Implementing PeerDist:

The BranchCache™ Protocol

Christopher R. Hertel
Samba Geek
May, 2012

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Introductions

Intermissions

Me

If you don't know me by now...

Introspections

Now with

redhat®

The opinions expressed are my own and not necessarily those of my employer, my spouse, my (lack of) religion, or my dog.

Introductorations

You

Introdictations

Cast of Characters

BranchCache: *The Product*

PeerDist: *The Protocol*

Prequel: *The FOSS Implementation*

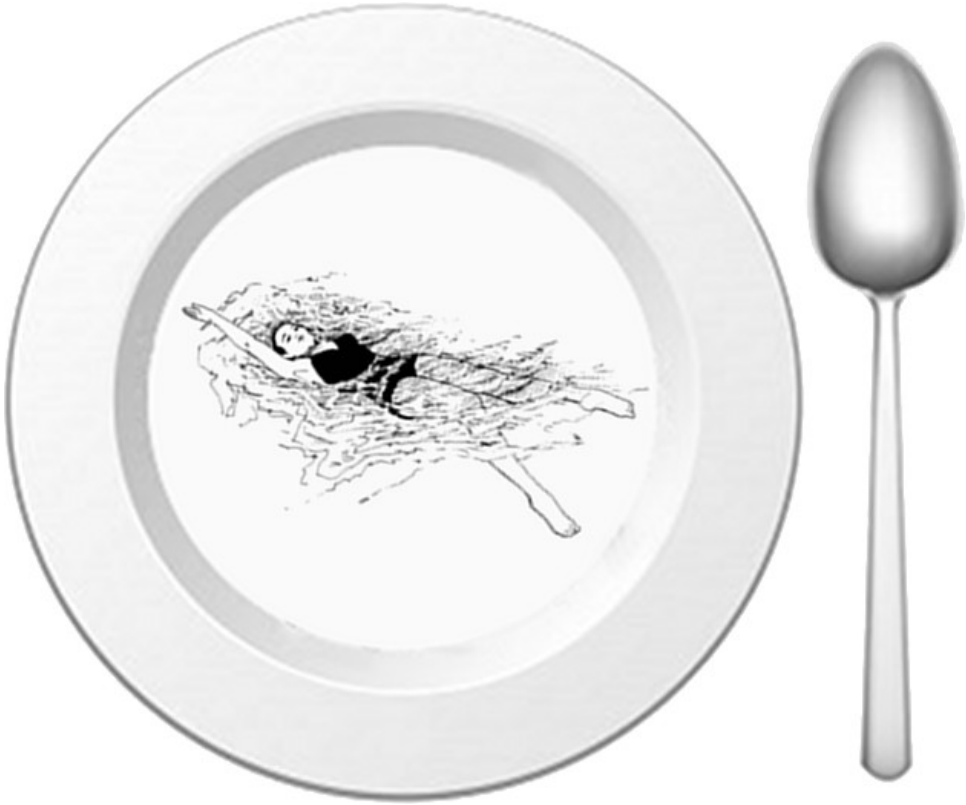
Interrogations

Where Are We Going?

- What is BranchCache™ and why do we want it?
  - PeerDist over HTTP
  - PeerDist over SMB2 and SMB3
- What is the Prequel Project?
  - Prequel CGI
  - Prequel Dæmon
  - Prequel in Linux
- Where do we want to be tomorrow?

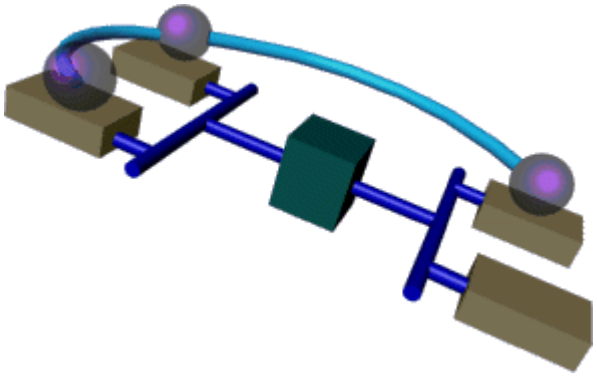
What is BranchCache™?

...and what is it doing in my soup?



What is BranchCache™?

