Salt: Combining ACID and BASE in a Distributed Database

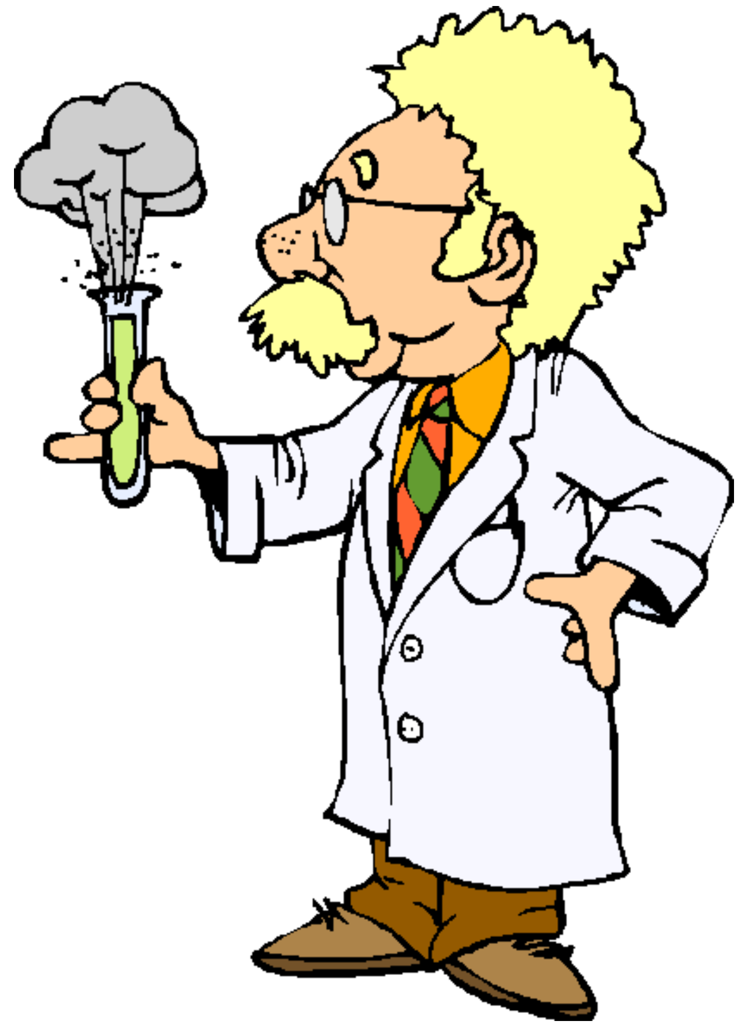
Authors (University of Texas Austin): Chao Xie, Chunzhi Su, Manos Kapritsos, Yang Wang, Navid Yaghmazadeh, Lorenzo Alvisi, Prince Mahajan

Presented By:
Sharanya Bathey

The tale of ACID…

- **Transaction** - Basic unit of work in an RDBMS

- **ACID**
  - **A**tomicity: all or nothing
  - **C**onsistency: always leave a database in a consistent state
  - **I**solation: every transaction is completely isolated
  - **D**urability: once committed always recorded



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The tale of ACID…(Oh No!)

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- What needs to be done to achieve this abstraction?
  - 2 Phase Commit
  - Locks
- What baggage do such abstractions come with?
  - Performance is sacrificed

Rise of BASE…

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- **BASE**
  - **B**asically **A**vailable - does guarantee availability, in terms of CAP theorem
  - **S**oft State - State of the system may change over time
  - **E**ventually Consistent - data will be consistent at replicas eventually

Rise of BASE… (What now?)

- Problem?
  - Complexity of programming
  - Consistency Management

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Is there no middle ground?

