13. Design Facebook photo storage

Motivation & Assumptions

- PB-level Blob storage
- Traditional NFS based design (Each image stored as a file) has metadata
- Bottleneck: large metadata size severely limits the metadata hit ratio.

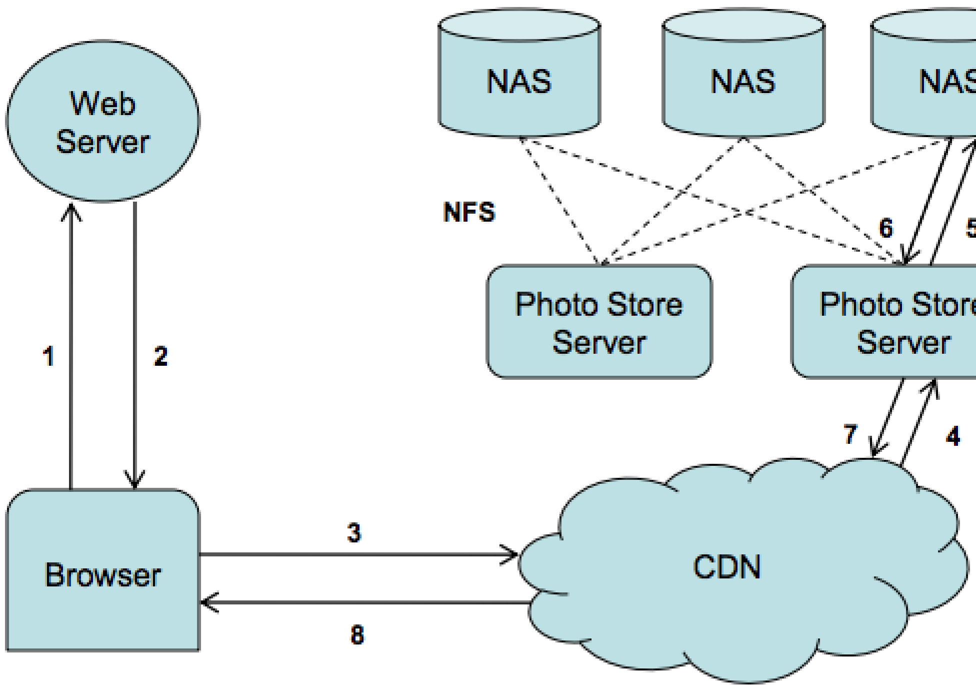
Explain more about the metadata overhead

For the Photos application most of this metadata, such as permissions, is unused and thereby wastes storage capacity. Yet the more significant cost is that the file's metadata must be read from disk into memory in order to find the file itself. While insignificant on a small scale, multiplied over billions of photos and petabytes of data, accessing metadata is the throughput bottleneck.

Solution

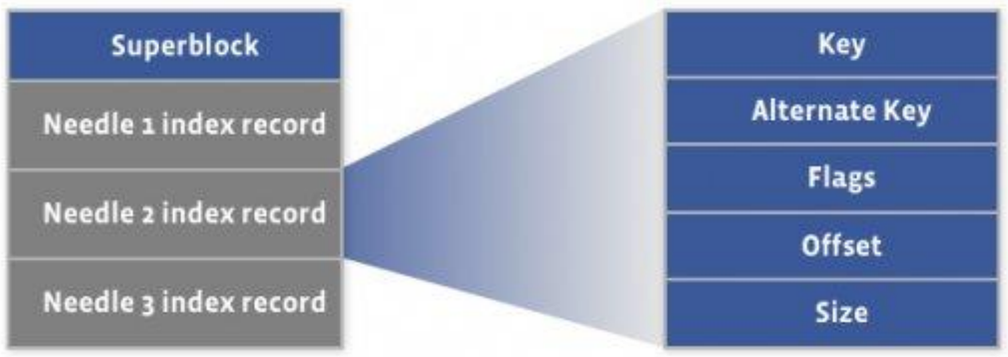
Eliminates the metadata overhead by aggregating hundreds of thousands of images in a single haystack store file.

