ACDC
Scalable Distributed Transactions

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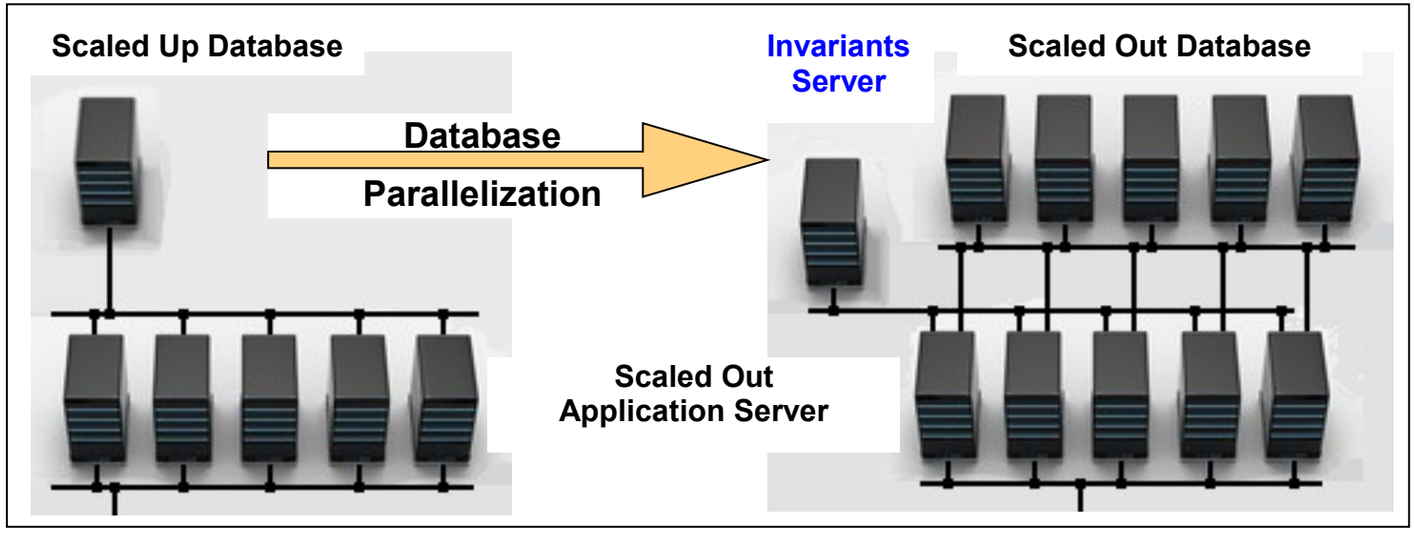
ACDC Transaction

- Atomic
- Consistent
- Distributed
- Concurrent

Transaction coordination with:

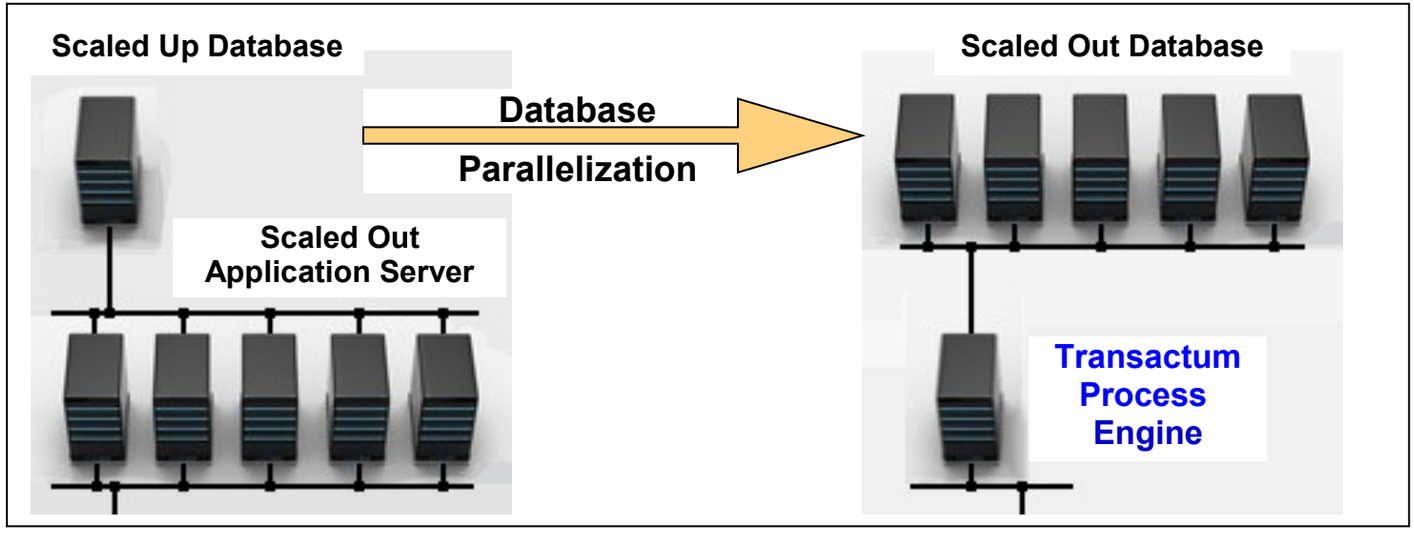
- Serializing schedules and
- Prevented violation of integrity
- Enforced as invariants.

