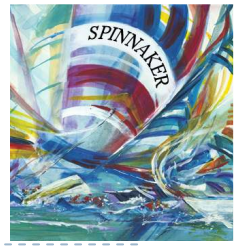
【VLDB2011勉強会】

Session 15 : Distributed Systems

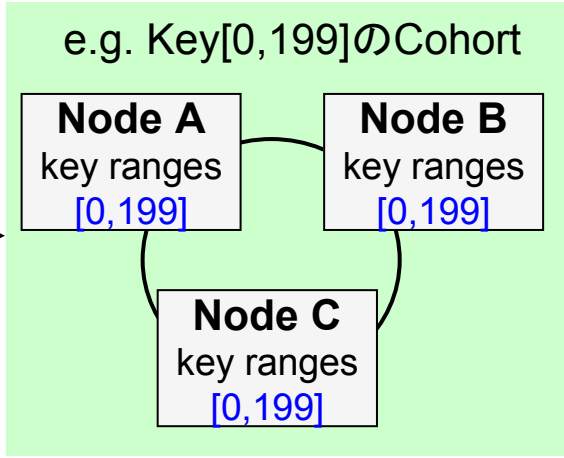
担当：榎　美紀（日本IBM）

Using Paxos to Build a Scalable, Consistent, and Highly Available Datastore

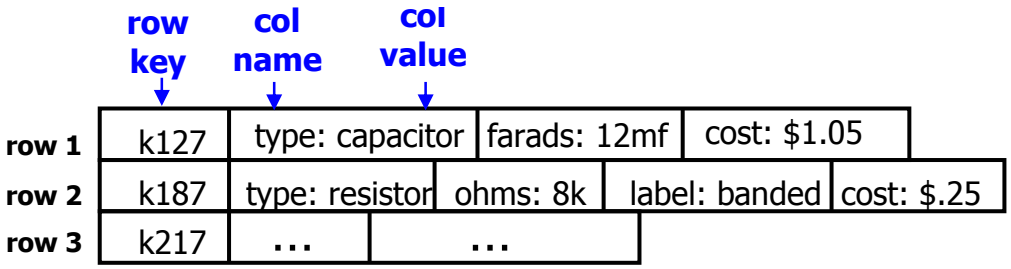
Jun Rao, Eugene Shekita, Sandeep Tata (IBM Almaden Research Center)



- Spinnaker
  - Key-range partitioning
  - Chained declustering
  - The replicas of every partition form a cohort
  - Multi-Paxos executed within each cohort
  - Timeline consistency (オブジェクト中心一貫性)



Data Model

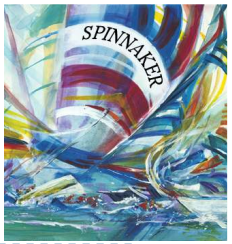


Basic API

insert (key, colName, colValue)
delete(key, colName)
get(key, colName)
test_and_set(key, colName, colValue, timestamp)

Paxos-basedな同期プロトコルについてフォーカスした論文

Multi-Paxos Replication Protocol



- 分散合意：Paxos
  - Quorum1:
    Propose -> Promise
  - Quorum2:
    Accept -> OK
- Multi-Paxos
  - Leaderを予め決めておくことにより，上記Quarum2から開始

Zookeeper
Make implementing a system that uses many instances of consensus much simpler than previously possible

