching

In a MDM that supports content caching, you create a configuration profile. In this section you learn about the configurable settings in the General tab of the Content Caching payload.

1. **Automatically Activate Content Caching** - This option both starts the content caching service and removes the ability to disable the service in Sharing preferencessettings on the computer running the content caching service. It's recommended that you select this option.

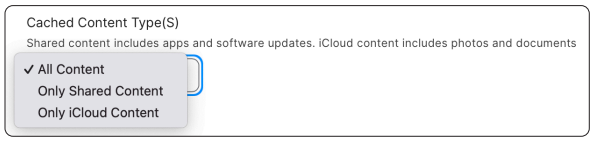
   NOTE: Restart client devices ensures they immediately detect the content cache. Otherwise, it may take some time for them to recognize the presence of a local cache.



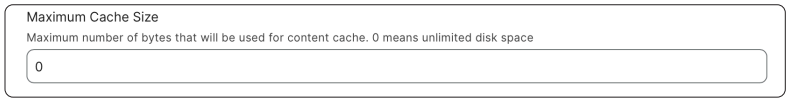
2. **Cached Content Type(s)** - This setting impacts your storage needs on the Mac providing content caching.

   - All Content - Store software updates and apps downloaded from Apple, and iCloud content on this Mac.
   - Only Shared Content - Store only software updates and apps downloaded from Apple on this Mac; do not store iCloud content.
   - Only iCloud Content - Store only iCloud content, such as photos and documents, on this Mac; do not store software updates and apps

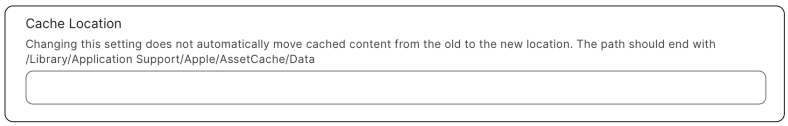
   NOTE: The All Content and the Only iCloud Content options will likely require significantly more storage space, depending on how many users with iCloud data are on your network, as it will store each user's iCloud data. All iCloud data is stored encrypted.



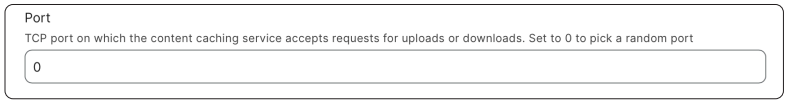
3. **Maximum Cache Size** - Maximum number (in bytes) that will be used to store content caching data. Setting to zero (**0**) means unlimited disk space.



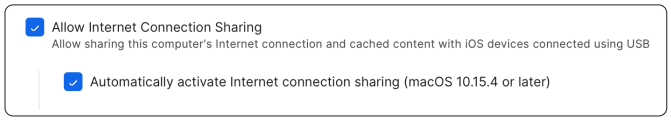
4. **Cache Location** - By default, content cache data is stored in /Library/Application Support/Apple/AssetCache/Data. If you use external storage, use this field to enter the absolute path to that location.



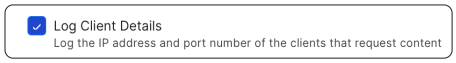
5. **Port** - This is a TCP port that is used for content caching requests. By default, this value is set to zero (**0**), which results in the service automatically selecting a random port. It is recommended to set a specific port.



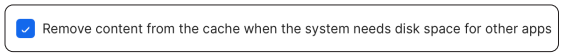
6. **Allow Internet Connection Sharing/Automatically Activate Internet Connection Sharing (macOS 10.15.4 or later)** - These options allow you to share the internet connection of your Mac with iOS and iPadOS devices connected over USB, even if their Wi-Fi and cellular connections are disabled. This can be particularly useful for iOS and iPadOS devices to enroll in MDM, "side-load" apps, and receive configuration profiles like corporate Wi-Fi, without the need for a provisioning network. You can also take advantage of hardware, like sync carts, to make the onboarding process faster for your mobile devices.



7. **Log Client Details** - Log the IP address and port number of the clients that request content. You can use the logged information for troubleshooting, for example, to verify that client devices are receiving content from the expected content caching Mac computer.

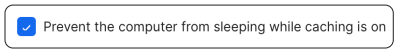


8. **Remove content from the cache when the system needs disk space for other apps** - For content caching to be most effective, turn this setting off so cache data is not deleted unnecessarily.



