Hello!

CS 744: OWL

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ADMINISTRIVIA

Project checkin – feedback

GPU availability → Cloudlab limited
↳ Roger reservation
Google Cloud → Recipes for Marius
Tools? Ask us!

Midterm 2: Dec 6th in class

Poster presentation: Dec 13th

Final report: Dec 20th

NEW DATA, HARDWARE MODELS

CONTENT DISTRIBUTION

What is content?

- Docker containers , binaries that are used.
- AI models ⟶ inference, serving.
- Search indexes ⟶ inverted index

Cache popular content

How is this workload different?

- Read heavy, very few updates
- Skew / hot content ⟶ launch 100,000 workers ⟶ all read the same binary at same time
- Hot spots which lead to slow down / failures

CHALLENGES / GOALS

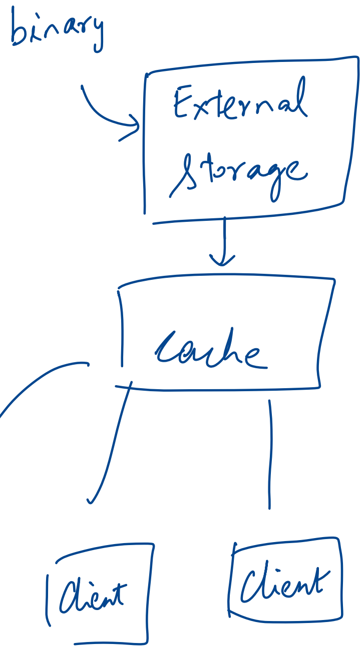
Goals

- Minimize requests to external storage → cache hit rate
- Latency of content fetch → minimize
- Availability → minimize failed requests

Challenges

- Load spikes hot content → spike in time
- Different policies for contents → configurable / flexible
- Manageability → Debugging, Updating

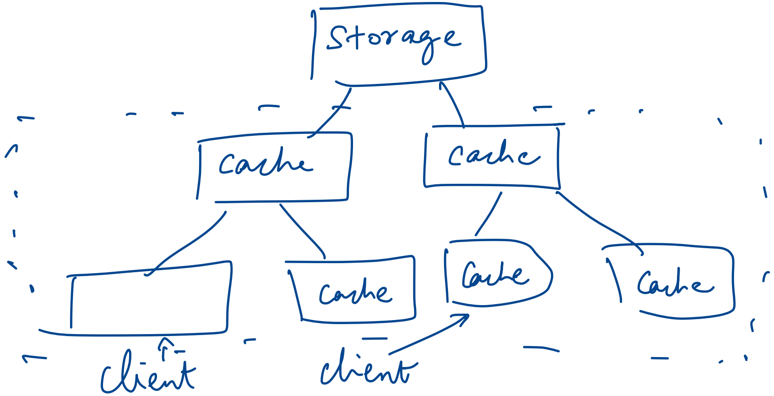
where is this cache?



