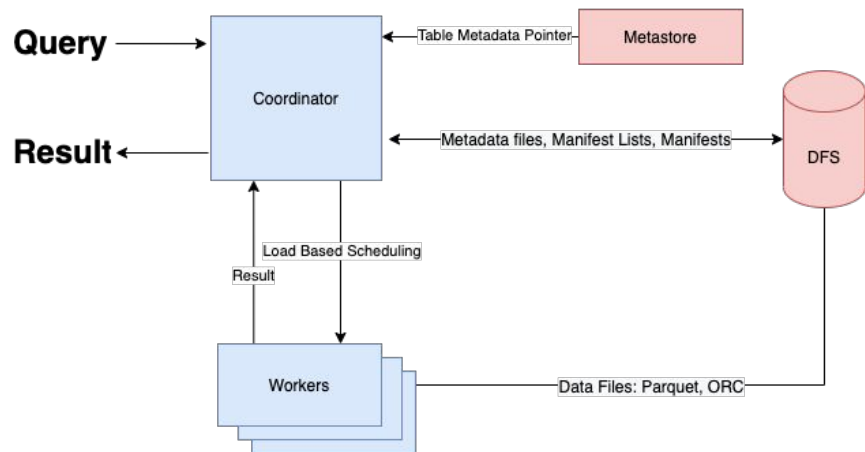


Affinity Scheduling and Node-Local Caching Effects on Query Latency

Big Data Compute
Islam Ismailov

Modern Disaggregated Data Warehouse

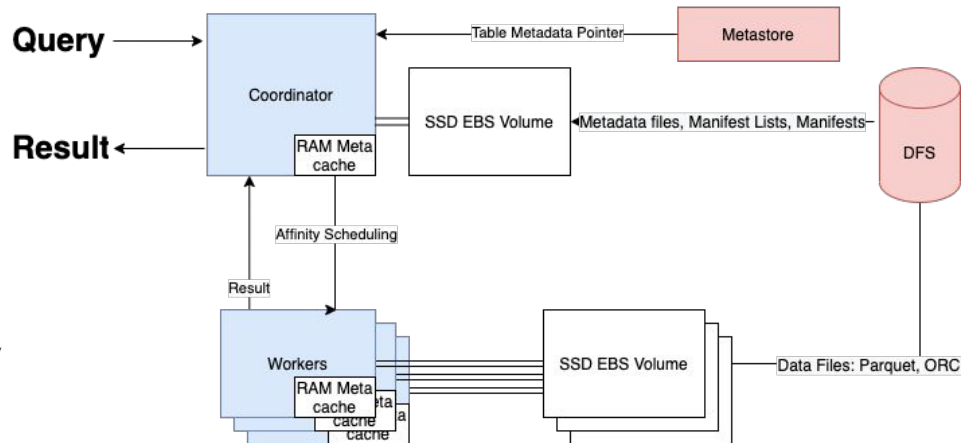
- Global data is growing faster than compute needs
- Scaling storage nodes and compute nodes independently is much more cost effective
- Queried data needs to be streamed remotely, increasing latency
- Scanning data across the network is often bound by I/O



Disaggregated architecture increases latency while reducing overall costs

Multi-Layer Caching for Interactive Use Cases

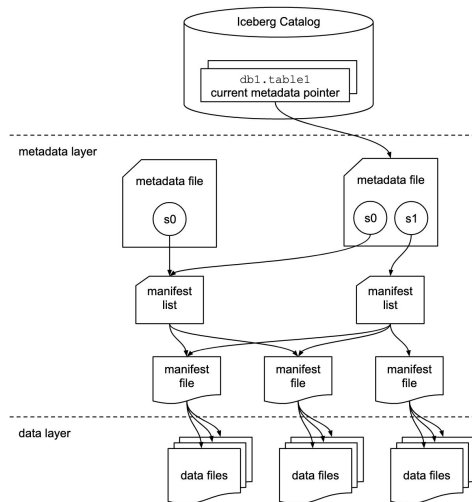
- EBS is ~5x cheaper than dedicated SSD per worker node, and can be scaled independently
- Seamless migration for the existing customers
- Interactive workload acceleration at petabyte scale is challenging
- Caching might seem like an obvious answer but in reality it is hard to implement correctly
- Caching of computed query fragments allows for significant CPU savings



