Hazelcast 5.1

The Hitchhiker's Guide

Grzegorz Piwowarek

@pivovarit

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{ 4comprehension.com }

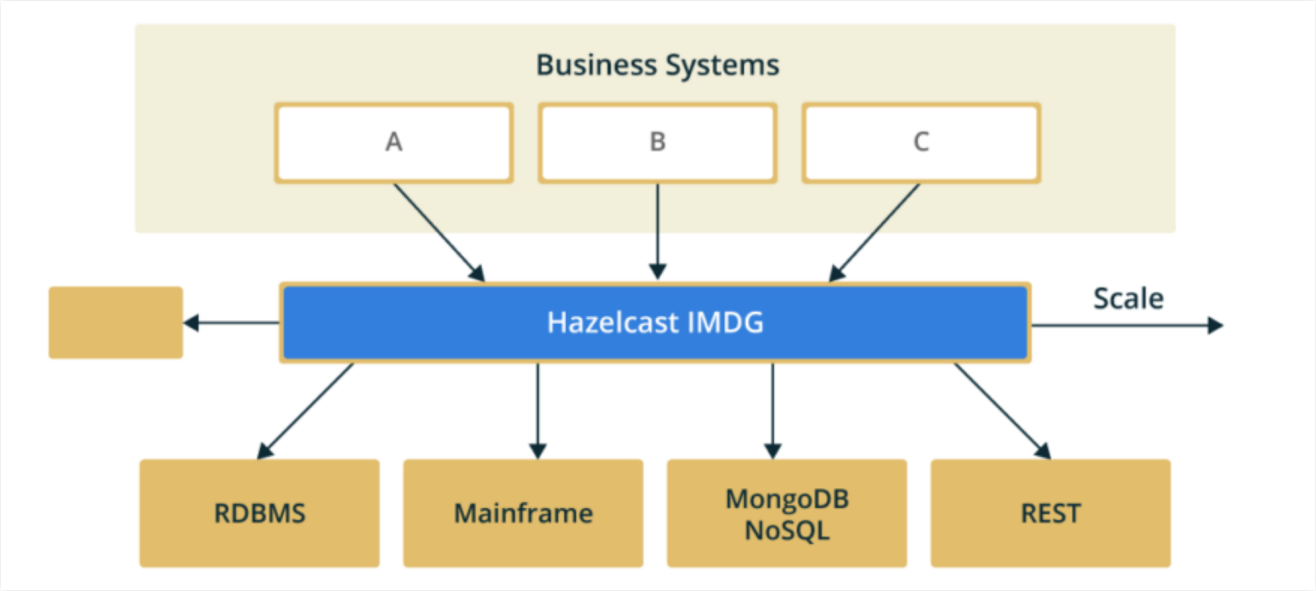
Lead Architect @ Hazelcast

Trainer @ Bottega IT Minds

@pivovarit

HAZELCAST

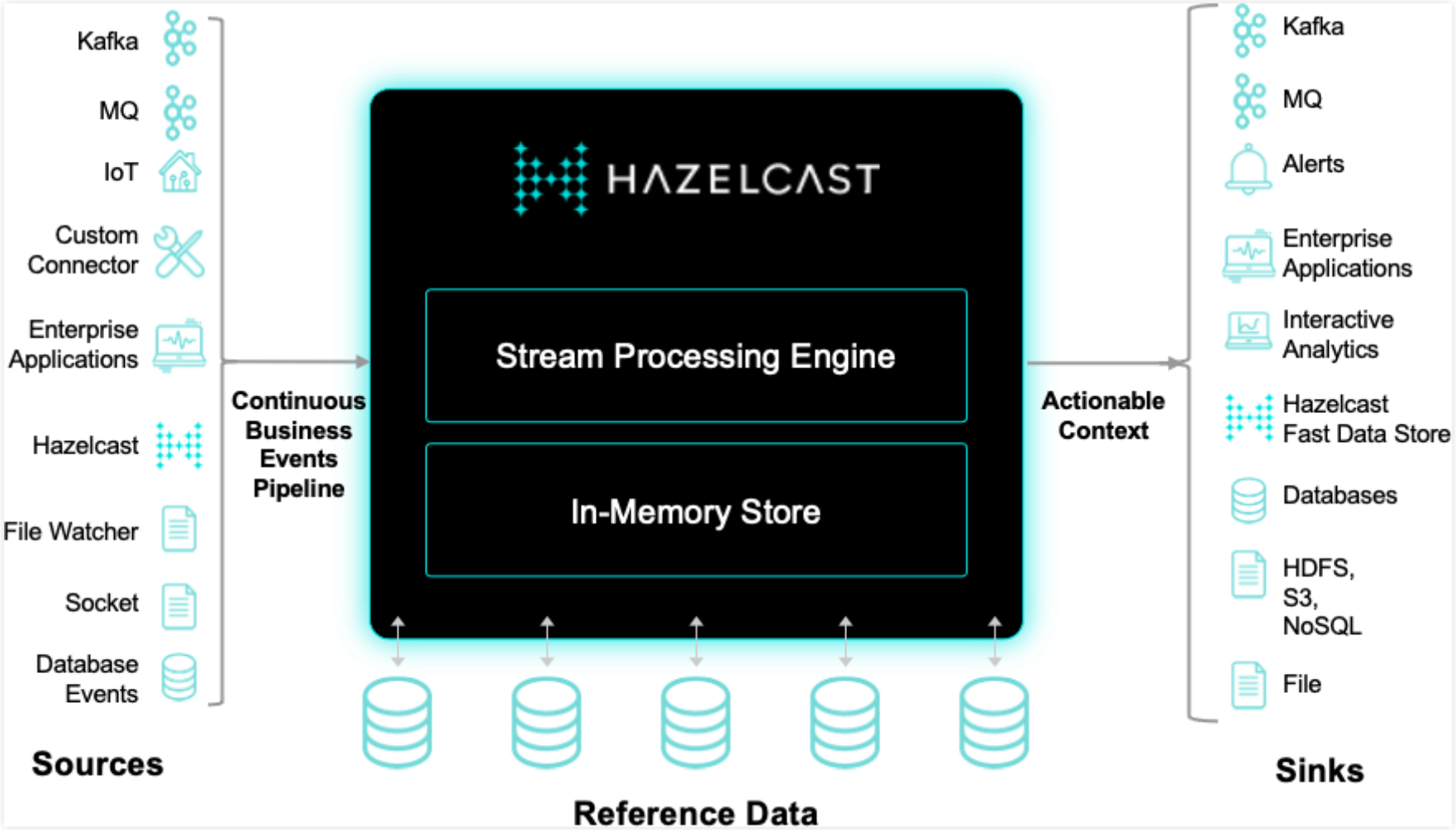
Born in 2008 in Turkey as a simple caching solution...