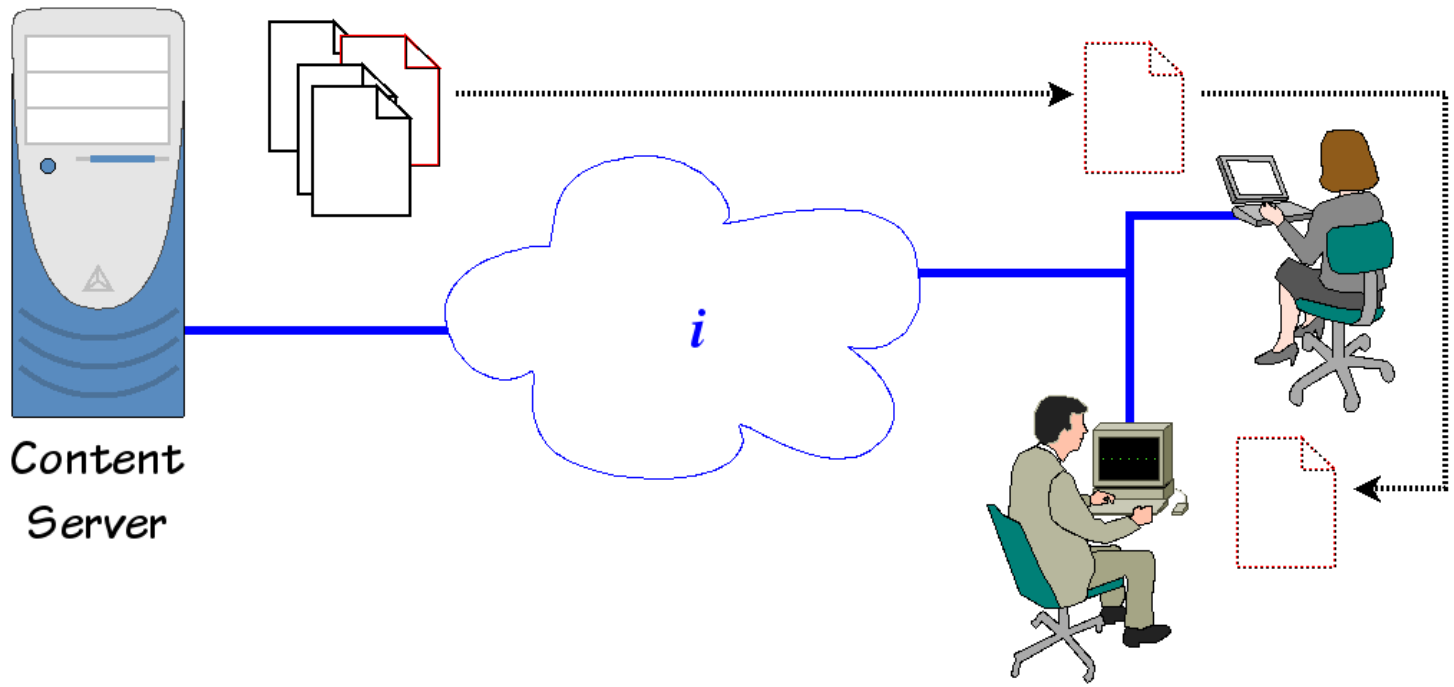
BranchCache™



A Distributed File Caching System

- Basic, simple WAN acceleration
- Supported in SMB2.1+, and over HTTP

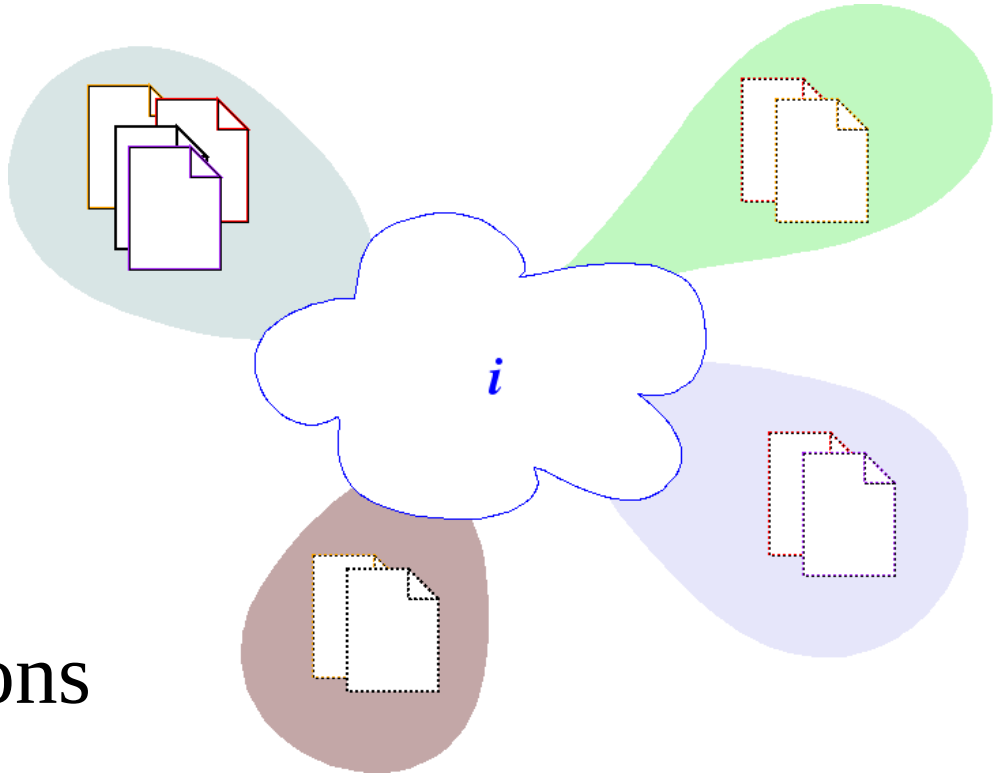
What is BranchCache™?



The basic idea:

- The 1st user fetches a file from the remote server
  - A copy is kept somewhere on the local LAN
- The 2nd user fetches the copy, not the original
  - Local transfer is faster and cheaper

What is BranchCache™?



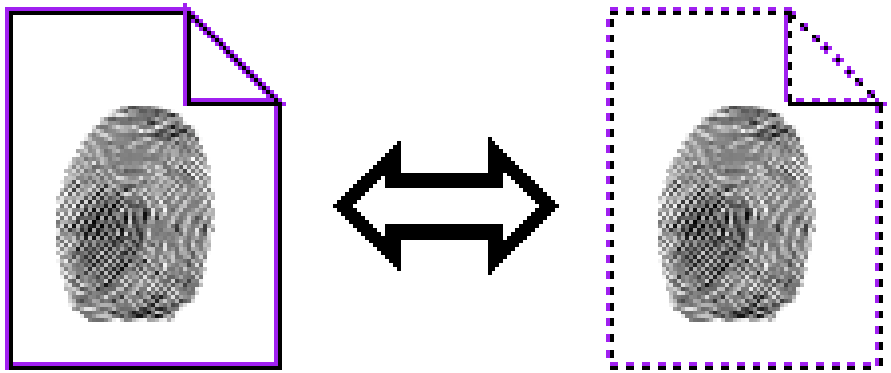
Cached Copies
May Exist in
Several Locations

- Copies are stored on the local networks
  - Copies are *not authoritative*
- What happens when the original changes?
  - How do clients detect the change?

What is BranchCache™?

Before the client can use the copy

- A file fingerprint must be retrieved from the server
- The fingerprint is much smaller than the original file (≈1/2000th)



If the **cached fingerprint** does not match the **server fingerprint**, the client must re-fetch the data.

What is BranchCache™?

Is This Cool?

Simple, easy to implement, *de facto* standard WAN Acceleration.

That's cool...but can we do more with it?

- Distributed file system?
- Scatter-gather network backup?

What is BranchCache™?

