Is Scalable OLTP in the Cloud a Solved Problem?

Analyzing Data Access for Distributed OLTP Architectures

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The Case for Shared Nothing

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ABSTRACT

There are three dominent themes in building high transaction rate multiprocessor systems, namely shared memory (e.g. Synapse, IBM/AP configurations), shared disk (e.g. VAX/cluster, any multi-ported disk system), and shared nothing (e.g. Tandem, Tolerant). This paper argues that shared nothing is the preferred approach.

1. INTRODUCTION

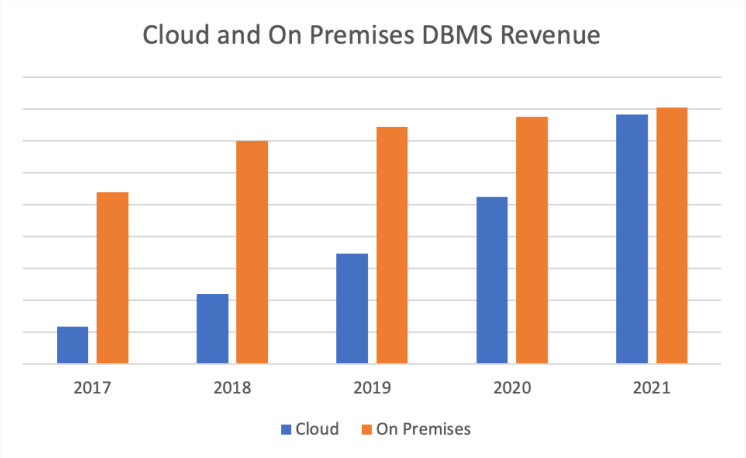
The three most commonly mentioned architectures for multiprocessor high transaction rate systems are:

shared memory (SM), i.e. multiple processors shared a common central memory

shared disk (SD), i.e. multiple processors each with private memory share a common collection of disks

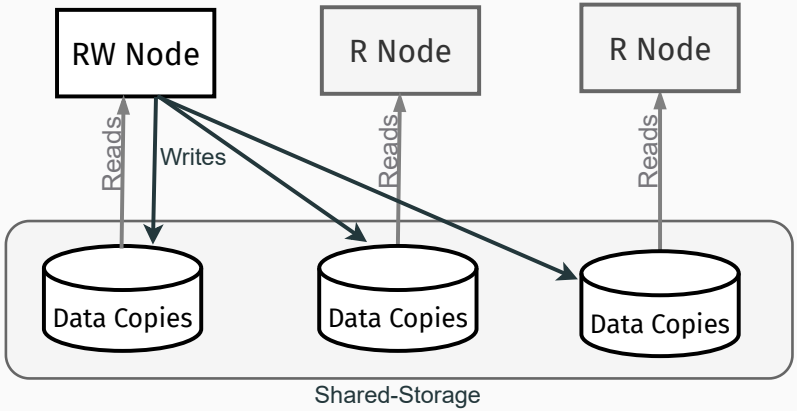
shared nothing (SN), i.e. neither memory nor peripheral storage is shared among processors

DBMS Market (Revenue): $80B/year [Gartner]



source: https://blogs.gartner.com/merv-adrian/2022/04/16/dbms-market-transformation-2021-the-big-picture/

Aurora


RW Node
R Node
R Node
Reads
Writes
Reads
Reads
Data Copies
Data Copies
Data Copies
Shared-Storage

This Talk

1. Improve conceptual clarity by mapping the distributed OLTP landscape
2. Understand why fully distributed systems have not become standard
3. Discuss research opportunities to get there

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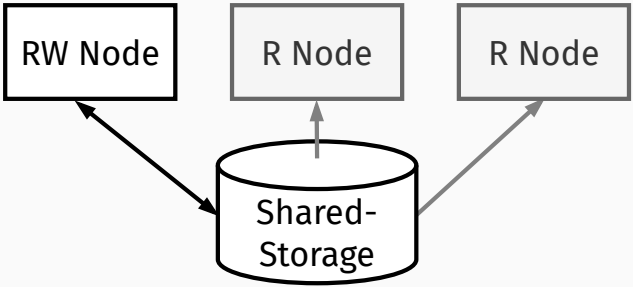
Methodology:

- Distill 4 paradigmatic architectures (“archetypes”)
- Scalability of data access path: uniform/skewed reads/writes
- Elasticity: scaling compute and storage separately