- Pareto Principle - 80-20 Rule

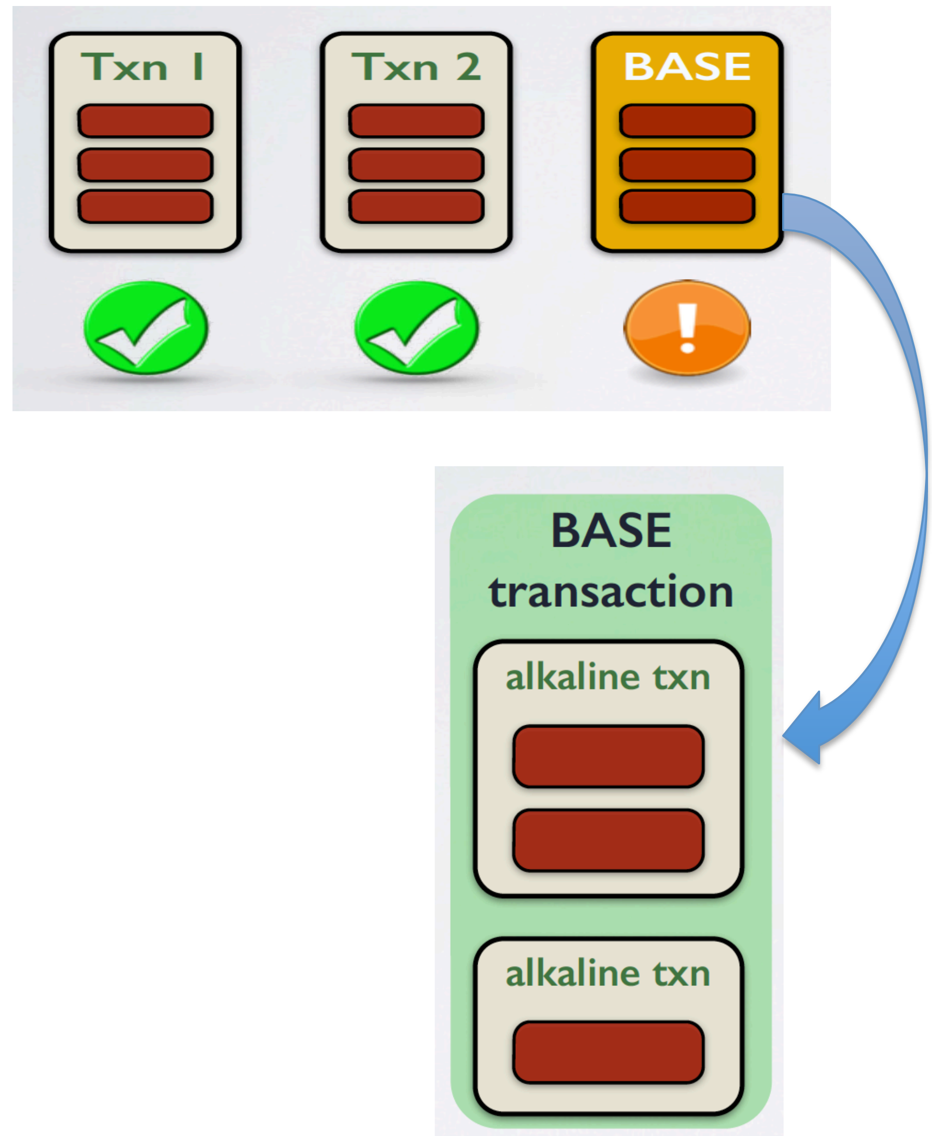
- Example:
  - Fusion Ticket (open source ticketing application)

  - Total of 11 different types of Transactions of which just 2 are performance critical