PRIOR SOLUTIONS

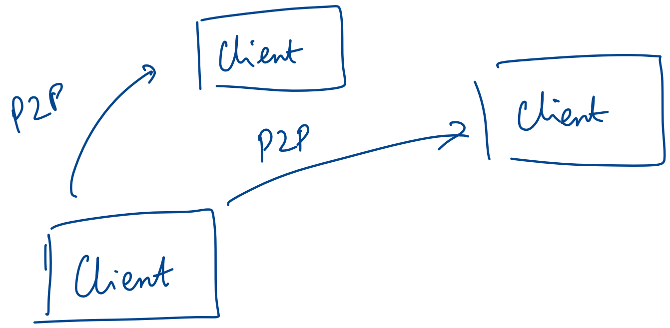
Centralized solution

Hierarchical caching



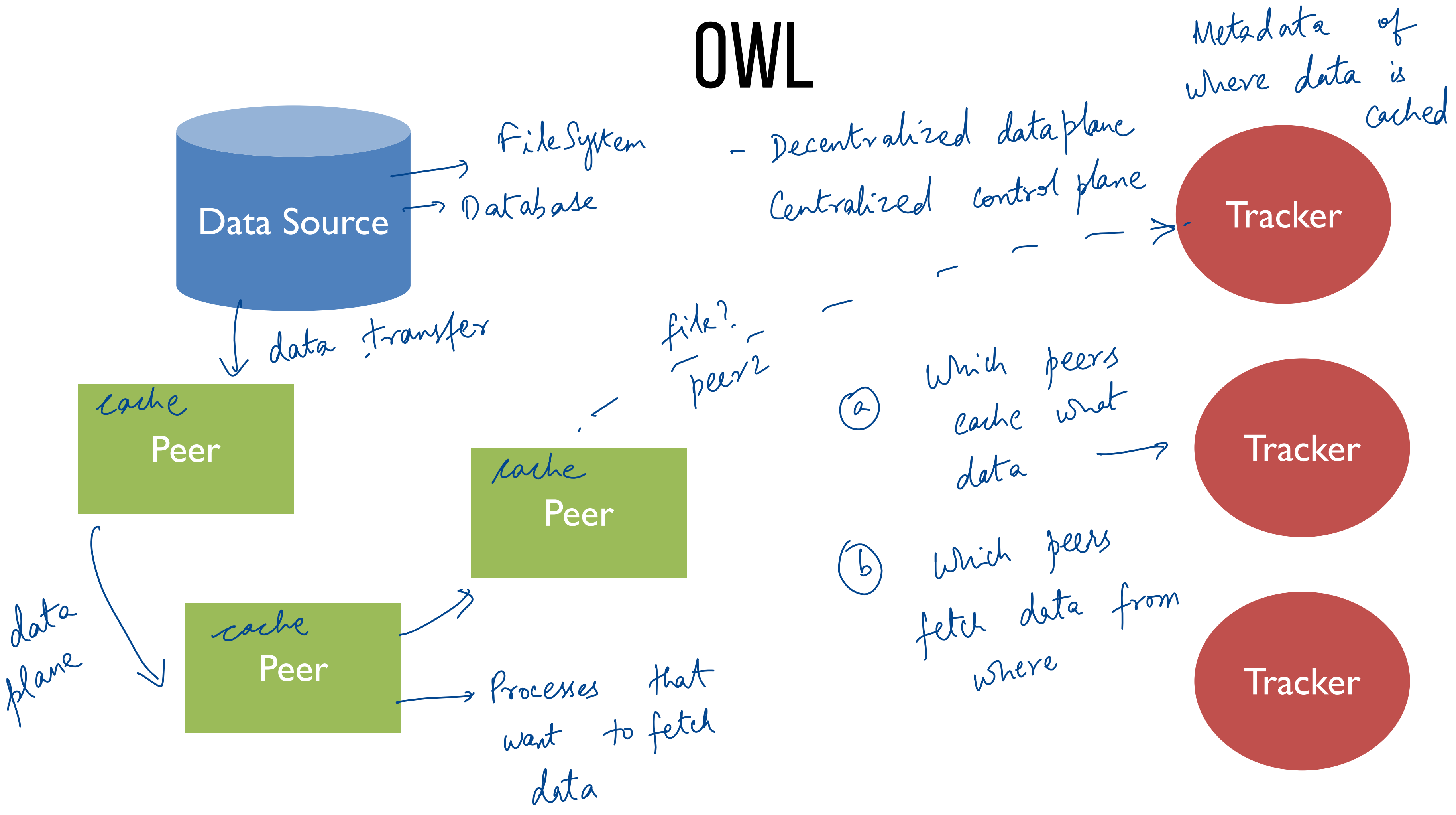
- Need a lot of resources
- Quotas, Traffic bursts
- Millions of clients

BitTorrent



- Scalable, decentralized
- Stale peer data, → Errors
- Lack of global picture → Manageability

OWL


Metadata of where data is cached
Data Source
File System
Database
- Decentralized data plane
Centralized control plane
data transfer
file?
peer?
cache
Peer
cache
Peer
cache
Peer
data plane
Processes that want to fetch data
Tracker
Tracker
Tracker
(a) Which peers cache what data
(b) Which peers fetch data from where