9. **Display Status Alerts** - Turn this setting on for user interface alerts related to the content caching service. The user of the Mac that's running the content caching service will receive notifications if the user is logged in.

10. **Prevent the computer from sleeping when caching is on** - The Mac that's running the content caching service should not go to sleep. Select this checkbox to keep the computer awake. Alternatively, you can manually adjust Energy Saver settings. If you are using this computer as a content cache only, it's recommended to configure this setting in the your configuration profile payload.

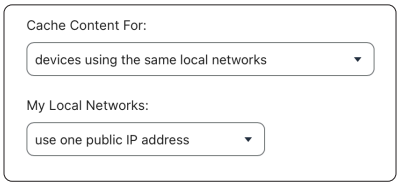


Section 4: Content Caching Configuration - Configuration for Advanced Networks

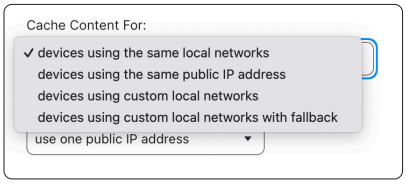
When you configure content caching beyond the basic settings, or when your outbound traffic spans more than one public IP address, you need to configure additional settings to ensure that the content cache is configured correctly. You also have the ability to tune your content cache depending on the topology of your network. When you configure advanced settings and multiple content caches with MDM, prepare to use a unique configuration payload for each content cache.

Clients
Use the Clients pane in content caching advanced options to specify the devices that can access the content cache.

1. There are two menus to configure: Cache Content For and My Local Networks.

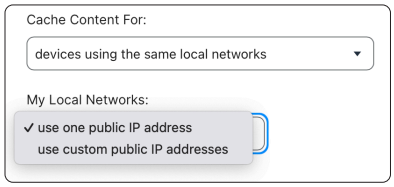


2. The first menu is Cache Content For:.



- **devices using the same local networks** - This computer caches content for devices that use the same network segment as this computer.
- **devices using the same public IP address** - This computer caches content for devices that use the same public IP address as this computer.
- **devices using the same local networks** - This computer caches content for devices that use the same network segment as this computer.
- **devices using custom local networks** - This computer caches content for devices that use the specified network segment(s) Listen Ranges (specified network segment(s)) as this computer.
- **devices using custom local networks with fallback** - This computer caches content for devices that use Listen Ranges (the specified network segment(s)), and for devices that use the same public IP address as this computer when their preferred content cache is unavailable. This combines the first second and third options in this MDM.

3. If you configure the Cache Content For menu, also configure the **My Local Networks** menu. Contact your network administrator if you are unsure of the configuration that is necessary. Matching your network topology is critical for clients to be able to access your content cache.

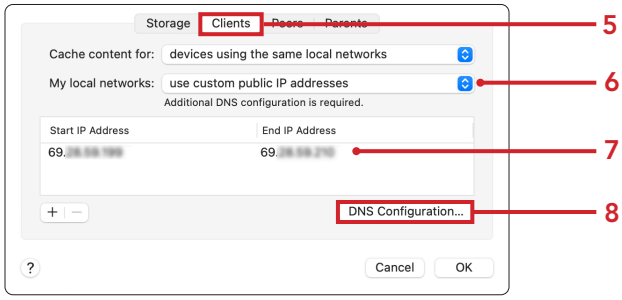


- **use one public IP address** - Select this option when your devices and your content cache share one public IP address.
- **use custom public IP addresse**s - Select this option to use a specific public IP address, or if you use multiple public IP addresses. Note: If you select this option, additional DNS configuration is required. Enter the multiple WAN IP addresses or range of IP addresses.

If your network uses multiple public IP addresses to connect to the internet, the content cache might register using a different address than a client uses for discovery. In this case, you need to provide both the content cache and the clients with a list of those addresses. These lists are used to cross- match registration and discovery requests involving multiple public IP addresses.

4. You can easily obtain the TXT record or command to add to your DNS by navigating to System Settings > General > Sharing > Content Caching on a Mac computer. Click info (ⓘ).

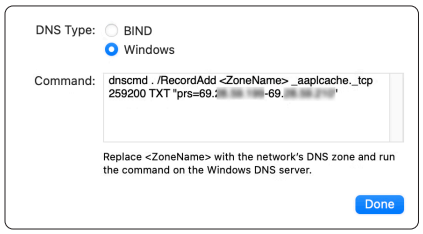
5. Hold down the option key, select Advanced Options, then select Clients.
6. Choose use custom public IP addresses
7. Configure the range
8. Choose DNS Configuration.