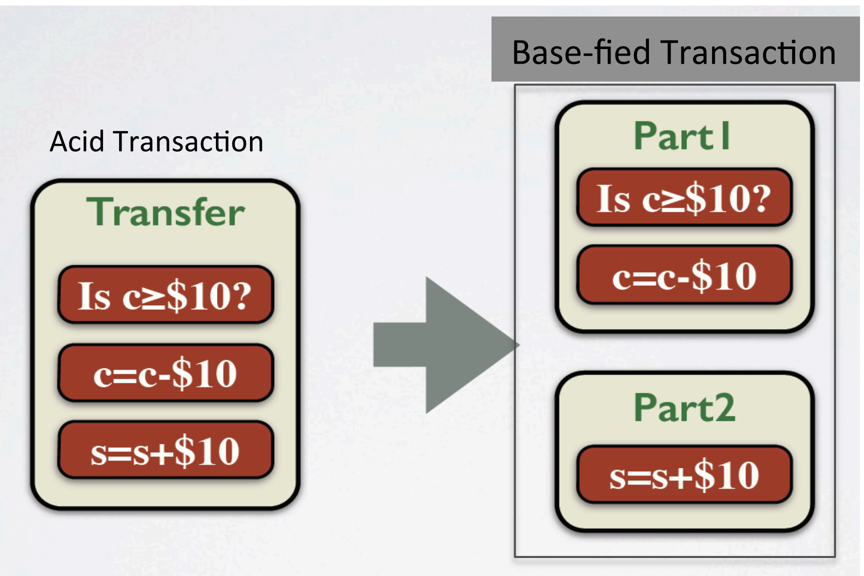
Introducing… BASE transactions

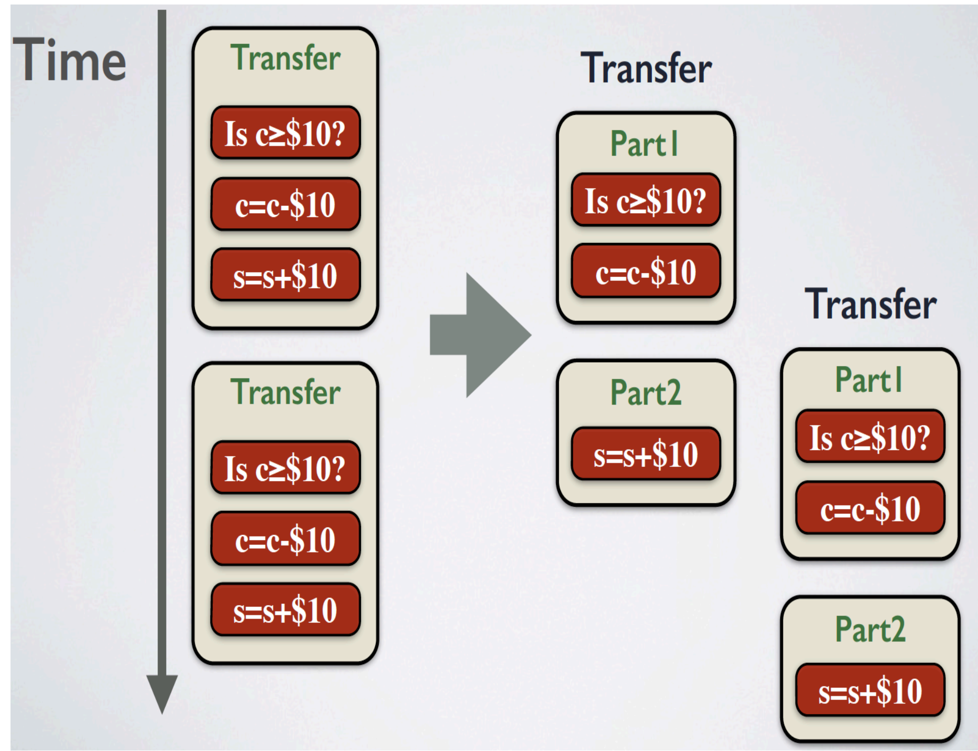
Manually Identify the key transactions that cause the performance bottleneck

Base-ify these transactions by breaking the transaction into alkaline sub transactions which are still contained within the same BASE transaction