Invariants-based Transactions
With Parallel Databases
Implementation with Mainstream Platforms



- Requires a dedicated Invariants Server.
- Injects latency with networking loops.
- Makes the transactions inefficient.

Invariants-based Transactions
With Parallel Databases
Implementation with Transactum Process Engine



Transactum Process Engine gives the advantage of:

- Scaling the application instances on one machine
- Running the invariants on the same machine.

ACDC Transaction

Concept

Definition

ACDC is:

- Flat transaction,
- Chaining multiple sub-transactions,
- Which can execute on individual shards.

It guarantees:

- Atomic and
- Consistent execution with a
- Distributed database over multiple shards and
- Concurrent performance of multiple conflicting instances.

ACDC Transaction

Concept

ACDC Atomicity

- Permits multiple consistent completion states.
- Prevents rollback as response to technical and semantic failures.
- Transactions with a technical failure:
  - In a sub-transaction – commit it on Replicated Database.
  - In coordination – continue on backup Process Engine.
- Transactions with semantic failure:
  - Continue with another chain of sub-transactions.
  - Commit with a state representing the semantic result.

ACDC Transaction

Concept

ACDC Consistency

- Serialization of local sub-transactions:
  - With syntactic invariants
  - As pre-execution condition
- Prevented violation of integrity:
  - With semantic invariants
  - As post-execution condition

ACDC Transaction

Implementation

Concurrency Control

- Based on global serializability schedules,
- Built from programmer-specified transaction syntax.

Integrity Control

- Checks for violation of integrity constraints,
- Before execution of a local sub-transaction, with
- Programmer-provided binary code with semantics.

ACDC Transaction

Implementation

Recovery

- Coordination clustering:
  - Persists transactions' intermediate state.
  - Takes care for availability of transaction coordination.
  - Continues the active transactions from their last committed step.
- Replication clustering:
  - Synchronously replicates local sub-transactions.
  - Takes care for partition tolerance of the database.

ACDC Transaction

Implementation

Partition Tolerance

Achieved with real-time response to failures of:

- Network by:
  - Duplication of network segments
  - Detection of failure and switching to backup segment
- Node by:
  - Synchronous replication of state of DB nodes.
  - Asynchronous replication of state of the Process Engine – Lost messages are dealt with Idempotent steps.
  - Detection of failure and switching to backup node.

ACDC Experimental Tests

Environment

Hardware

$500-Computers with:

- Intel i5 Quad-Core CPU
- 4MB RAM
- 2 x Spinning HD
- 2 x 1Gb LAN

Software

- Windows 2003 Enterprise Server x64
- MS SQL Server 2008 x64
- Transactum Process Engine
- Test Application

ACDC Experimental Tests

Test Application

Performs 5 steps in two alternative configurations:

