Be Fast, Cheap and in Control with SwitchKV

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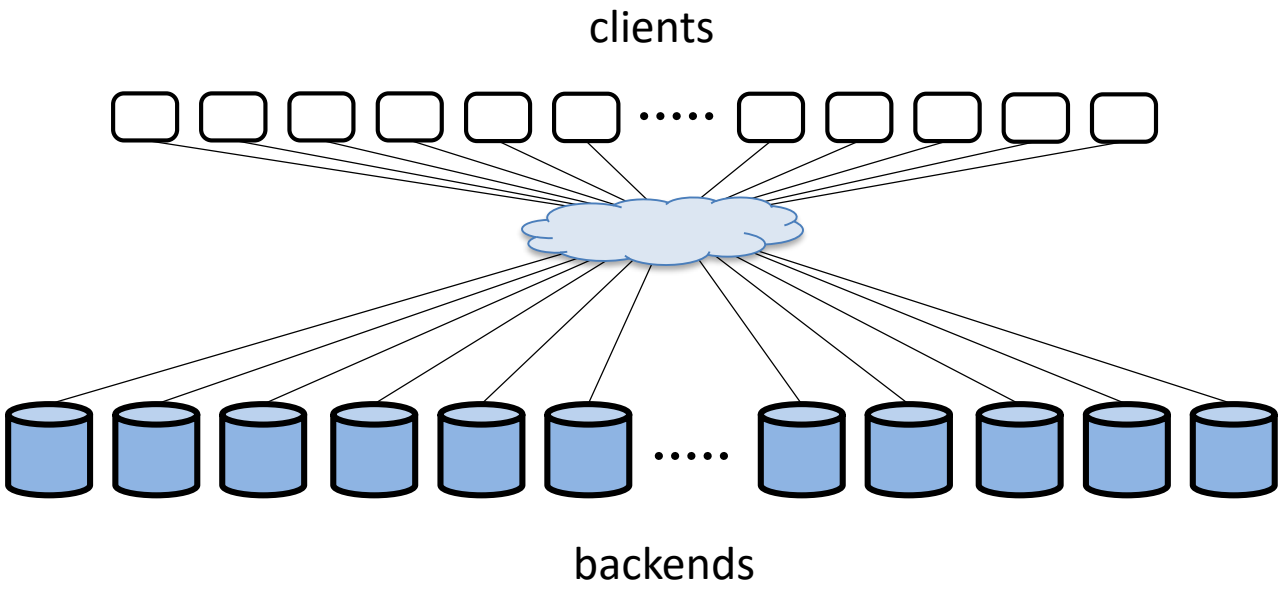
Fast and cost-effective key-value store

- Target: cluster-level storage for large, active data sets
  - Small key-value items, persistent, strongly consistent
- Goal: meet the service level objectives (SLOs)
  - Aggregate throughput and tail latency
- Fast SSDs are opening up new points in the design space
  - Emerging hardware and software technology
  - Can meet the SLOs of many cloud services ***cost-effectively***