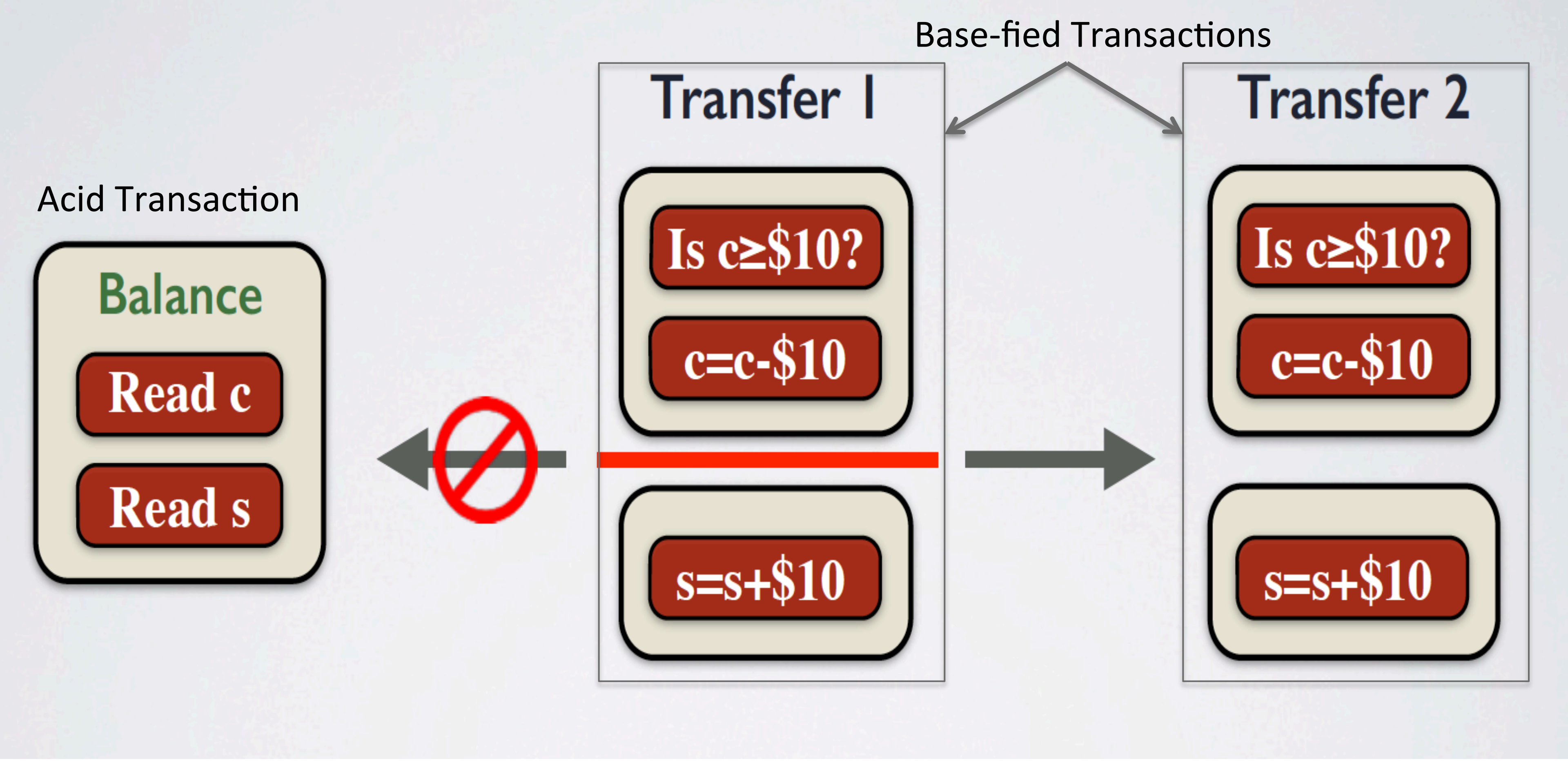


Example of Base-iying an ACID transaction





But the problem being?