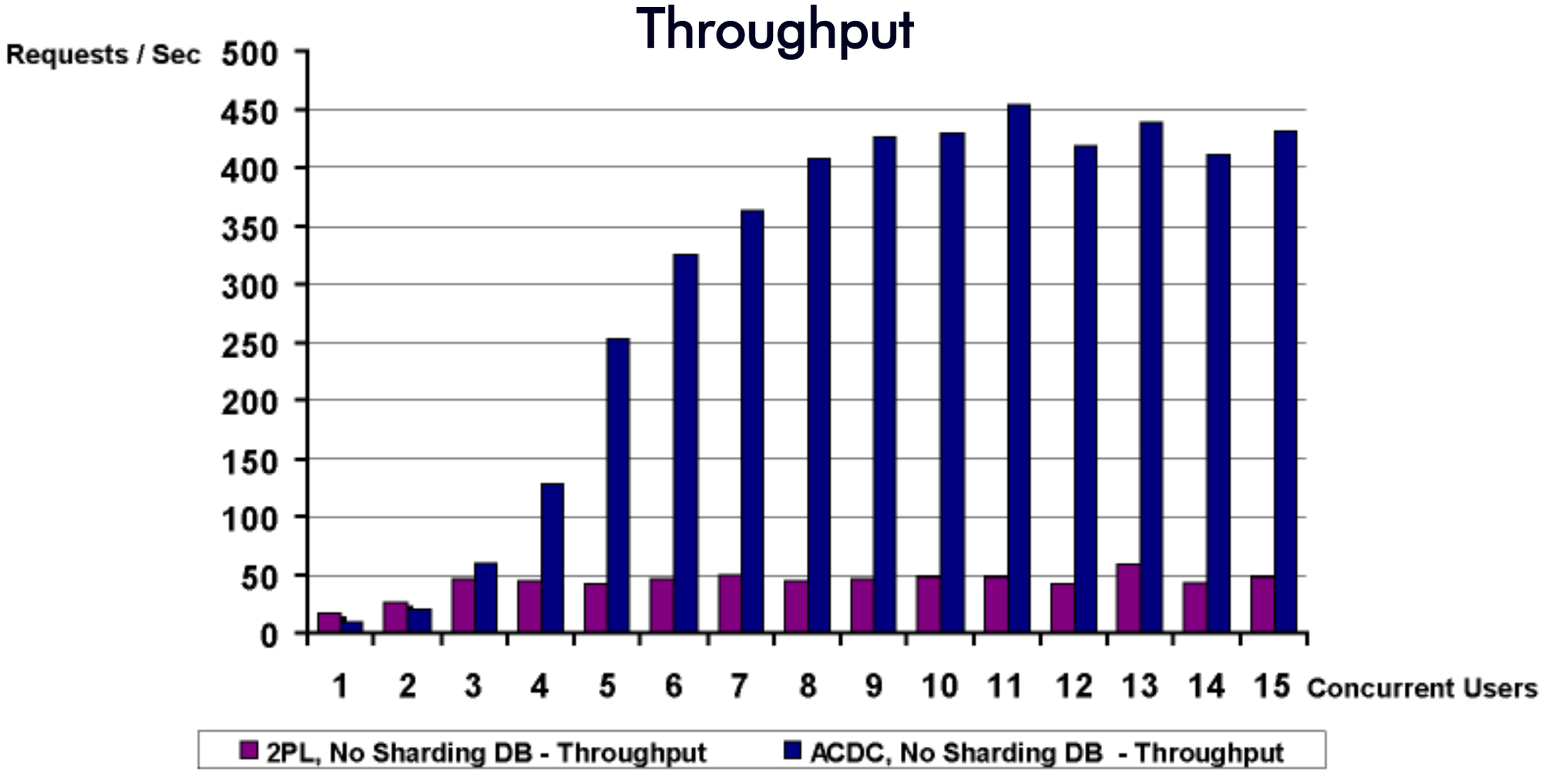
- With 5 Chained 2PL transactions.
- With a single ACDC transaction.

The steps:

- Insert a short DB record (all steps).
- Update a DB aggregation (all steps).
- Insert a DB record with 6 strings (step 5 only).

