From Causal to $\mathbf{z}$-Linearizable Transactional Memory

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Improve performance of long transactions

- Long read-only txns: No problem if time-based transactional memory + multiple object versions (see DISC 2006, SPAA 2007)

- Problem: Long/large update transactions:
  - Very low performance in current transactional memories

- What we did:
  - Tried vector clocks for STM in practice
  - Created a faster concurrency control algorithm that provides z-Linearizability
Long update transactions: Serializability vs. Linearizability

- Current STMs:
  - 2PL or first-committer-wins
  - Gives linearizability
  - Reduces level of concurrency for long update transactions

- Serializability is not evil!
- If threads only run txns via STM (program analysis), they can’t detect difference from linearizability
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Vector clocks as time base for transactional memory

- Vector clocks with one element per processor, or plausible clocks
- Object versions timestamped with txn commit time
- Causal Serializability:
  - Check requires moderate overhead
  - But weaker than serializability
- Serializability:
  - Expensive construction of partial precedence graphs for causally preceding active txns
- Disadvantage: High runtime overhead
z-Linearizability

- Idea: Large txns partition other txns into time zones
- Zone borders are stored in object versions
- Zones are created by accesses by large txns
- Red txns access objects in different zones ("cross" first long txn $T_{L1}$)
- Red txns will be aborted (at time of bad access)
- Short txns don’t need to wait for long txns (e.g., $T_5$)
z-Linearizability: Results

- Guarantees serializability for all txns, linearizability in each timezone (can switch to linearizability for all txns when necessary)
- Can combine existing algorithms (e.g., time-based) with special algorithm for long txns
- Short txns: only 1 additional comparison per access
- Only 1 additional timestamp per object version
- Long txns: Set and check zone only, no unlock phase on commit
- Performance results look good, per-access overheads for short txns are moderate