Workers' caches "hide" disaggregated architecture's inherent latencies

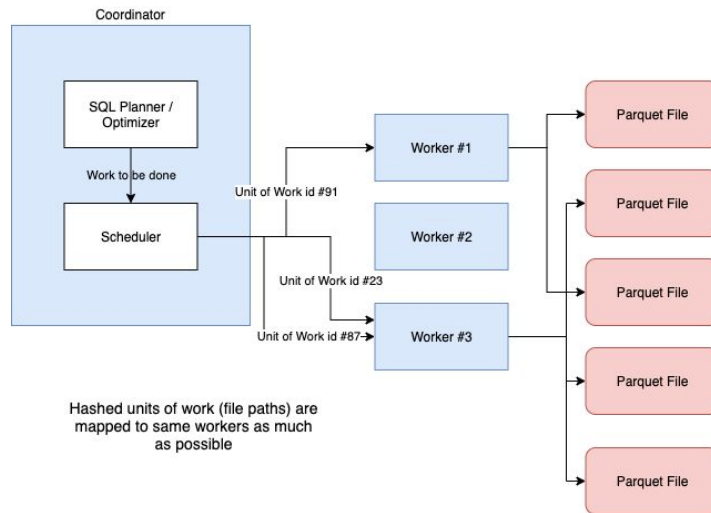
Metadata File Caching on Coordinator

- Coordinator is responsible for reading metadata files and figuring out which files to prune and which for workers to read
- Manifest Lists, Manifest and Metadata files can get complex and large
- Coordinator caches metadata to avoid reading them from DFS
- Snapshots are immutable so caching is effective



Affinity Scheduling for Cache Locality

- Normally, scheduling optimizes worker utilization uniformity
- Affinity based scheduling predictably maps work units to particular nodes
- Affinity scheduling maximizes cache hit rates while minimizing IO and allows for design where workers do not talk to each other
- Affinity scheduling is flexible in that it is able to detect unavailable workers and be flexible when necessary



Affinity Scheduling allows for the workers to have isolated caches

FileStatus and Footer Cache

- `getS3ObjectMetadata()` consistently appeared in profiling, and are required to access data in S3
- Footers have high hit rate as they contain crucial stats
- Worker nodes cache FileStatus in RAM to avoid calls to remote storage
- Current supported format is Parquet

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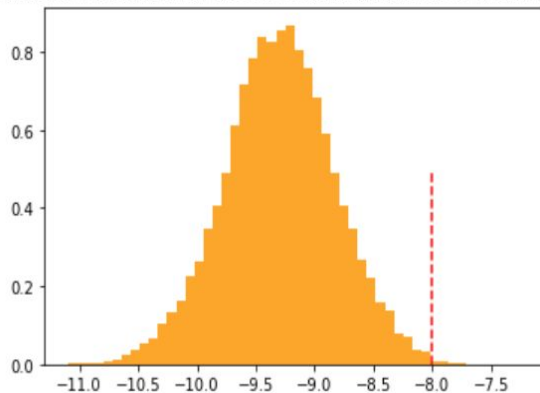
Affinity Scheduling allows for the workers to have isolated caches

Simple Metadata Caches allow up to -10% latency savings

- We benchmarked with real production queries replaying them on both control and test clusters
- Results were statistically significant, which shows that even simple LRU metadata caches can be effective in combating latency
- Additionally, CPU savings are achieved by skipping SerDe

The probability that the variant performed -8% better than the control is: 99.8%

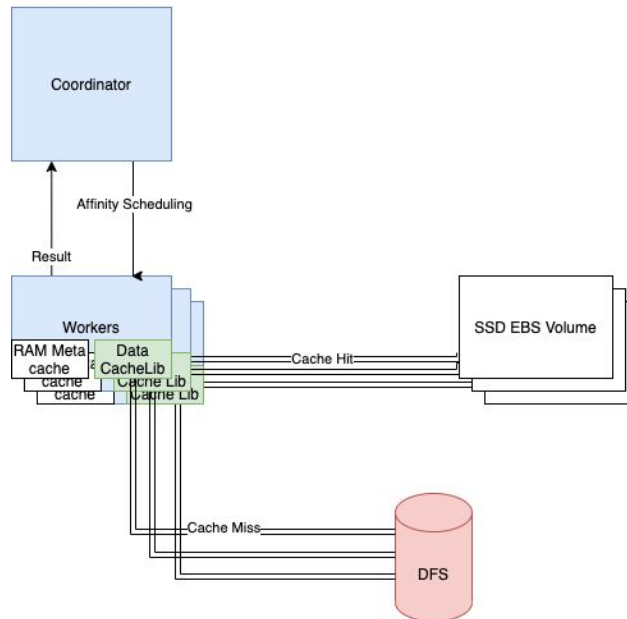
Posterior distribution of the the relative difference of mean values