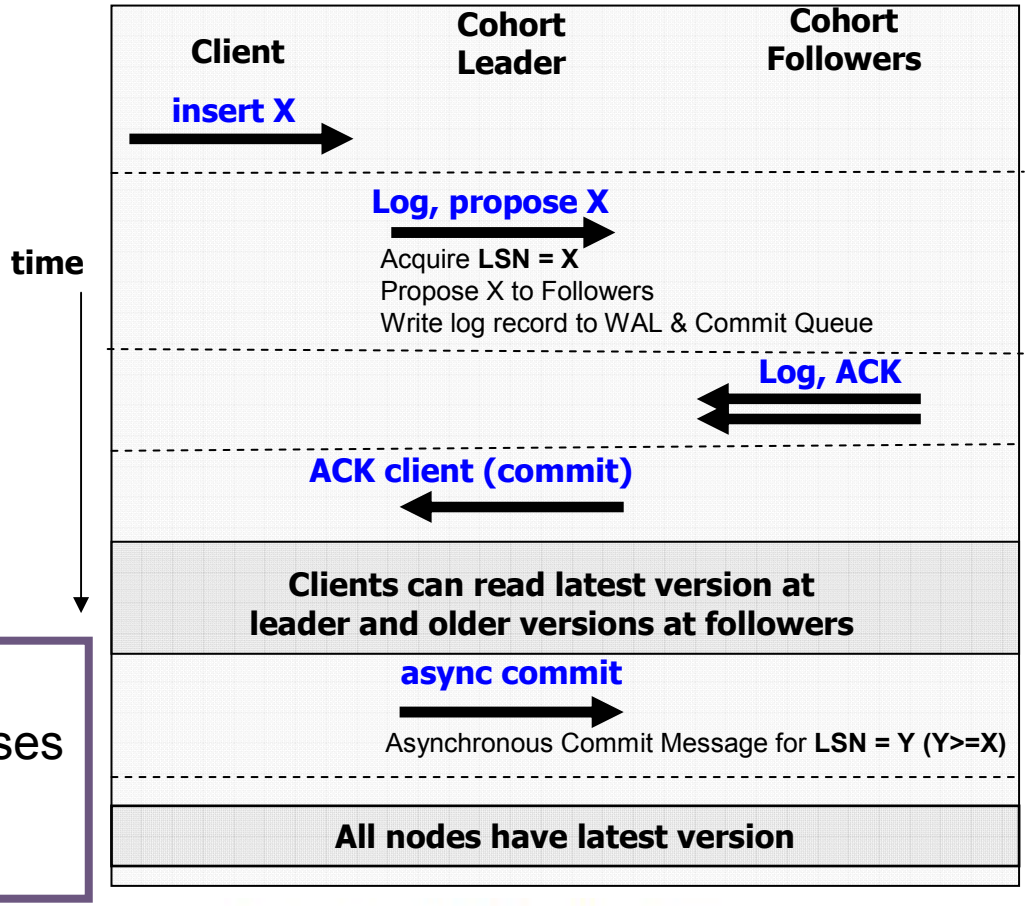
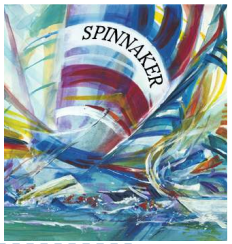


Figure 4: The replication protocol.

類似製品との比較



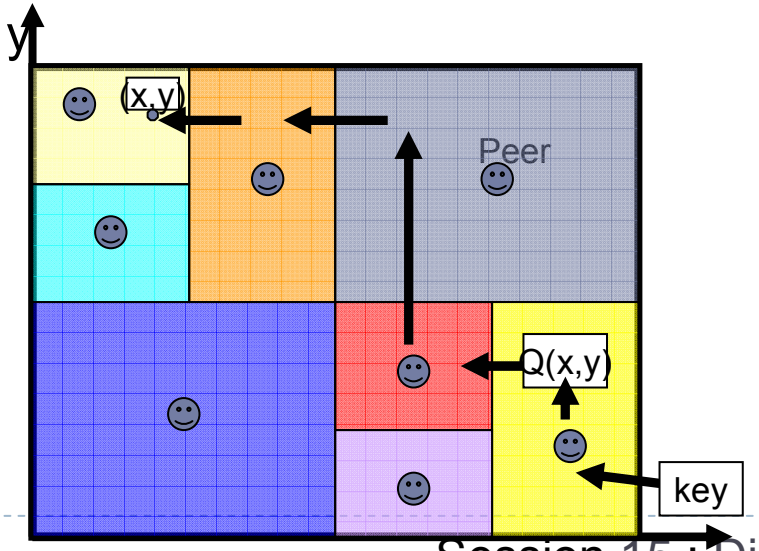
- vs BigTable (Google)
  - Strong consistency
  - LogのGFS(Google File System)への書き込みが遅い
- vs Dynamo (Amazon)
  - Eventual consistency
    - Vector timestampにより，conflictを解消する
- vs PNUTS (Yahoo)
  - Timeline consistency
  - Cross-datacenter向け