Solution being? Restrict Interaction

	ACID	BASE	Alkaline
ACID	No	No	No
BASE	No	Yes*	Yes*
Alkaline	No	Yes*	Yes**

* - intermediate committed state of alkaline sub transactions
** - only read alkaline sub transactions

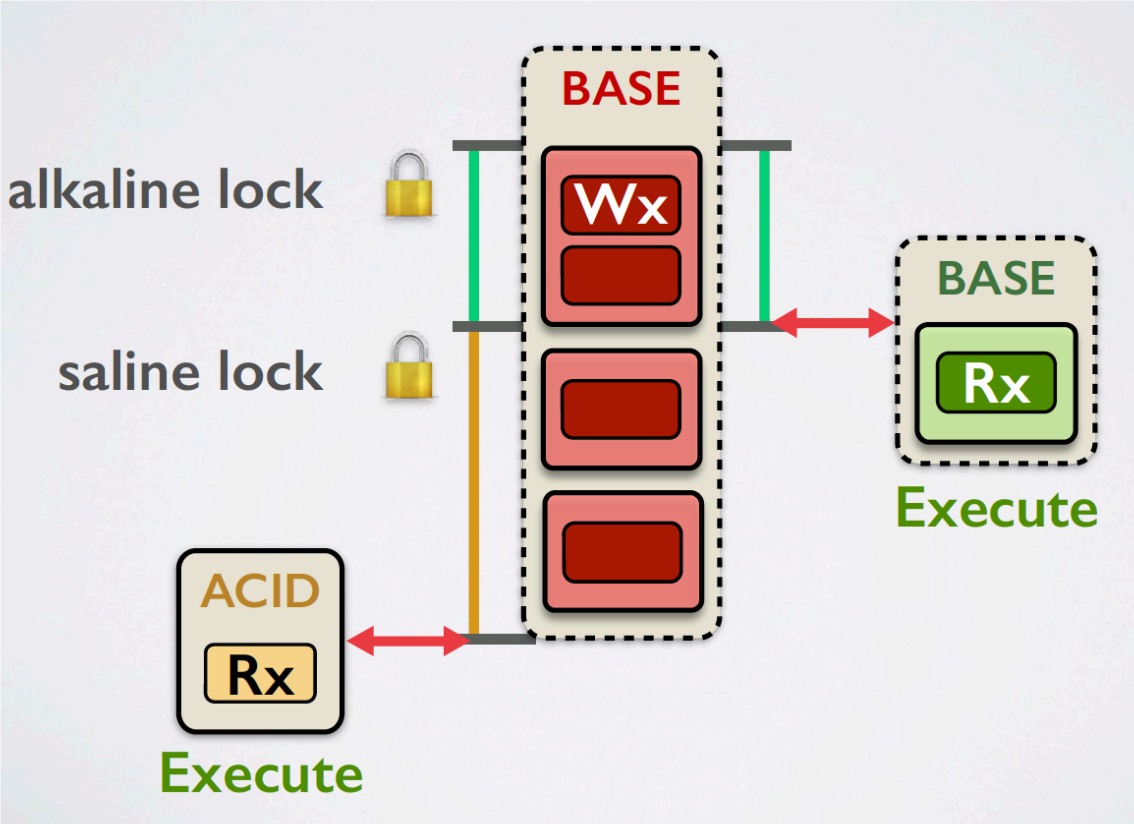
Base Transactions (Contd...)

- Major life events of BASE transactions: Accept & Commit
- How does a BASE transaction provide ACID abstraction?
  - Atomicity - once accepted will eventually commit
  - Consistency - Interactions keep ACID and BASE transactions isolated
  - Isolation - **SALT Isolation** coming up next..
  - Durability - Accepted BASE transactions are guaranteed to be durable through logging

Introducing the MVP – Salt Isolation

- Uses Locks - Isolation level chosen is Read Committed

- Locks:
  - ACID Locks - write with any other operation conflicts
  - Alkaline Locks - alkaline sub transactions isolated from ACID and other alkaline sub transactions
  - Saline Locks - ACID isolated from BASE, but increased concurrency by exposing intermediate state to of BASE transactions to other BASE transactions



So does it actually work?