Affinity Scheduling allows for the workers to have isolated caches

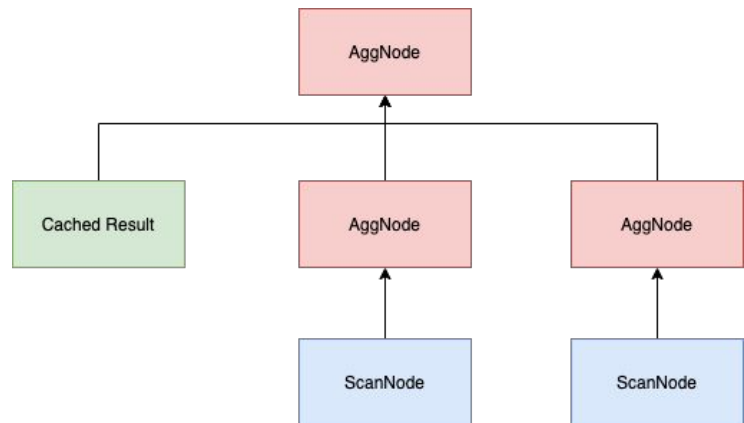
Worker Data Cache DFS Wrapper: 2x-3x improvement

- Improved latency by caching file chunks on SSD EBS drives mapped 1:1 for each worker
- Cache is implemented as a transparent layer, and falls back to DFS on cache miss
- On a cache hit, data is read from the SSD EBS drive, otherwise it reads it from DFS and fills the cache for future requests
- Files are divided into chunks to simplify cache size management, and easier eviction of colder chunks



Query Fragment Cache: Latency and CPU Savings

- Won't help if queries have too many non-deterministic filters / UDFs, etc
- Good fit for dashboards with slice & dice use cases, drilldowns and drop-down menus, especially if expensive computation is performed
- Each worker caches result of a split that's identifiable with a hashed canonical query plan fragment and split identifier (which is usually a file path)
- Partially computed results are cached on workers forming a fragment result, and can be retrieved on a subsequent query skipping scan & compute steps



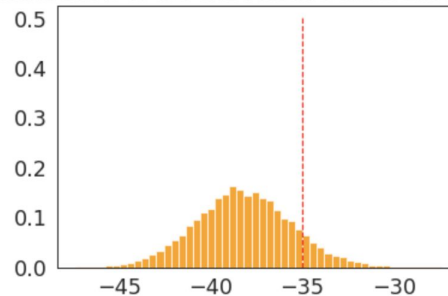
Large Benchmark on Production Traffic

Replay: up to 2x latency improvement

- Replay production traffic from one of the adhoc clusters
- No query was replayed twice, to create a tough-to-beat scenario close to real world
- Real use case for the caching setup is to support dashboard-like scenarios
- Currently in the process of rolling out to production on one of the main dashboard use case clients inside Netflix

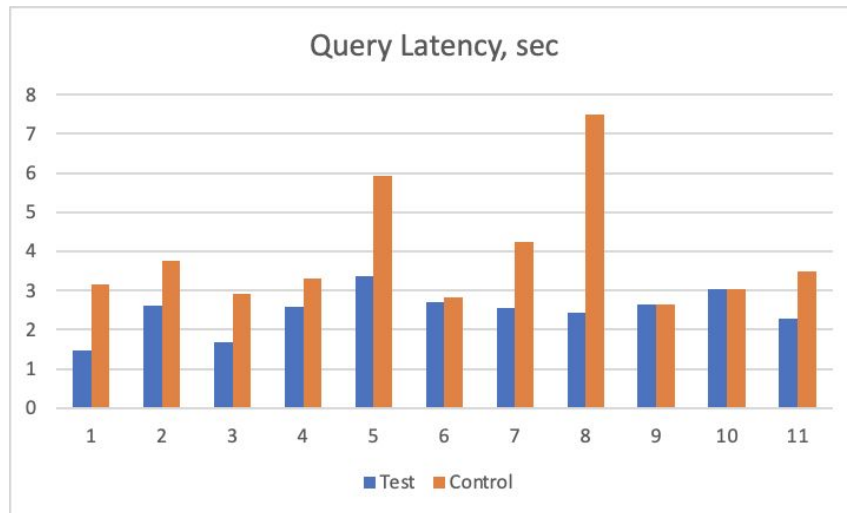
The probability that the variant performed -35% better than the control is: 88.83%

Posterior distribution of the the relative difference of mean values



Up to 3x Faster Than Non-Cached Queries

- Won't help if queries have too many non-deterministic filters / UDFs, etc
- Good fit for dashboards with slice & dice use cases, drilldowns and drop-down menus, especially if expensive computation is performed
- Each worker caches result of a split that's identifiable with a hashed canonical query plan fragment and split identifier (which is usually a file path)



A solid red vertical bar is located on the far left side of the slide, extending from the top to the bottom.

Thank you