# Replication and Consistency: Being Lazy Sometimes Helps

Presentation of a paper by Yuri Brietbart and Henry F. Korth from the 1997 ACM Symp. on Principles of Database Systems (PODS'97)

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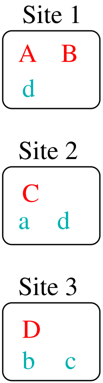
# System Model

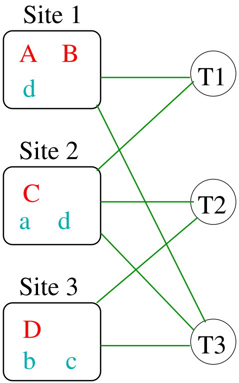



- lazy/master replication, each object has a designated master copy
- partial replication allowed
- no distributed transactions

**Goal**

Ensure global serializability.

# Simplified Global Serializability (GS) Protocol

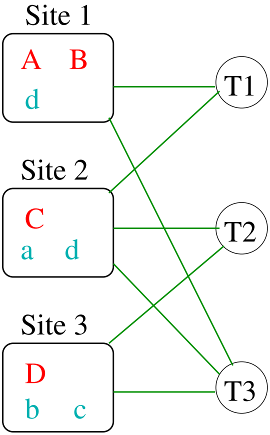



- $T_1$: read $B, d$, write $A$ (Site 1)
- later, update $a$ at Site 2
- $T_2$: read $C, a, d$, write $C$
- later, update $c$ at Site 3
- $T_3$: read $b, c$, write $D$
- later, update $d$ at Sites 1,2
- replication graph

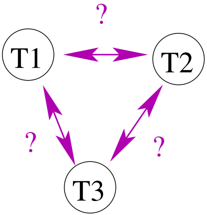
## Main Idea

Acyclic replication graph implies global serializability.

# GS Graphs and Serialization Graphs




replication graph



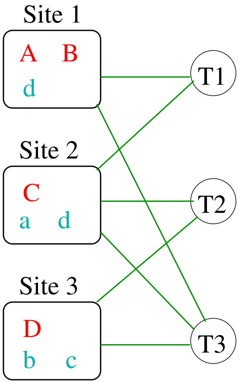

serialization graph

# Generalization #1: Dynamics

- GS protocol maintains replication graph dynamically
- when $T$ writes data, try to add required arcs to replication graph
  - if graph would be acyclic, $T$ proceeds
  - otherwise, $T$ aborts or is delayed
- Question: when can $T$ be removed from the replication graph?
- Answer: when all parts of $T$ are committed, and no other transactions in the graph precede $T$

Similar to condition for removing transactions from dynamically maintained serialization graphs.

# Generalization #2: False Conflicts

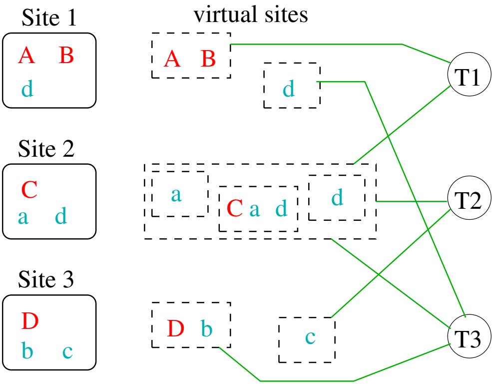



- $T_1$: read $B$,~~d~~, write $A$
- $T_2$: read $C, a, d$, write $C$
- $T_3$: read $b$,~~c~~, write $D$
- replication graph is same as original example, but these transactions can always be serialized.

## False Conflicts

Simplified protocol conservatively assumes that read/write conflicts exist, though they may not.

# Virtual Sites




- $T_1$: read $B$, ~~$d$~~, write $A$ (Site 1)
- $T_2$: read $C$, $a$, $d$, write $C$
- $T_3$: read $b$, ~~$c$~~, write $D$

Virtual sites reduce false conflicts.

# Comparisons to Other Papers

vs. Ganymed:

- centralized updates in Ganymed
- more complex and demanding global concurrency control in GS protocol
- serializability vs. SI

vs. Postgres-R:

- eager vs. lazy replication
- Postgres-R needs underlying group communication mechanism
- no local DBMS mods for GS

# Discussion

- demands on local DBMS
  - expose serialization order (for managing replication graph)
  - expose transaction readset and writeset (for managing virtual sites)
- performance issues
  - distributed deadlocks are possible
  - even purely local transactions experience overhead, aborts
  - even local read-only transactions experience overhead, aborts
- similar protocol for SI? Would it perform better?
- physical design problem
  - given workload description and a set of sites, decide where to place primary copies and replicas
  - constrained optimization problem
  - objectives: balance load, minimize aborts/delays