Acorn: Replicate Your Data Where it is Likely to be Used
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Problem
- Cost of geo-replicated storage in global-scale applications keeps increasing as the volume of data and the number of datacenters increase.
- Many partial geo-replication systems have been introduced lately to lower the cost [Kadambi ’11][SpanStore ’13][Pileus ’13][Tuba ’14].
- However, they have high cost and latency due to suboptimal replication decisions:
  - They use a static record attribute “user” regardless of the application types.
  - They use only a single attribute to make replication decisions.
  - They use non-continuous replications, leading to suboptimal performance under SLO constraints.

We propose Acorn, an Attribute-based continuous partial geo-replication system to achieve lower cost and latency than existing systems.

Design Principles
1. Use the right attributes for different types applications
   - Private data-sharing applications, such as Facebook or Snapchat, objects are accessed mostly through friends, thus “user” is the best attribute to monitor and predict future accesses.
   - Public ones, such as YouTube or Flickr, have diverse sources of accesses. “Topic” has stronger geographic and temporal locality than “user”.

2. Use multiple attributes
   - Using more attributes makes you make better educated guesses where to place replicas.
   - E.g., replicate YouTube videos to Atlanta, GA when either they have a topic “tennis” or they are uploaded by “John Isner.”

3. Use continuous replications
   - Acorn adds extra random geo-replicas, to achieve the optimal cost or latency under SLO constraints.

Implementation
- Modified Apache Cassandra
- write makes selective geo-replicas.
- read (a) first reads the object in local datacenter, and when misses, fetches it from a remote datacenter. (b) updates attribute popularity monitor.
- Popularity metadata synchronizer
- Object location metadata

Preliminary Results
- Evaluation with a public and a private data-sharing application using workload of YouTube and Yelp on 8 and 5 simulated datacenters.
- Cost and latency reduction with the right attribute
- 40.62% cost reduction with continuous replications.
- Overall, Acorn achieves up to 54.28% and 89.91% cost overhead reduction and 43.12% and 91.69% latency overhead reduction for the public and private data-sharing applications.

\(^1\) Atlanta has the highest number of USTA members per capita in the US.
\(^2\) Isner played for University of Georgia and is a top-ranked tennis player in the US as of Aug. 2015.