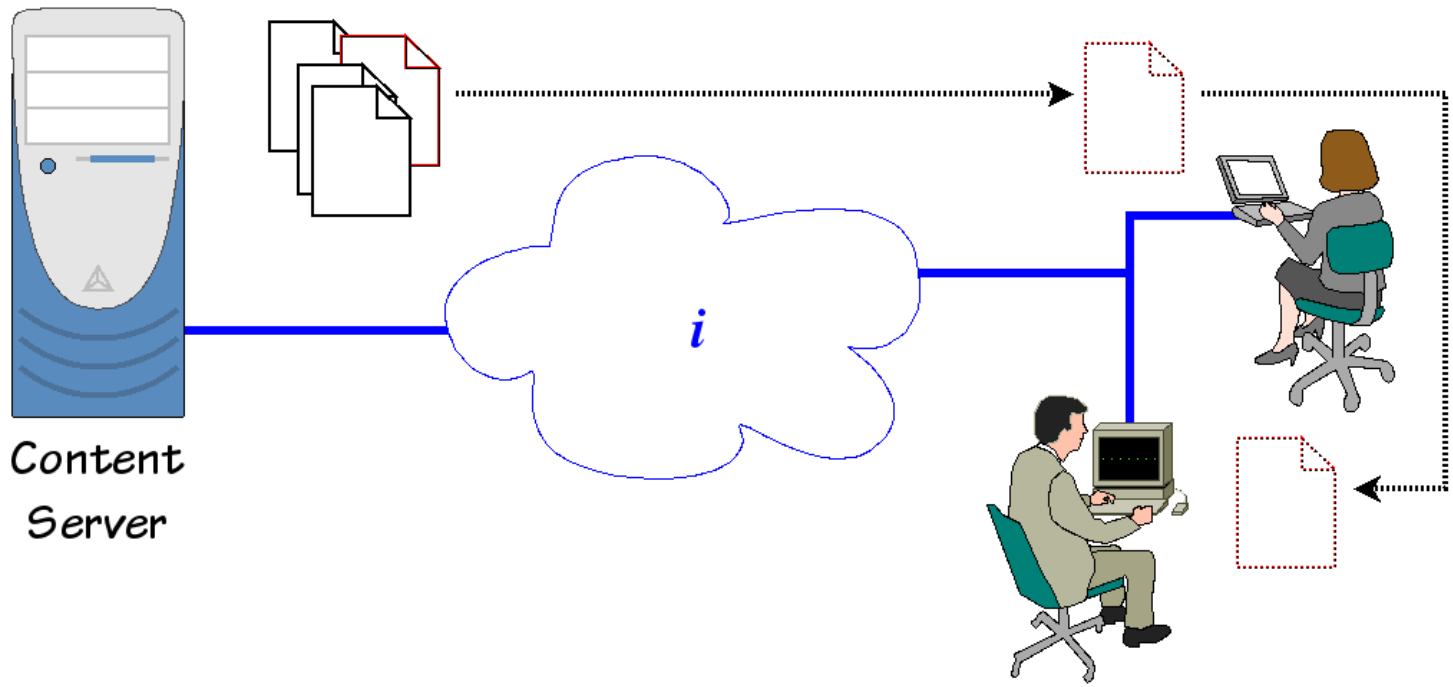
How this is done: the details

BranchCache is an implementation of PeerDist

PeerDist is a documented Microsoft protocol:

- [MS-CCRSO] – Overview
- [MS-PCCRC] – The 'fingerprint' format
- [MS-PPCRD] – Finding local copies
- [MS-PCCRR] – Retrieving local copies
- [MS-PCCRTP] – PeerDist over HTTP
- [MS-PCHC] – Using a hosted cache
- [MS-SMB2] – PeerDist over SMB2.1+

What is BranchCache™?