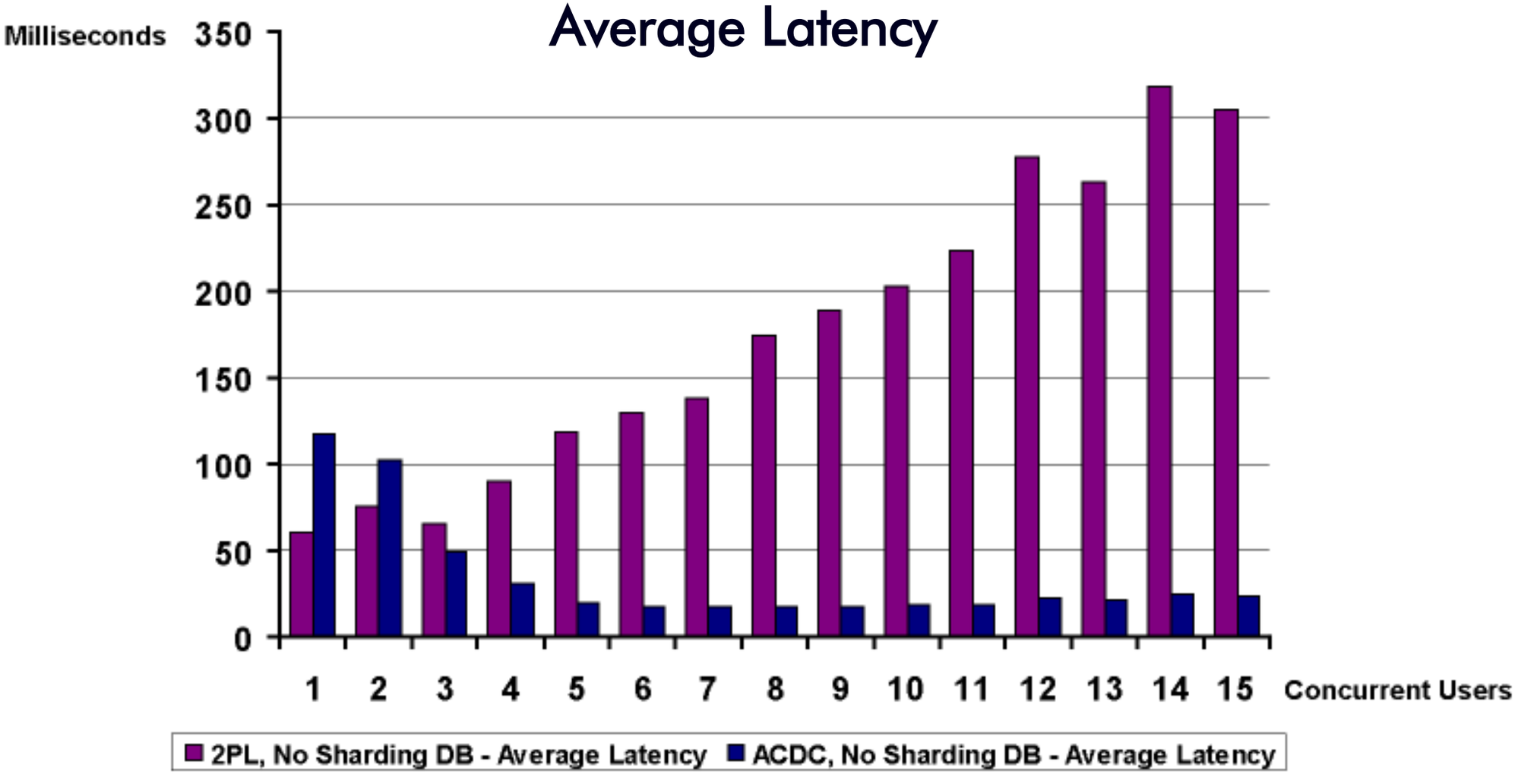
ACDC Tests Results

2PL Chained vs. ACDC



ACDC Tests Results

2PL Chained vs. ACDC