DNS Configuration - This button is available when you specify custom public IP addresses. After you click this button, select BIND or Windows, depending on the type of your DNS Server, and use the information that's displayed to create a TXT record on that server. You may need to send the information to another administrator with the ability to create the DNS record.

9. The record is a comma separated range of IP addresses. It can be a single IP address or a range of addresses in CIDR notation.

   The client searches for this known DNS TXT Record prior to making a request to Apple. The contents of this record are then forwarded by the client to Apple. Apple is made aware that these multiple addresses are actually from the same network, allowing a match to take place and to return the appropriate list of available content cache(s).



   For more information on DNS TXT records, go to:

   https://support.apple.com/guide/deployment/use-dns-txt-records-depe6ded0780/web

Peers

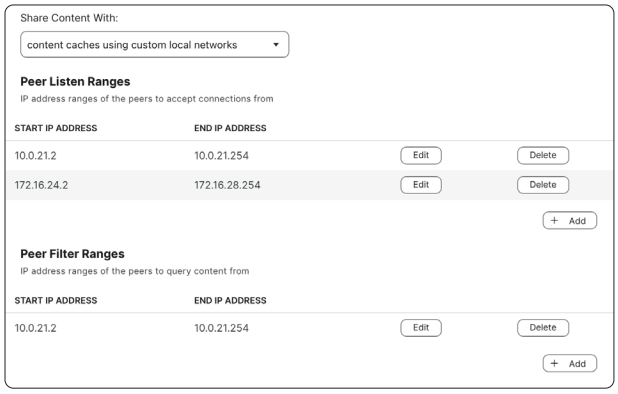
Peers are other content caches on the same network that share content with each other. A benefit to peering is to reduce bandwidth and strain on the network. In a simple network with a single subnet, content caching peers can automatically discover each other after registering the service with Apple. This is similar to the client discovery process. With advanced or complex networks, it may be necessary to adjust advanced settings so peers do not attempt to communicate across multiple subnets or different buildings.

There are three possible settings for configuring content caching peers:

- content caches using the same local networks (default) - Peering will occur with other content caches on the same local network.
- content caches using the same public IP address - If other content caches have the same public IP, they will act as peers.
- content caches using custom local networks - Selecting this option allows manual entry of network ranges for two types of communication:

  - "Peer Listen Ranges" This is a range to accept incoming connections from peers that request cached content.

  "- "Peer Filter Ranges" This is a range of content caches to request cached content from.



Parents
Use Parents to arrange your content caches in a hierarchy. When you add the IP address of other content caches here, they will be parents to the content cache that receives this configuration profile. Parent content caches download any requests from Apple, and serve them to children content caches, saving bandwidth and potentially allowing children content caches to serve more clients.

It might be appropriate to configure a parent to serve only child content caches (instead of serving macOS, iOS, iPadOS, and tvOS clients). If you define more than one parent, select the appropriate Parent policy.

- Round robin - Rotate through the parents in order. This is also useful for load balancing.
- First available - Always use the first parent in the list that is available. This is useful for designating permanent primary, secondary, and subsequent parents.
- Random - Choose a parent at random. This is useful for load balancing.
- Sticky available - Always uses the first parent in the list exclusively, and continues to use that parent until it becomes unavailable. When it becomes unavailable, move to the next parent. This is useful for designating floating primary, secondary, and subsequent parents.
- Hash - Hash the path part of the requested URL so that the same parent is always used for the same URL. This is useful for maximizing the size of the combined caches of the parents.

Configuration plist keys and values
On Mac, the content caching plist is located at /Library/Preferences/com.apple.AssetCache.plist. You modify this file using the defaults command, or by using the Custom Settings payload in MDM.

Refer to "Configure advanced content caching settings on MacAdvanced content caching settings on Mac," in the macOS User Apple Platform Deployment Guide for a list of the keys and values that can be set on a content cache.

https://support.apple.com/guide/deployment/advanced-content-caching-settings-depc8f669b20/web

Section 5: Verification & Troubleshooting

Overview
It is critical to verify that each Mac that provides content caching is providing the service as expected. This includes caching content, either from Apple, a peer, or a parent, and sending that content to clients consistently.