Architecture

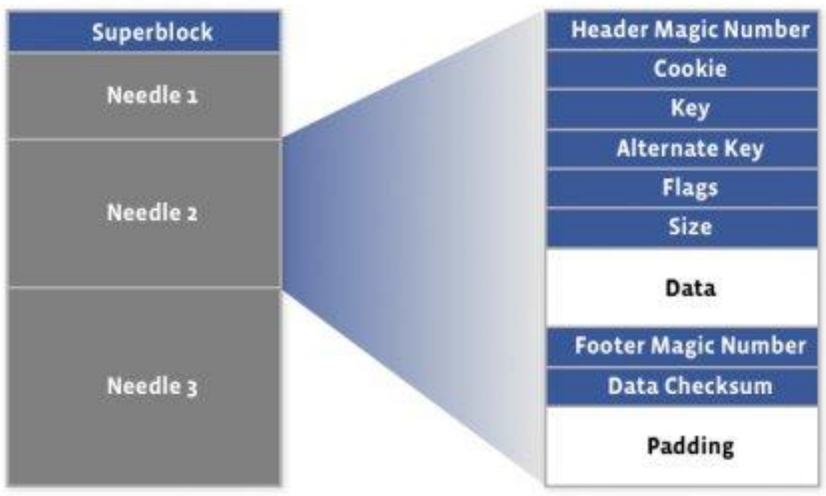


Data Layout

index file (for quick memory load) + haystack store file containing needles.