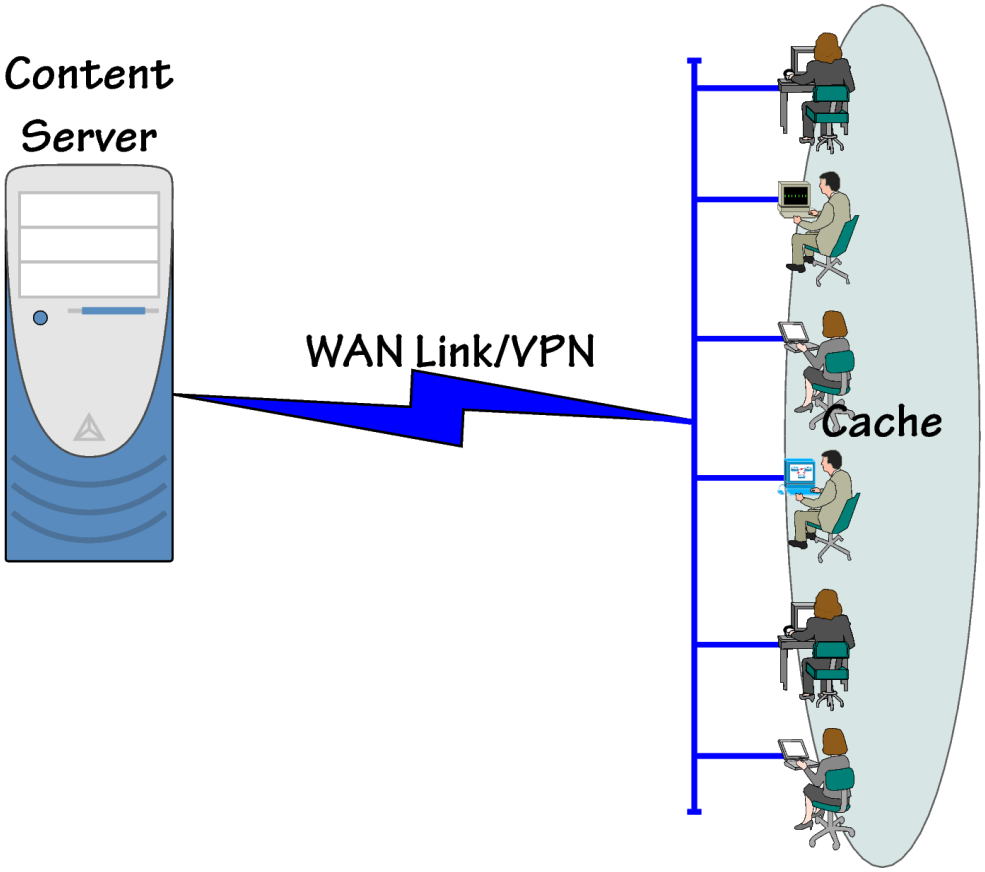


Remember these folks?

- The 1st request tries to get both the fingerprints and the content.
  - Both are required in order to cache the content.
- Once the data is cached, subsequent client requests need only retrieve the fingerprints.

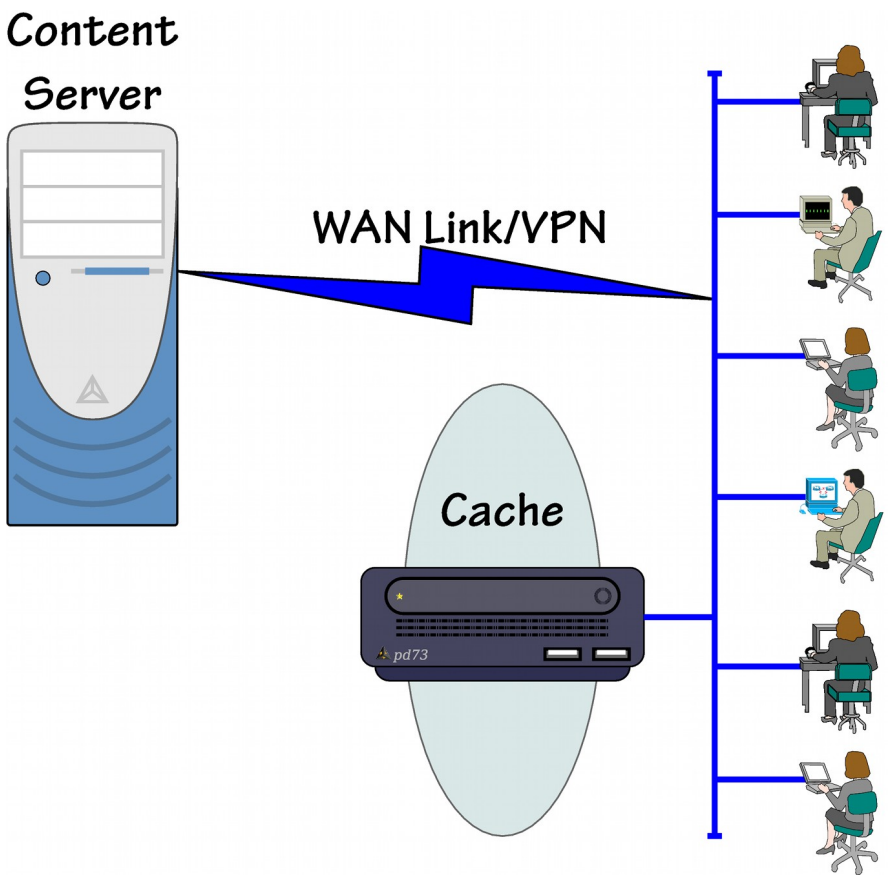
What is BranchCache™?