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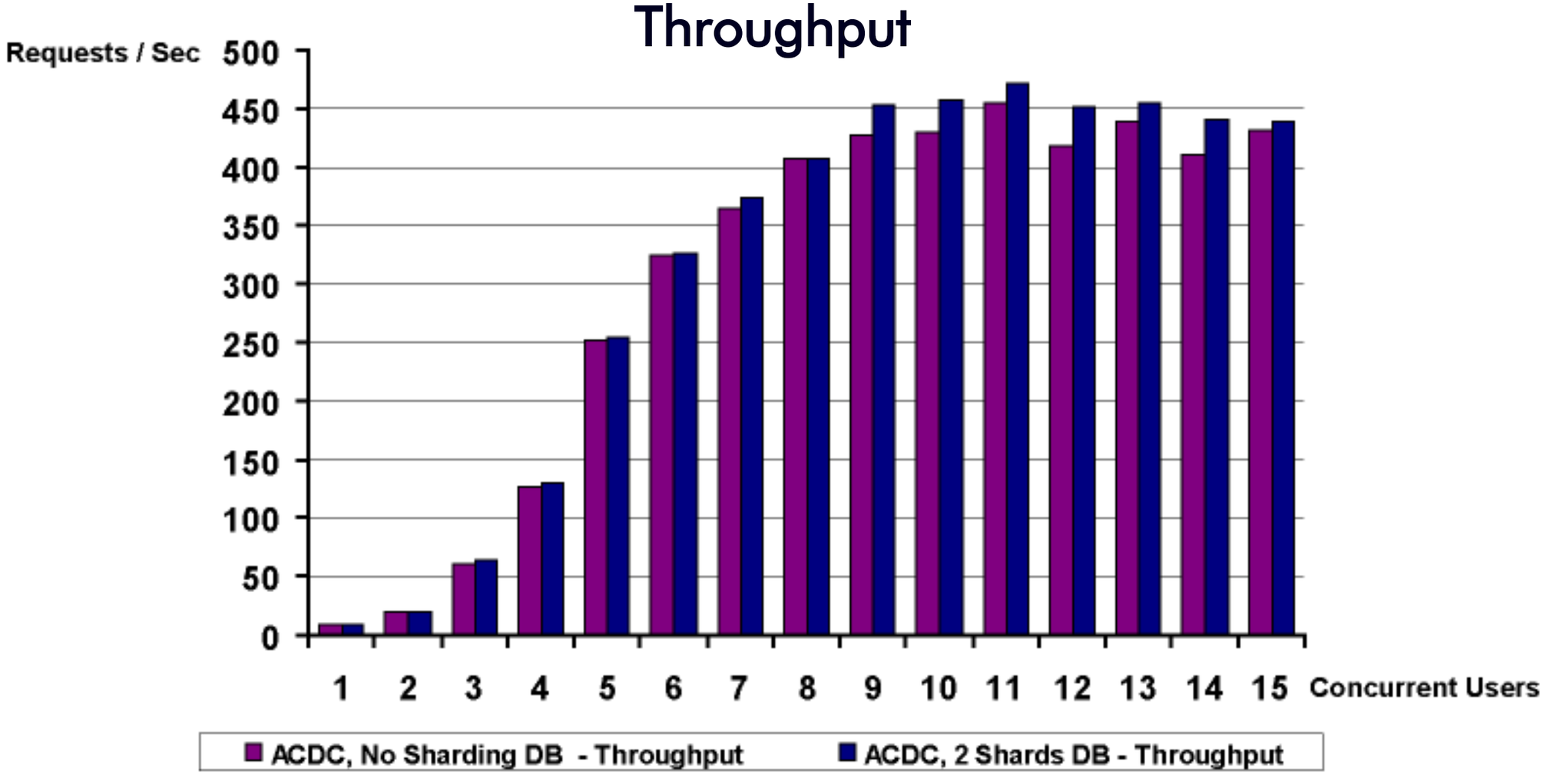
ACDC Tests Results