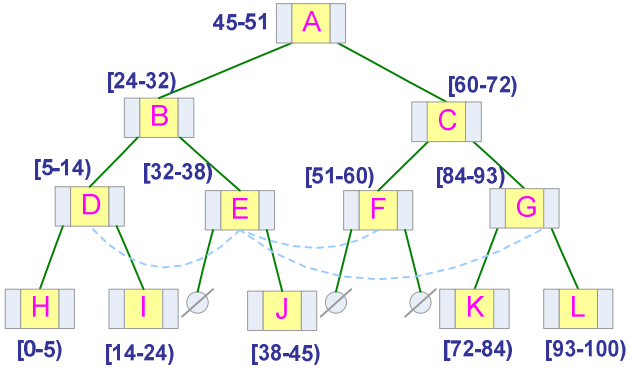
Spinnaker can be used for replication with *good* performance
10% slower writes, faster reads compared to **Cassandra**

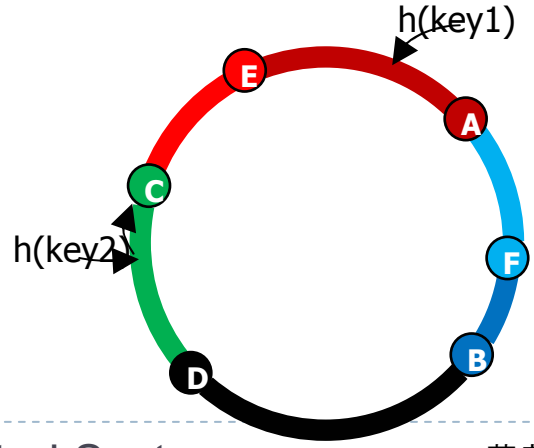
A Framework for Supporting DBMS-like Indexes in the Cloud

Gang Chen, Hoang Tam Vo, Sai Wu, Beng Chin Ooi, M. Tamer Özsu

- クラウド上にScalableでDBMS-likeな分散Indexを生成
- Different overlays are required to support different types of indexes
  - BATON for B-tree
  - CAN for R-tree
  - Chord for Hash