OWL DESIGN

Peers, Superpeers

Trackers

Ephemeral Distribution Trees

Tracker Sharding

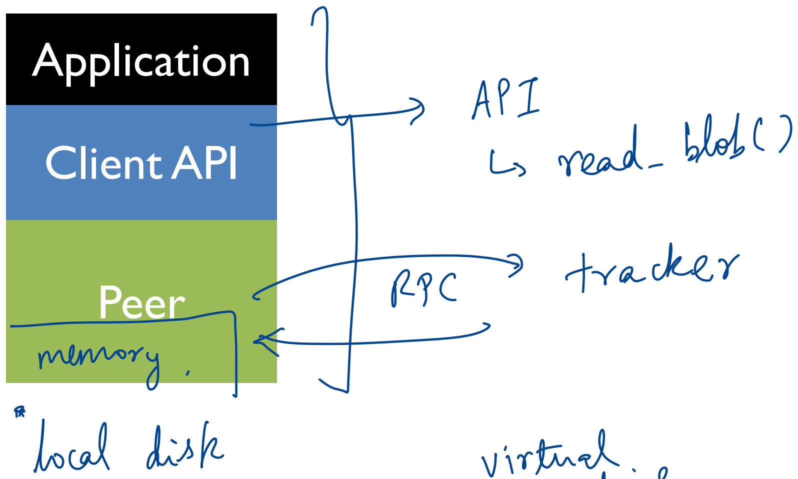
Fault Tolerance

PEERS, SUPERPEER

What is a Peer?

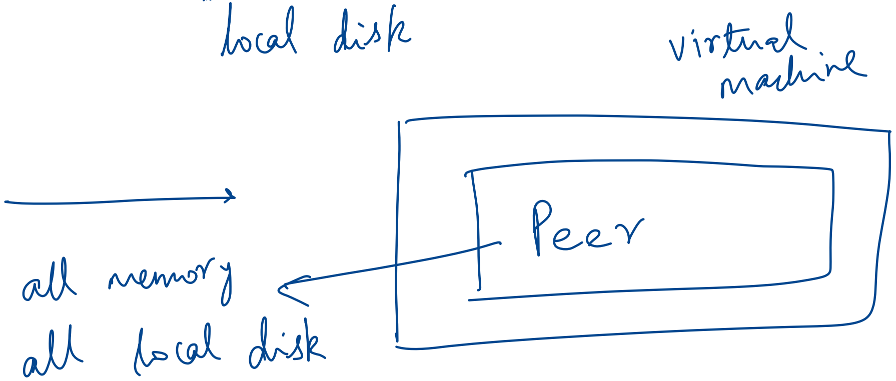
- Simple API, functionality
- Ask Tracker where to fetch
- Cache in memory / local disk

hard to update Peers.



SuperPeer

- Standalone process (no client)
- More resources for caching



TRACKERS

Centralized state for large number of peers → millions of peers in a data center

Peers register with a random tracker

What is state? → Two Datastructure

- Chunk → Peers caching it
- Peer → List of chunks cached

Soft-state (similar to GFS)

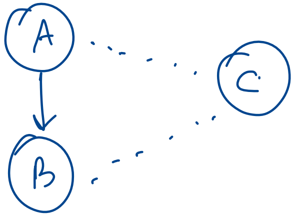
Tracker

chunk → which peers

Peer 2 → chunk 1, chunk 5 ....