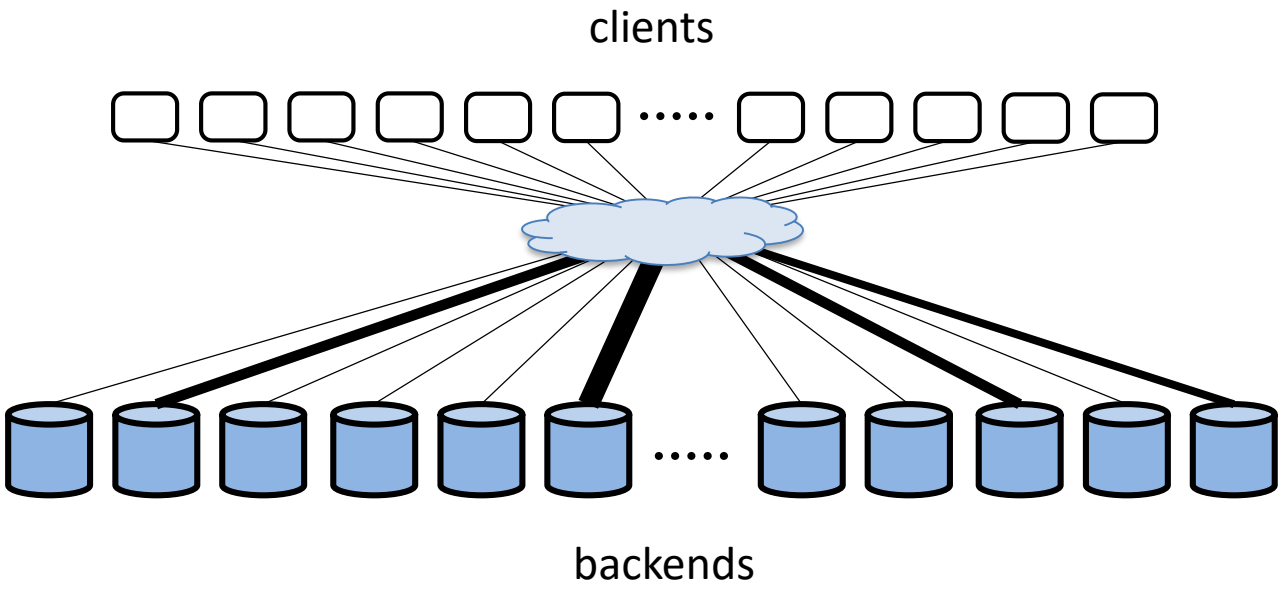
Scale out SSD-based cluster

- Meet the SLOs without substantial over-provisioning



Scale out SSD-based cluster

- Meet the SLOs without substantial over-provisioning
  - **under widely varying and rapidly changing workloads.**

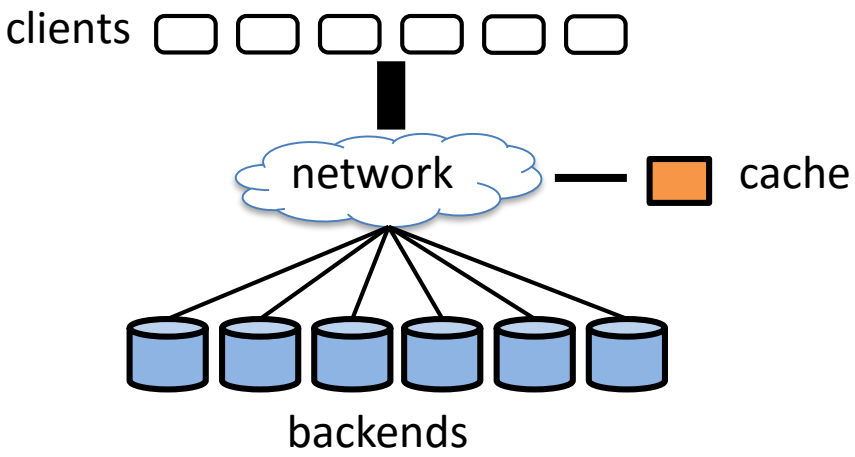


Key challenge: dynamic load balancing

- Load imbalance hurt performance
  - Lower throughput
  - Higher (tail) latency
- Existing methods (e.g., data migration) have limitations
  - system overhead
  - consistency challenge
- Fast, ***small*** cache can ensure effective load balance
  - Only need to cache the $O(n\log n)$ hottest items, ***n*** is the total number of *backend nodes* [Fan, SOCC'11]