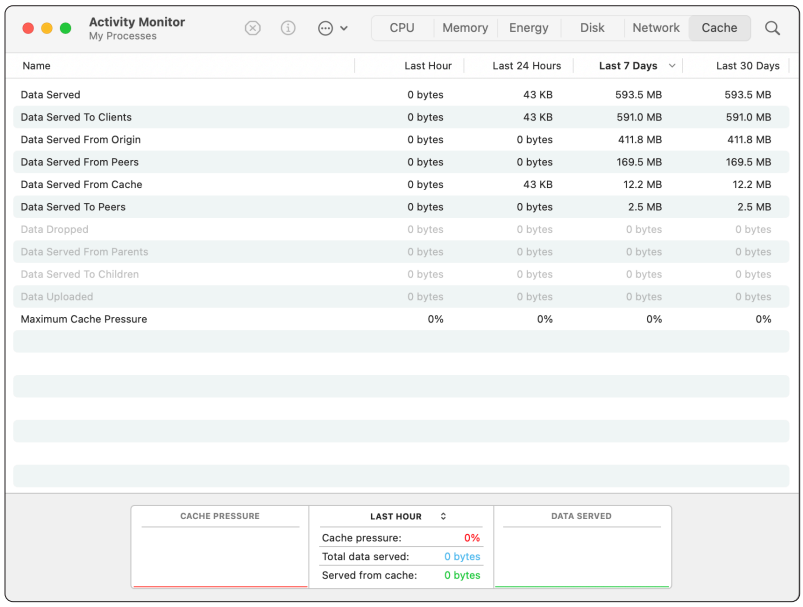
Logging & Metrics
Use the following tools to analyze logging and metrics related to content caching.

Activity Monitor
On the content cache, you use Activity Monitor to view data served for up to 30 days. Depending on how many other peers and parents exist, additional information may be displayed.

One value that is often overlooked is Cache pressure. If this value rises above 50%, it is likely that the cache needs more storage space. Either a larger volume or additional content caches should be considered. For more details, refer to "View cache activity in Activity Monitor on Mac," in the Activity Monitor User Guide and "Get cache pressure data" in the Apple Platform Deployment guide at the links below.

https://support.apple.com/guide/activity-monitor/view-cache-activity-actmcdbbd395/mac

https://support.apple.com/guide/deployment/content-caching-metrics-dep0504346e1/1/web/1.0



Another set of data to pay close attention to is that the Data Served From Cache is close to the Data Served totals. Values rising in this column indicate Content Caching is working, and data is being served locally as opposed to over the internet. If not, this value would remain at 0 or static.

Terminal
The log command in Terminal can display detailed information about the content caching service. Content caching logs to the subsystem com.apple.AssetCache. Open Terminal, enter the following command, then press Return:

```
log show --predicate 'subsystem == "com.apple.AssetCache"'
```

Similar to Activity Monitor, the output from that log command reveals information about data served to clients, as well as the source of the data served (ie. From Origin, peers, parents).

Console

You can use Console to investigate logs. Open Console, then in the Search field, enter:

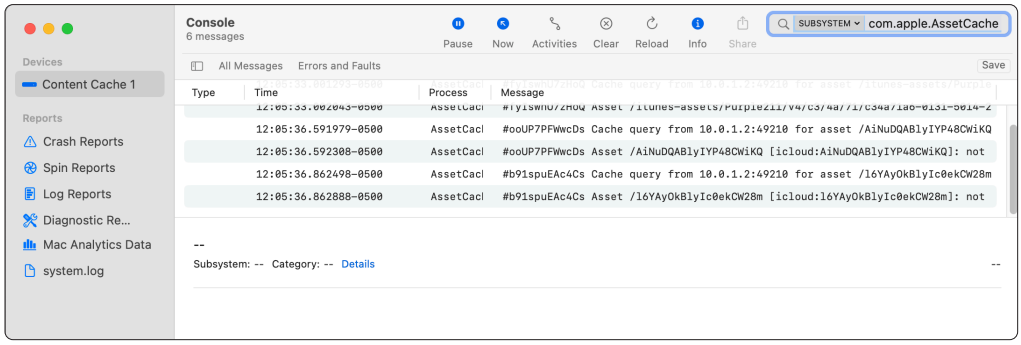
s:com.apple.AssetCache

Choose Start streaming, then press Return. This will narrow down the amount of data being displayed to focus only on content caching.