No Sharding ACDC vs. 2 Shards ACDC



ACDC Tests Results

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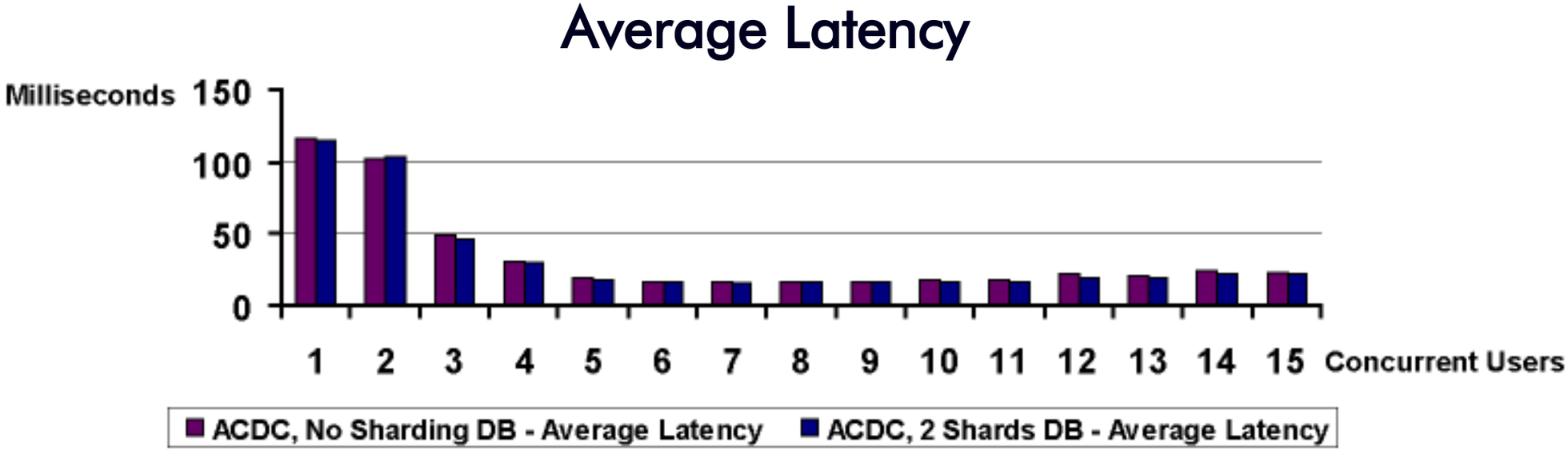
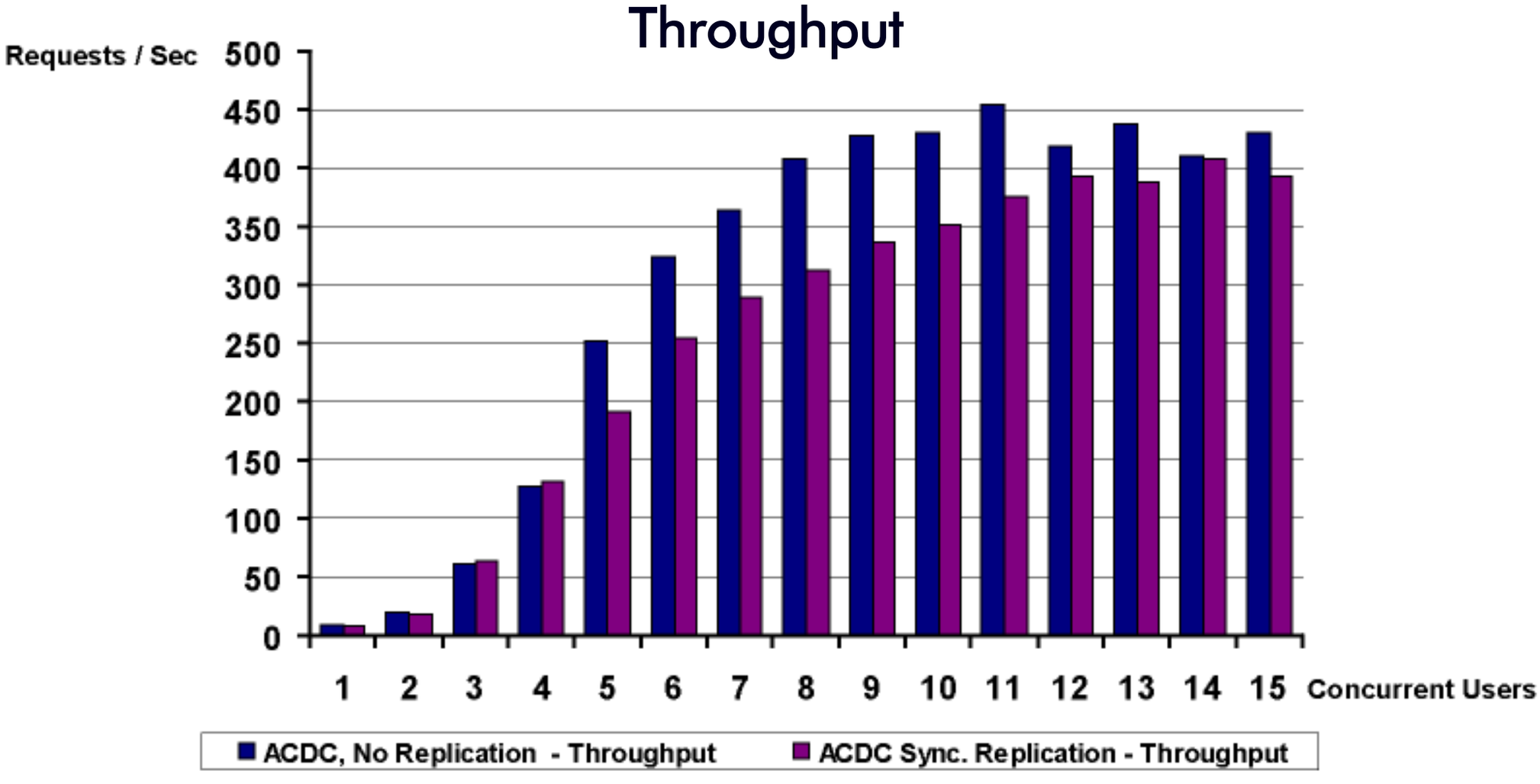