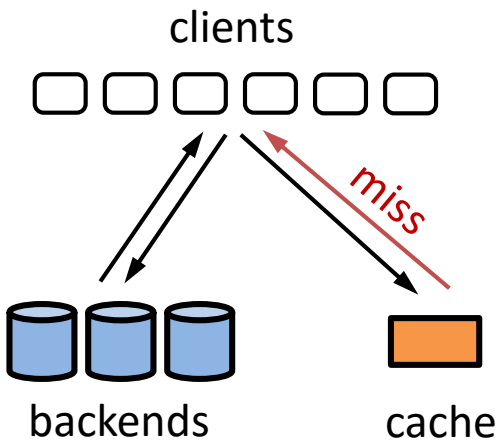
SwitchKV: heterogeneous key-value storage cluster

- Large scale SSD-based backend servers
  - Cost-effective but resource-constrained
  - Provisioned for the performance goals
- Specially-configured high-performance node
  - Fast, small in-memory cache

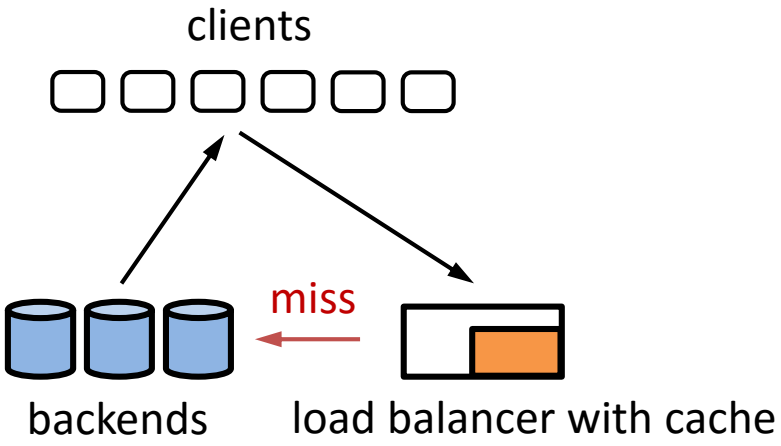


Traditional systems: cache must process all queries

- High system overhead when cache hit ratio is low
  - Throughput is bounded by the cache
  - High latency for queries for uncached keys