You can turn on verbose logging by editing the plist for content caching. You can perform this with MDM using a Custom Settings configuration profile payload or manually using the defaults command. For example, use the following command:
NOTE: The command below includes line breaks. You need to enter the entire command before you press Return.

```
sudo -u _assetcache defaults write /Library/Preferences/com.apple.AssetCache.plist
verbose yes
```

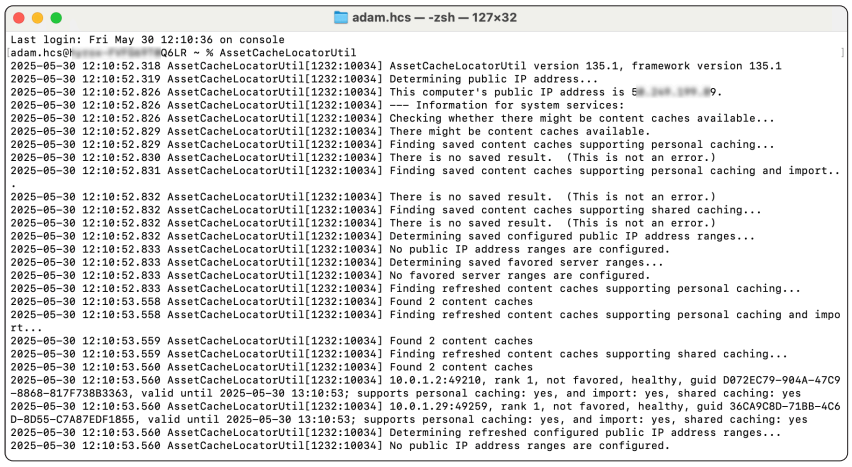
https://support.apple.com/guide/deployment/advanced-content-caching-settings-depc8f669b20/web



AssetCacheLocatorUtil

The steps above focus on investigating and troubleshooting the content caching service from a computer providing caching. However, a handy utility within Terminal is AssetCacheLocatorUtil. You can use this on Mac to detect any content caches, either on the local computer or on the network.

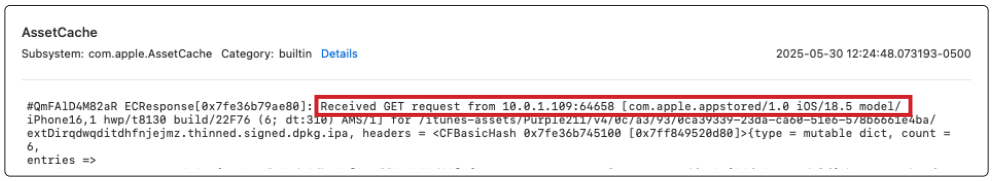
The output of the command includes details about the type of content being cached and information such as listen ranges and warnings about potential issues. In more complex networks, these warnings could relate to public IPs differing between content caches and clients, which would prevent the client from using the content cache. Lastly, these warnings can report information on the health status of a content cache. For example, if there have been multiple communication failures with a particular content cache, it may be deemed as unhealthy



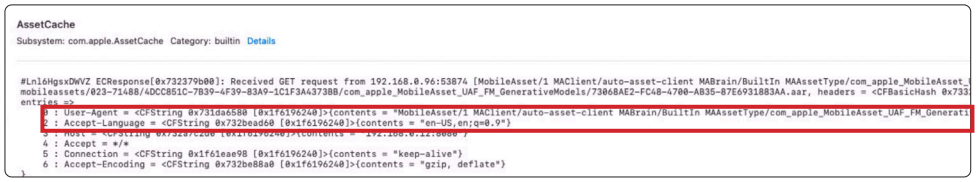
AssetCacheManagerUtil
From the Mac providing content caching, use AssetCacheManagerUtil to display and manage settings. This can assist in situations where you may want to use SSH or run remote commands to activate the service, flush the cache, or view details of the content cache settings. To learn more visit:

https://support.apple.com/guide/deployment/advanced-content-caching-settings-depc8f669b20/web

Log Client Identity
This feature can be particularly useful as it allows you to review the logs to confirm the IP addresses of clients communicating and requesting cached data. This makes it easy to identify the client when a request is made. Enabling this feature can be done within the content caching payload in MDM or by adjusting the plist by changing the key LogClientIdentity to Yes.



Apple Intelligence and Content Caching
Apple Intelligence has a large data footprint, equivalent to another OS install. As Apple Intelligence becomes more prevalent, it is important that content caches are updated to reduce the network load. Apple Intelligence models are cached as mobile assets as in the screenshots below



This completes the guide.