- Implementation:
  - Modified MySQL to allow BASE transactions and Alkaline Sub-transactions
  - Allow alkaline and saline locks

- Optimizations:
  - Early commit - A client that issues a BASE transaction sees the transaction completion when when its first Alkaline sub transaction commits
  - Failure recovery - Logging with redo and roll forward
  - Transitive dependencies - Per object queue
  - Local Transactions

- Replication of data was done across 10 partitions and each partition was three-way replicated

- Evaluated: Performance Gain, Programming Effort, Contention Ratio

Case Study

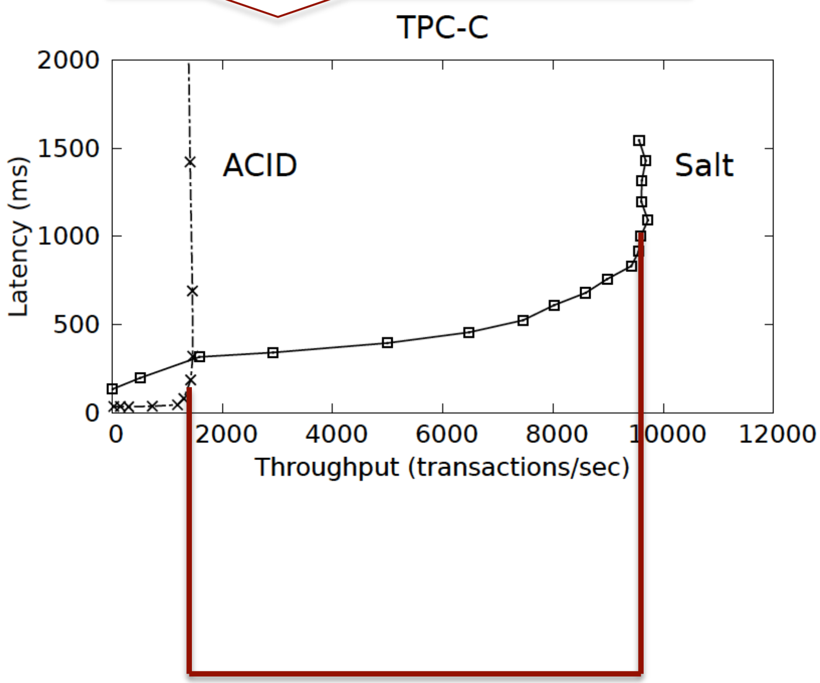
```
begin BASE transaction
    Check whether all items exist. Exit otherwise.
    Select w_tax into @w_tax from warehouse where w_id = : w_id;
    begin alkaline−subtransaction
        Select d_tax into @d_tax, next_order_id into @o_id from
              district where w_id = : w_id and d_id = : d_id;
        Update district set next_order_id = o_id + 1 where w_id =
              : w_id AND d_id = : d_id;
    end alkaline−subtransaction
    Select discount into @discount, last_name into @name, credit
          into @credit where w_id = : w_id and d_id = : d_id and
          c_id = : c_id
    Insert into orders values (: w_id, : d_id, @o_id, ...);
    Insert into new_orders values (: w_id, : d_id, o_id);
    For each ordered item, insert an order line, update stock level, and
          calculate order total
end BASE transaction
```

Applications used for the experiments

- TPC-C benchmark : database performance standard
  - 5 transactions (new-order, payment, stock-level, order-status and delivery)
  - New-order and payment are responsible for 43.5% of total number of transactions
- Fusion Ticket: open source ticketing application in PHP and MySQL
  - Includes several transactions
  - Create-order and payment most frequent and performance critical
- Micro benchmark:
  - Contention ratio
  - Contending transaction position
  - Read-Write ratio