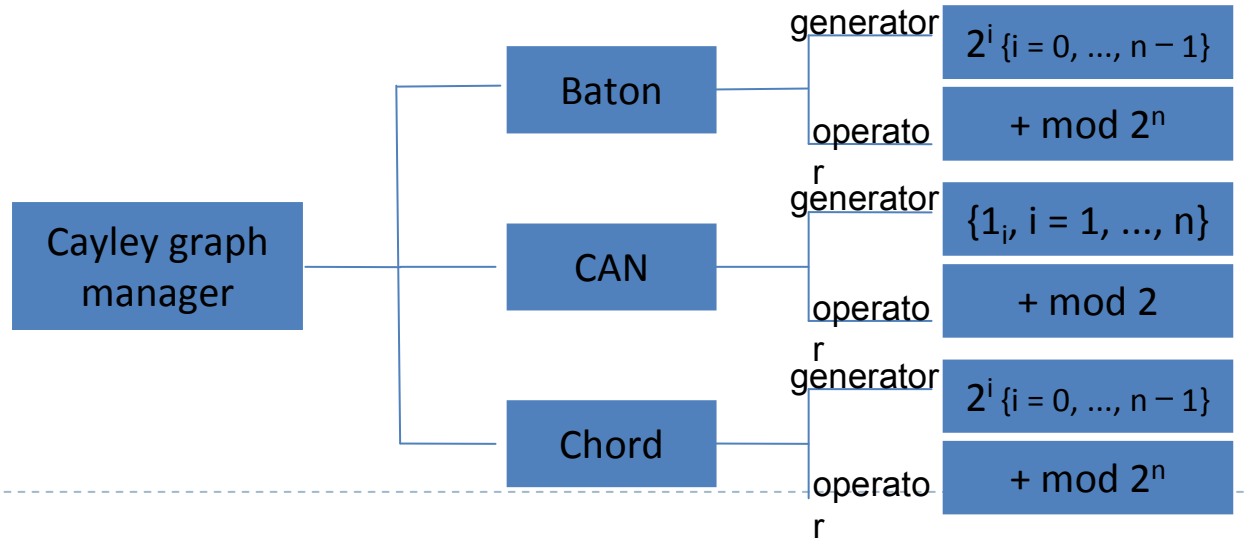
著者スライド図より抜粋

Overlay Mapping

- Two interfaces for mapping a specific type of overlay to Cayley graph
  - Generating set
  - Operator

DEFINITION 1. ***Cayley Graph*** *: A Cayley graph* $\mathcal{G} = (S, G, \bigoplus)$*, where* S *is an element set,* G *is a generator set and* $\bigoplus$ *is a binary operator, is a graph such that*

1. $\forall e \in S$*, there is a vertex in* $\mathcal{G}$ *corresponding to* e*.*
2. $\bigoplus : (S \times G) \rightarrow S$*.*
3. $\forall e \in S$ *and* $\forall g \in G$*,* $e \bigoplus g$ *is an element in* S *and there is an edge from* e *to* $e \bigoplus g$ *in* $\mathcal{G}$*.*
4. *There is no loop in* $\mathcal{G}$*, namely* $\forall e \in S, \forall g \in G \rightarrow e \bigoplus g \neq e$*.*



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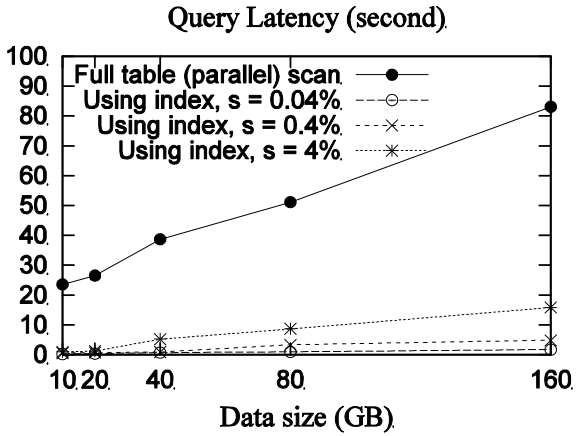
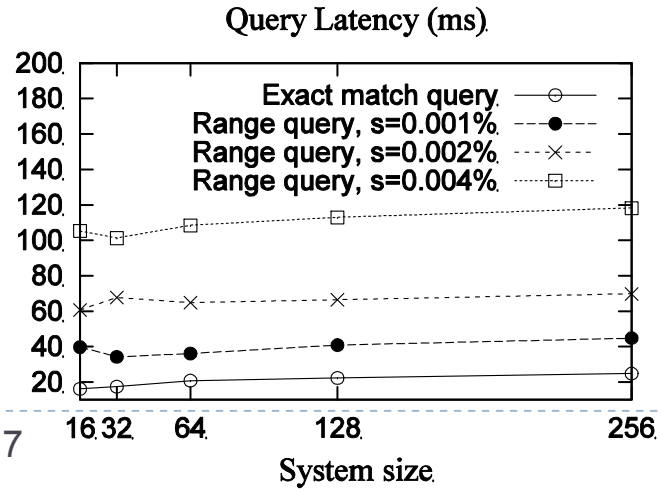
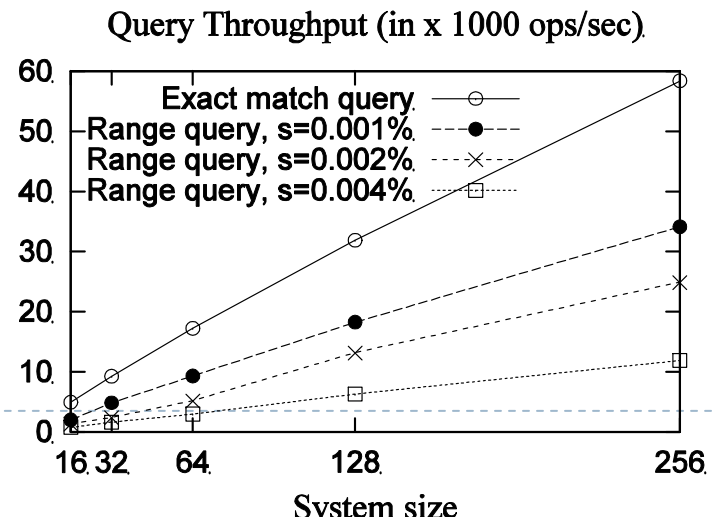
Performance and Scalability