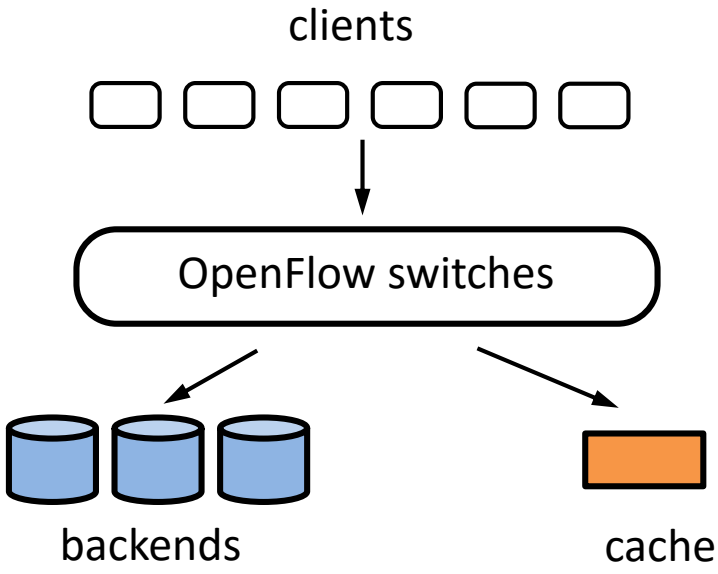
Look-aside architecture



Look-through architecture

SwitchKV: effective content based routing

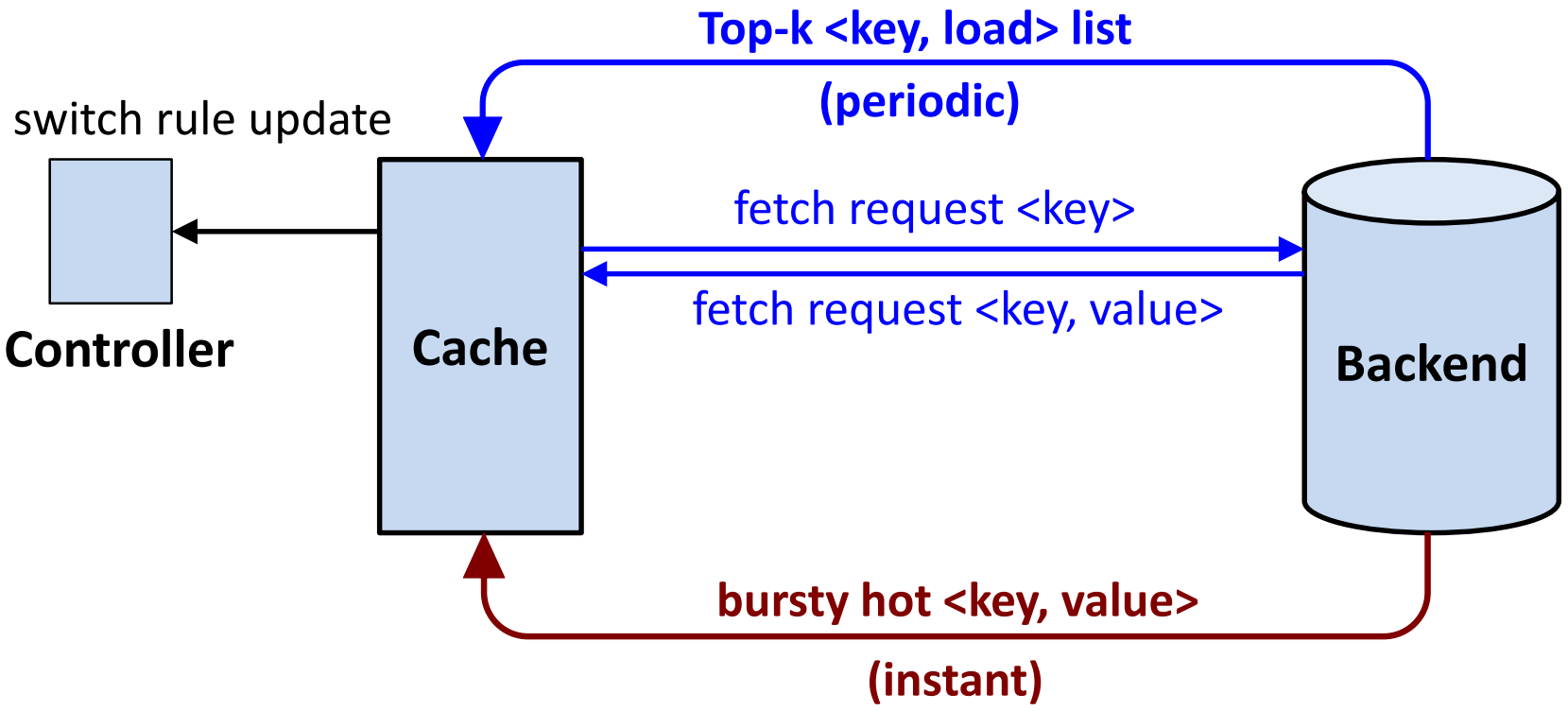
- Exploit SDN and deeply optimized switch hardware
  - Encode key information in the packet MAC header
  - Install exact match rules for all cached keys
  - Switches forward requests directly to the right nodes



How to update the cache?

- Backends add each recently-visited key to the cache?
  - Works fine when the cache hit ratio is high
  - What if backends are responsible for most queries?
    - Unnecessary cache churn
    - High bandwidth and computation overhead
    - Switch rule update rate is limited

SwitchKV: minimize unnecessary cache churn



Conclusion

- SwitchKV: load-balanced cluster-level key-value store
  - Load balancing guaranteed by fast, small cache
  - Efficient content-based routing
  - Reacts quickly to workload changes with hybrid cache updates
- Meet the SLOs more efficiently than traditional systems
- Checkout our NSDI paper this March ☺