The results with 2-Shards ACDC:

- Show that DB is already not the system bottleneck.

ACDC Tests Results

No Replication vs. Synchronous Replication ACDC



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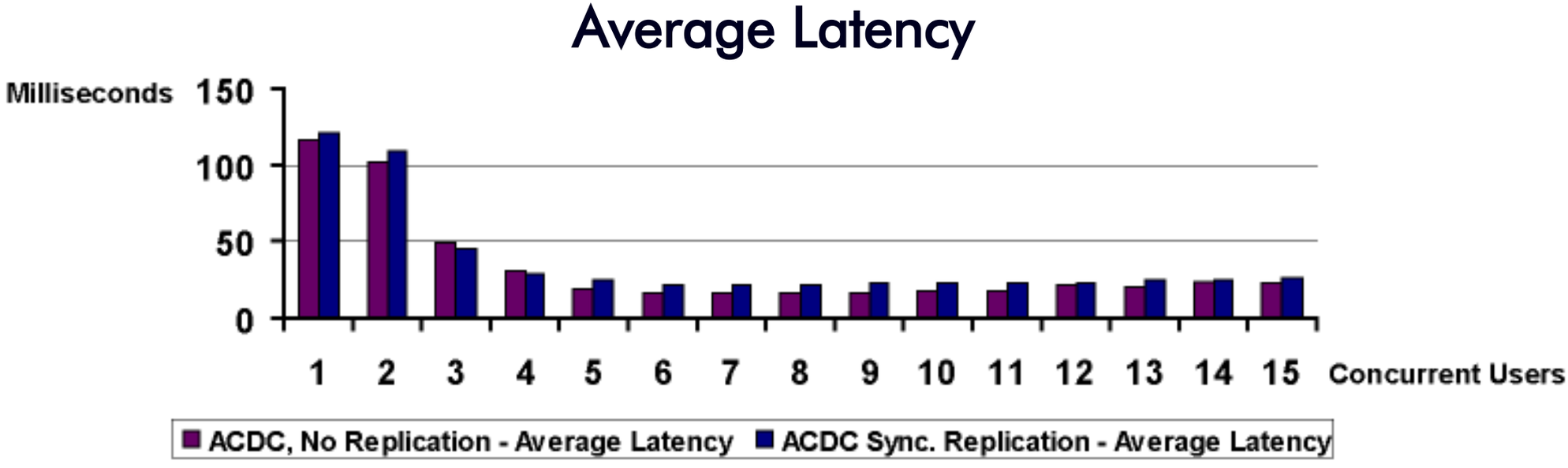
ACDC Tests Results

No Replication vs. Synchronous Replication ACDC



Results with the synchronous replication show:

- The price for partition tolerance:
  - 14% average decrease of throughput
  - 17% average increase of latency

Conclusion

ACDC transactions run on Transactum Process Engine:

- Guarantee the consistency,
- Enhance the partition tolerance,
- Boost the performance with
  One order of magnitude.

Interest for test-driving is welcome!

Thank You

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