Index plan vs. full table (parallel) scan



Scalability on EC2





Serializable Snapshot Isolation for Replicated Databases in High-Update Scenarios

Hyungsoo Jung, Hyuck Han, Alan Fekete, Uwe Röhm
(The University of Sydney, Seoul National University)

- New algorithm for 1-copy Serializable
  - 1 SR over SI replicas
  - Update anywhere-anytime-anyway transactional replication
  - Strong Consistency
  - Optimized for update heavy

Snapshot Isolation [Berenson et al., SIGMOD'95]

各トランザクションは開始時にsnapshotを取得し，開始以前にcommitされたデータのみ読める
DBMSはReadロックを回避するため複数のバージョンを保持しており，トランザクションCommit時に競合(write-write)が検出された場合はトランザクションをロールバック

Replicated Snapshot DBでSerializationを保証したい

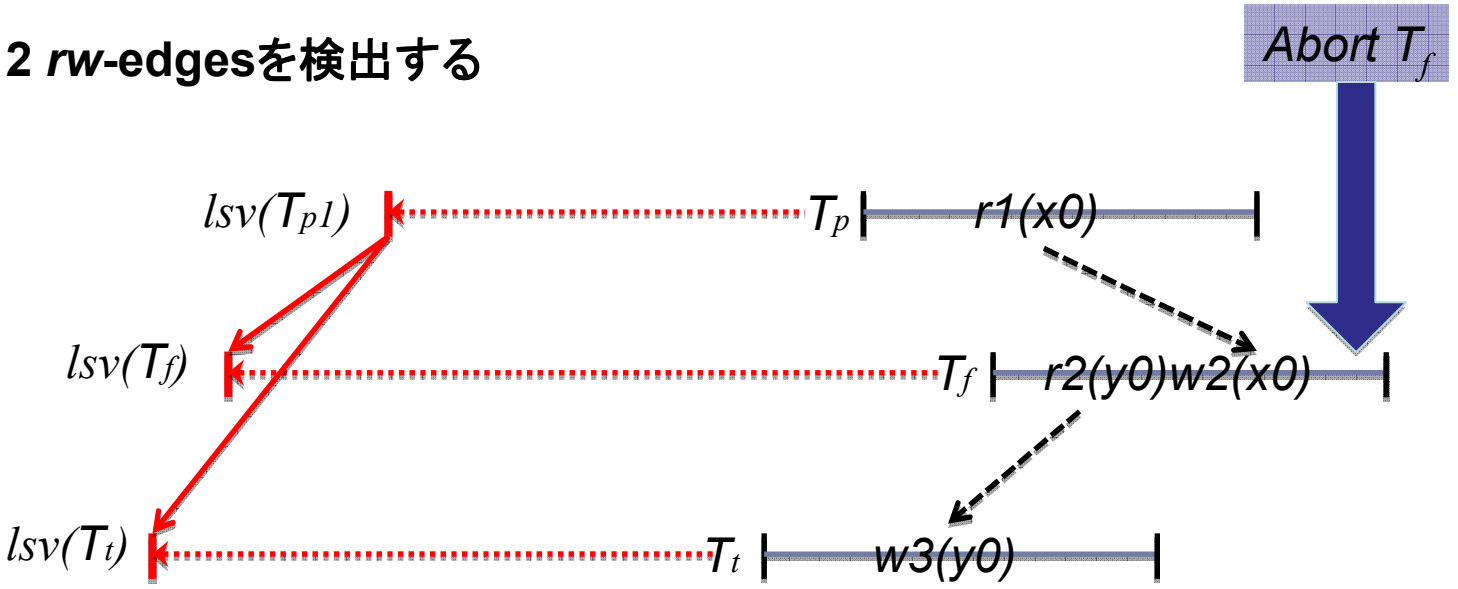