(5 MB free)

Single Tracker
- Bottleneck peers connect
- Fault Tolerance
- Memory for state



DISTRIBUTION TREES

blob_id

[0, 512MB] → 11 chunks

if c_size = 50 MB

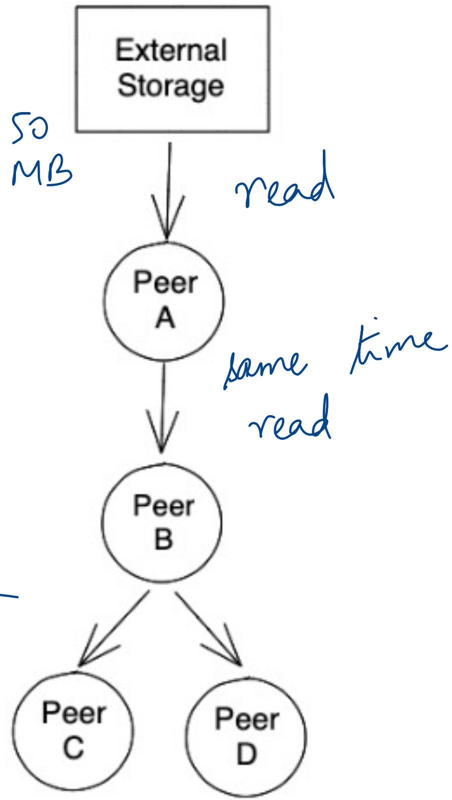
To fetch data

- Peer sends get_data(range) → Chunks
- For a chunk, getSource(chunk) →
  - Peer/Super Peer/External Storage

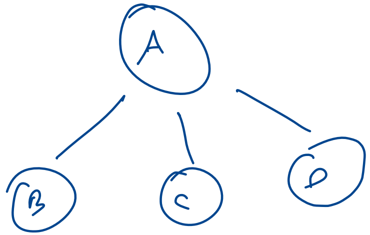
Peer directly reads from Source.

Trackers

- Build ephemeral distribution tree for a chunk
- Stream data from peers
- Locality based



POLICIES IN TRACKERS



Selection Policy

Which peer should we fetch from

→ locality based, load balancing

Caching Policy

Which blocks should be stored in memory

→ Cache eviction

LRU as default, least rare chunk is evicted.