PeerDist: Peer-to-Peer mode



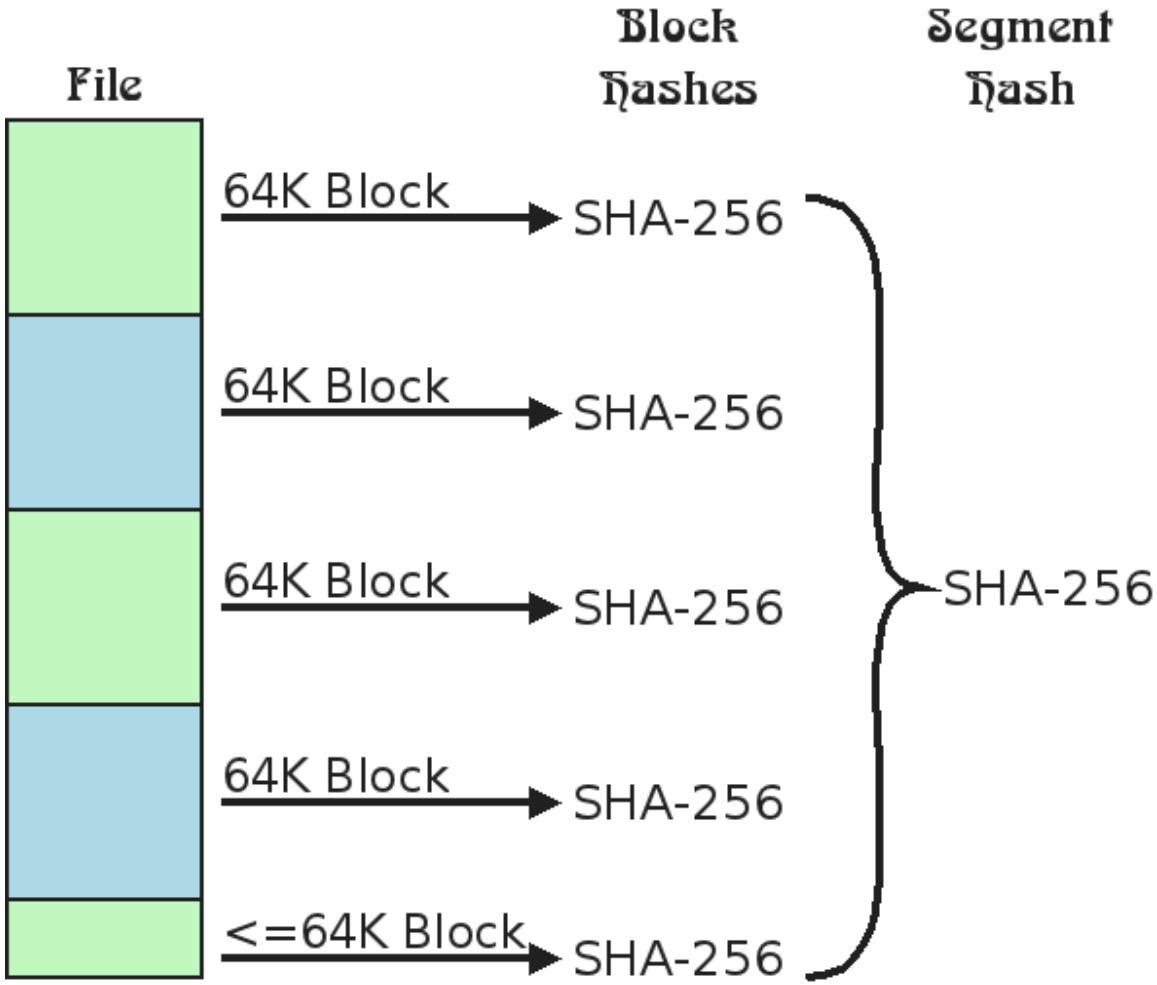
What is BranchCache™?