Descending Structure

【Definition 3.1】

Three transactions T_p, T_f *and* T_t with the following relationships:

1. $T_p \xrightarrow{rw} T_f$ and $T_f \xrightarrow{rw} T_t$
2. $lsv(T_f) \preceq lsv(T_p)$ && $lsv(T_t) \preceq lsv(T_p)$

2 *rw*-edgesを検出する

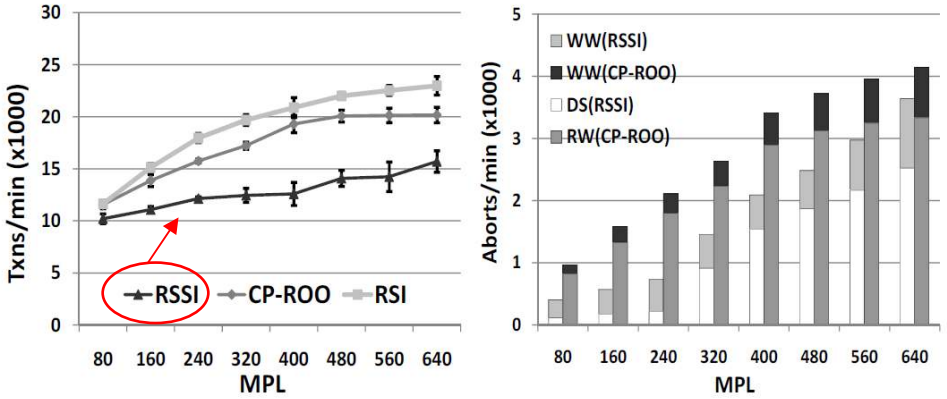


著者スライド図より抜粋

Experiments

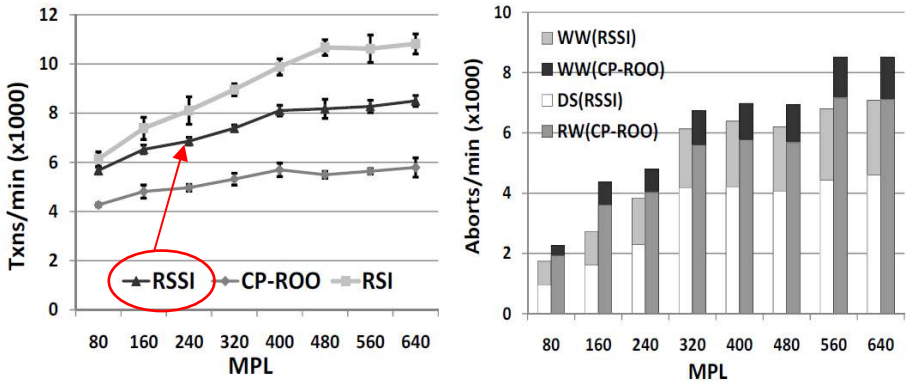
	Bornea et al. (CP-ROO)	This Work (RSSI)
Architecture	**Middleware**	**Kernel**
Readset Extraction	**SQL parsing**	**Kernel interception**
Certification	***ww*-conflict 1 *rw*-edge**	***ww*-conflict 2 *rw*-edges**
Optimized for	**Read mostly**	**Update heavy**

Read mostly Scenario



(d) 75%RO-25%W

Write mostly Scenario



(b) 25%RO-75%W