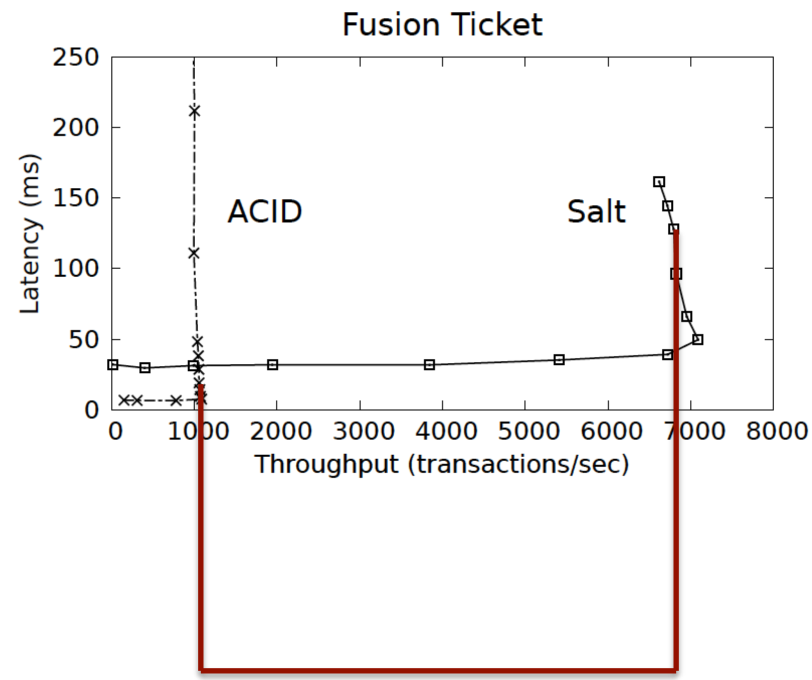
Did Salt win the award? (Yes…)

Base-ify: new-order and payment



6.6x higher

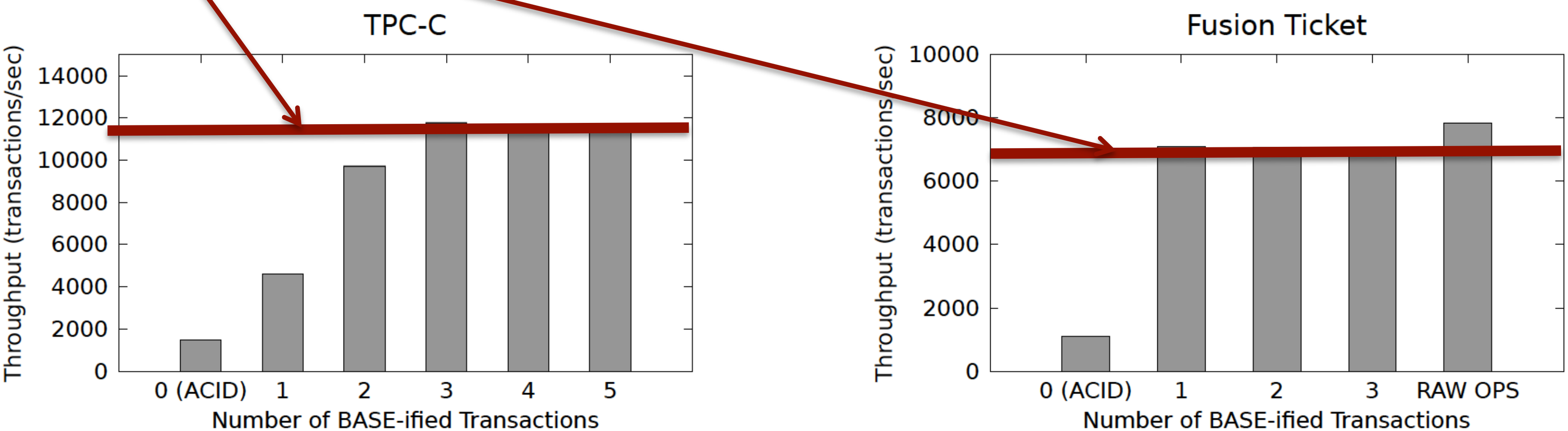
Base-ify: Create-order and payment



6.5x higher

Did Salt win the award? (Contd...)