PeerDist: Hosted Cache mode



What is BranchCache™?

PeerDist v1 (Windows 7)



What is BranchCache™?

PeerDist v1 (Windows 7)

- Each 64K block is hashed
  - The last block may be less than 64K
- Every 512 block hashes (representing a 32M segment) are hashed
  - The last segment may be less than 512 blocks
- Each Segment Hash is HMAC signed using a server secret key
  - The signing key can be extracted

What is BranchCache™?

PeerDist v2 (Windows 8)

Needs more study

- The format is different
- The fingerprinting algorithm is unspecified, leaving “Innovation Space” for implementers

A chance to leverage other Linux development efforts (e.g., BtrFS deduplication).

Prequel

Prequel

Prequel: A small project to implement PeerDist for Linux.

Early success

- `pq_cgi`: A CGI program for HTTP servers that can create PeerDist v1 Content Information[1]
- The structure of the PeerDist v1 fingerprint does not lend itself to on-the-fly delivery

[1] Content Information == Fingerprint

Prequel

Prequel: A small project to implement PeerDist for Linux.

Some Simple Tools

- `pdDump`: Dumps PeerDist v1 Content Information
- Tools to extract a Windows BranchCache Server Secret (signing key) and Passphrase

These are proof of concept tools, and they do prove the concept.

Prequel

Prequel Dæmon

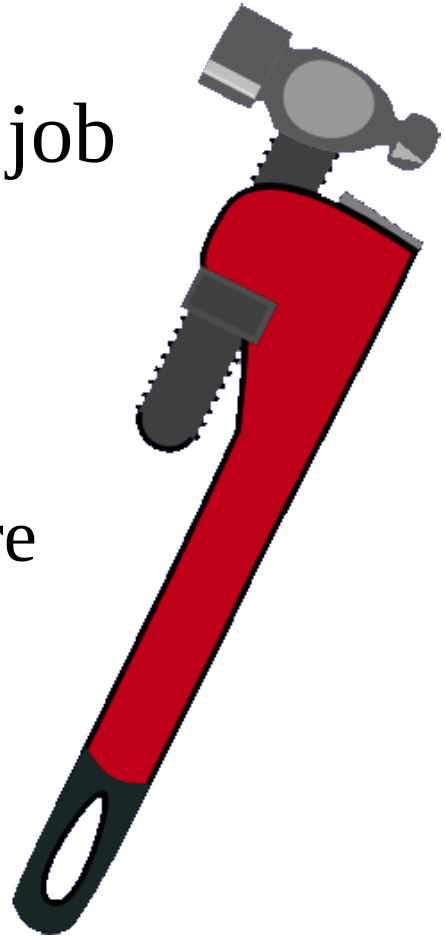
Work in Progress

- `PrequelD`: Generate Content Information files from original data
- Make Content Information available to HTTP servers and Samba
- Garbage-collect outdated Content Information files

Prequel Dæmon

Possibly not the best tool for the job

- Access rights complexities
- Must scan source files to detect changes and new files
- Needs separate directories to store Content Information files
- Must check Content Information files to ensure that they are still valid



Prequel

The Dream: Kernel PeerDist

Content Information as FS metadata

- Content Information generated asynchronously
  - invalidated on write to file
  - accessed using an open file handle
- Kernel lease (OpLock) handling is correct
- Children sing, Flowers bloom, Sun shines

Prequel

The Dream: Kernel PeerDist

A few outstanding questions...

- Can this be done in a kernel VFS?
  - Where would Content Information be stored?
- Can we access BtrFS de-dupe tags for use as a PeerDist v2 fingerprint?

Prequel Client-side Cache

PeerDist Consumers

- Clients need to be PeerDist aware
  - They must know to request PeerDist
  - They must know how to retrieve content from the cache

- Where should the cache be kept?
  - In the kernel or in userspace?

Prequel Client-side Cache

PeerDist Consumers

- Top consumers will likely be the CIFS kernel client and user-land HTTP clients (including package update programs)
- Both peer-to-peer and hosted mode should be supported by clients

The Prequel Project

Getting our act together

- Homepage:
  http://www.ubiqx.org/proj/Prequel/

- Wiki and Git (just recently created):
  http://fedorahosted.org/prequel/

The End