index file layout



haystack store file

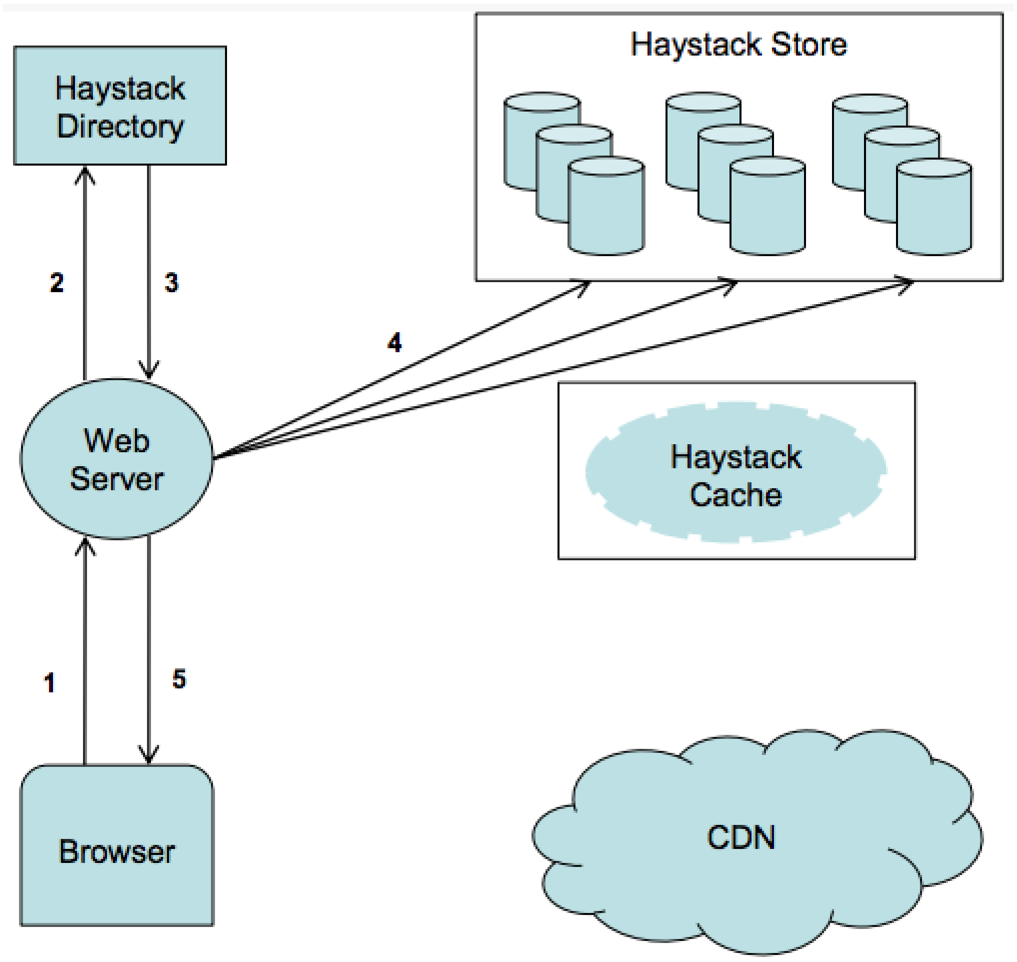
CRUD Operations

- **Create**: write to store file and then ==async== write index file, because index is not critical
- **Read**: read(offset, key, alternate_key, cookie, data_size)
- **Update**: Append only. If the app meets duplicate keys, then it can choose one with largest offset to update.

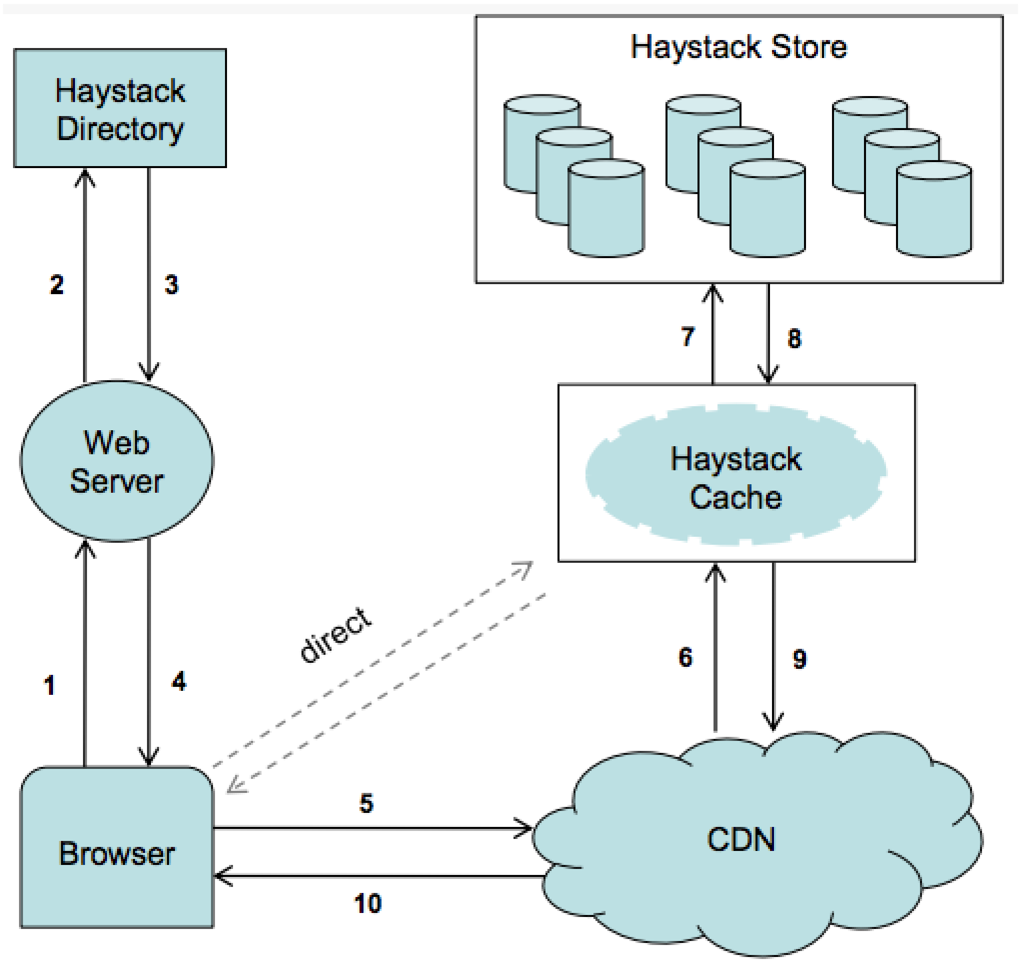
- **Delete**: soft delete by marking the deleted bit in the flag field. Hard delete is executed by the compact operation.

Use cases

Upload



Download


Haystack Directory
Haystack Store
2
3
7
8
Web Server
Haystack Cache
direct
1
4
6
9
5
Browser
CDN
10