Buckets to control configuration across applications

TRACKER SHARDING

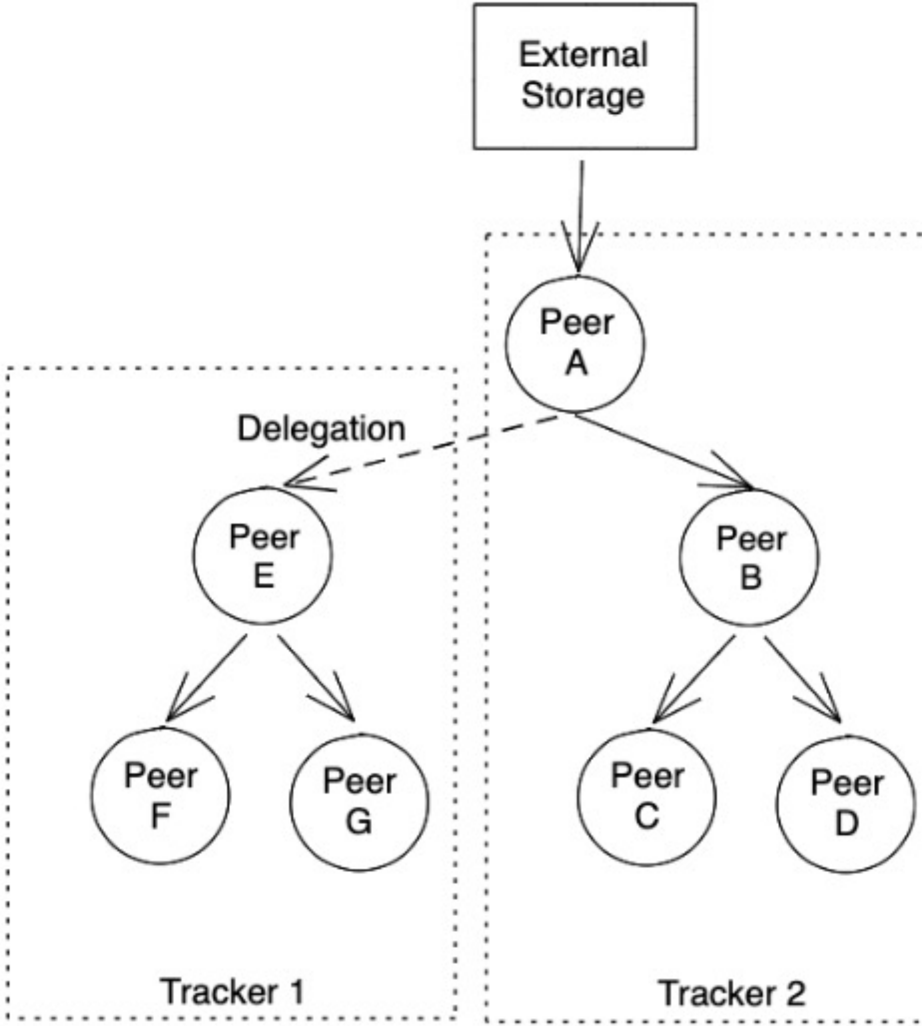
Millions of peers, tracker bottlenecks

Partition peers across trackers

- peers pick a random trackers

Challenge?

- We need to share knowledge of chunks cached by peers in other tracker!
- Periodically exchange list of chunks cached



Virtual Superpeers

What data should a peer store?

- So far: Data already fetched a peer
- Can we use a peer for caching other data?

Partition cache space into peer / virtual superpeer

- Use spare memory on the machine

Tracker-only concept!

SUMMARY

Problem: Content distribution is challenging

Approach: Decentralized data-plane, centralized control plane

Features

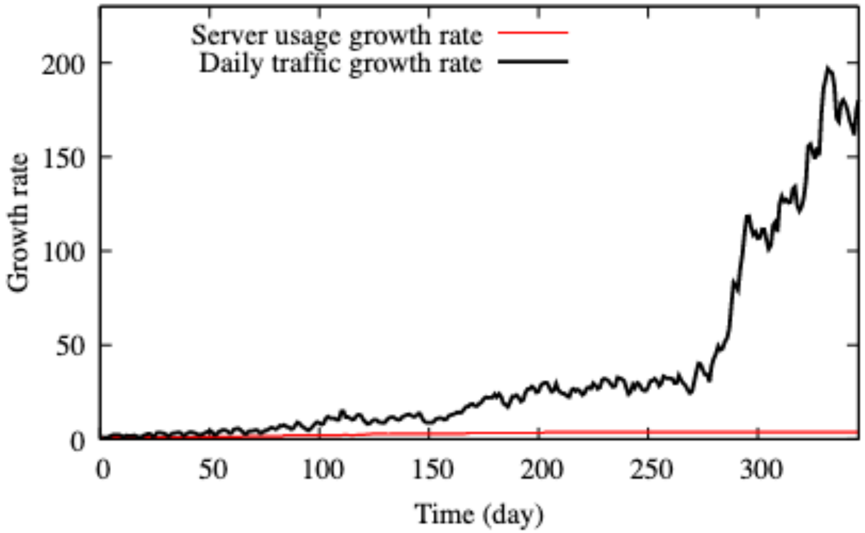
- Ephemeral data distribution trees
- Policies on tracker for selection, caching
- Sharding trackers for scalability, fault tolerance

DISCUSSION

https://forms.gle/cbAyPYsVGqdcaZyx9

What is one disadvantages of the design used in Owl? Construct one scenario to highlight how this disadvantages might affect a client.

- Client needs to sacrifice memory / disk space → affects performance
- If you use no space on clients, caching is only on super peers, which is similar to hierarchical caching
- Peer churn could be high → if app is short lived
- Client network bandwidth is used by Owl (esp for hot data)
- Shard peers → tracker only looks at peers within shard → sacrifice locality
- very small files → latency added by RPCs to tracker



Server usage growth rate
Daily traffic growth rate
Growth rate
0
50
100
150
200
0
50
100
150
200
250
300
Time (day)

NEXT UP

Next steps:

- TPU Paper
- Midterm 2, Dec 6th
- Poster session, Dec 13th