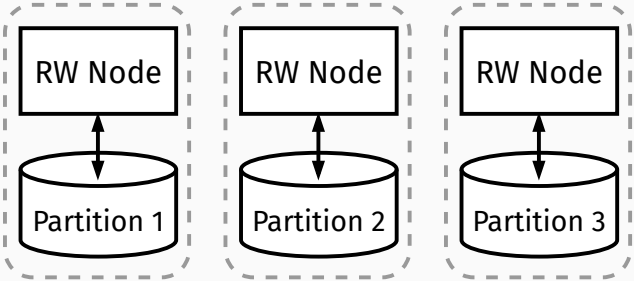
Archetype #1: Single-Writer



examples: AWS Aurora, Azure SQL Hyperscale, Google AlloyDB

uniform reads | uniform writes | skewed reads | skewed writes | elasticity

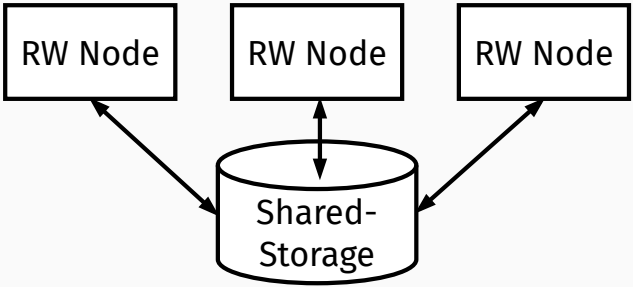
Archetype #2: Partitioned-Writer



examples: System R*, CockroachDB, Spanner

uniform reads	uniform writes	skewed reads	skewed writes	elasticity

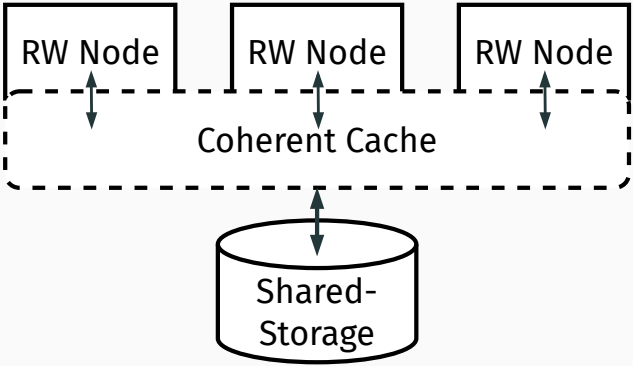
Archetype #3: Shared-Writer (Without Cache)



examples: NAM-DB, Sherman

uniform reads	uniform writes	skewed reads	skewed writes	elasticity

Archetype #4: Shared-Writer With Coherent Caches (“Shared-Cache”)



examples: Oracle RAC, ScaleStore

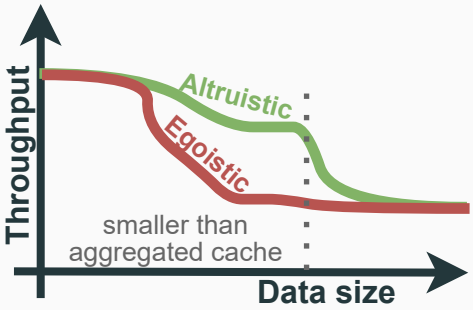
uniform reads	uniform writes	skewed reads	skewed writes	elasticity

The Case For Shared-Cache

+ good scalability properties
+ supports arbitrary workloads (no user-defined partitioning)
+ supports arbitrary data structures (e.g., B-trees)
– difficult implementation, little research

Research Challenges For Shared-Cache Architecture

- Cache coherence: ✓
- Altruistic eviction: ?
- Elasticity: ?
- Transactions (ACID):
  - A+C: ✓
  - I: ?
  - D: ?
- HW/Cloud: emerging network technologies (EFA, RDMA), cloud services



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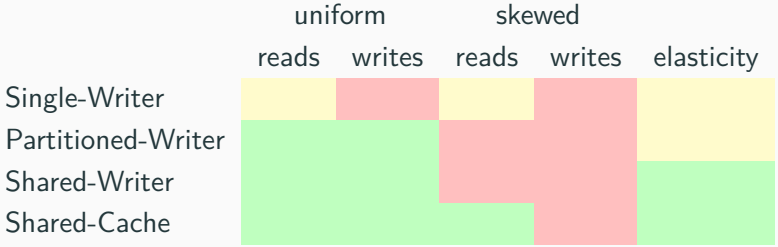

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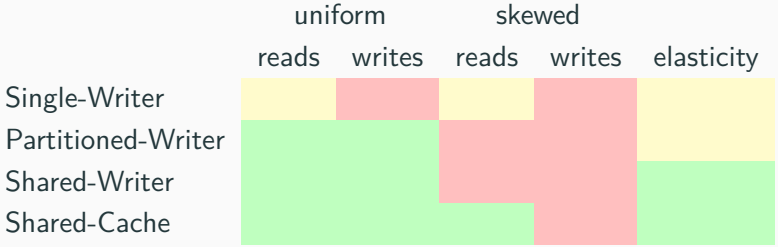

No, but there's a path to getting there