Performance gain becomes stagnant



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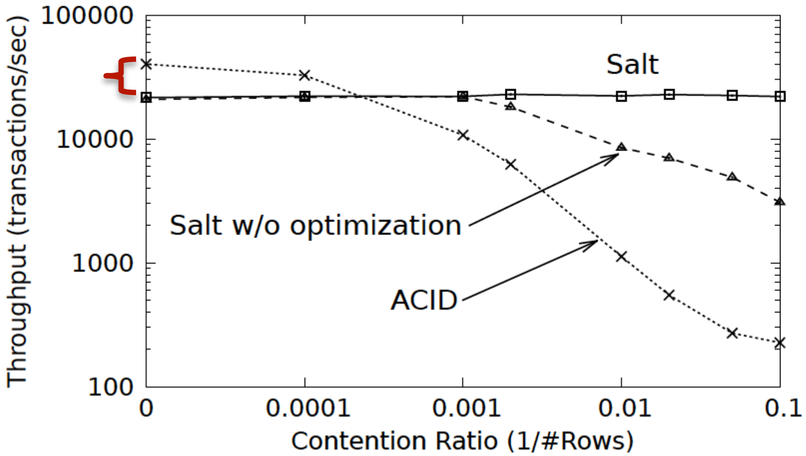

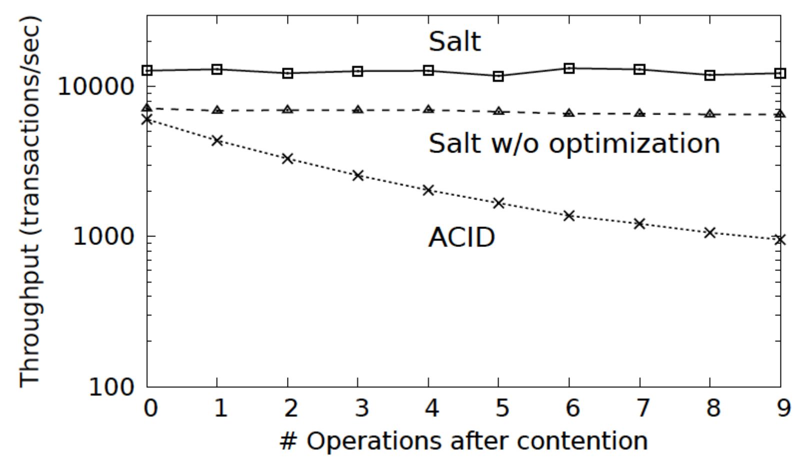

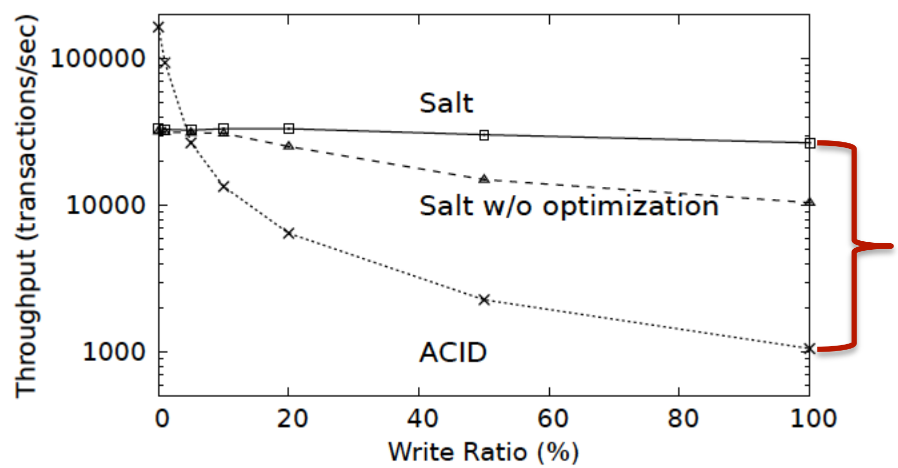

Discussion & Q-A

- Pros:
  - Performance gain is drastic
  - Control in the hands of the programmer

- Cons:
  - Cassandra allows batching of commands into groups to form transactions called atomic batches
  - Leverage the power of MySQL clusters - MySQL does not allow nested transactions and MySQL now has several NoSQL/NewSQL like features
  - Programming complexity - the difficulty of identifying the transactions that need to be converted and verifying the correctness is a daunting task

Thank You!