source: Hazelcast

HAZELCAST

The Hazelcast IMDG is an operational in-memory computing platform that manages data and distributes processing using memory and parallel execution for breakthrough application speed and scale.



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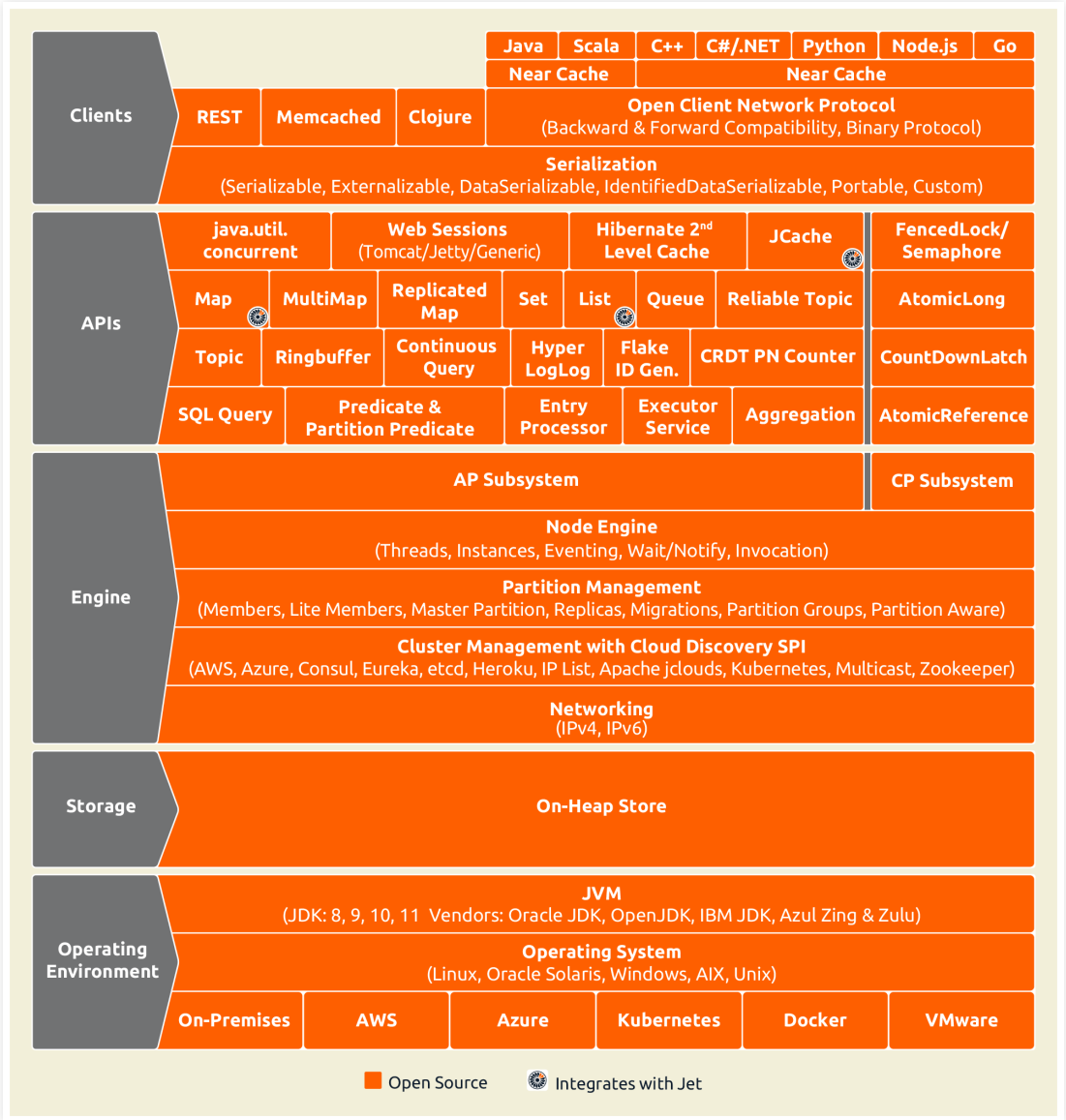

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IMDG

In-Memory Data Grid

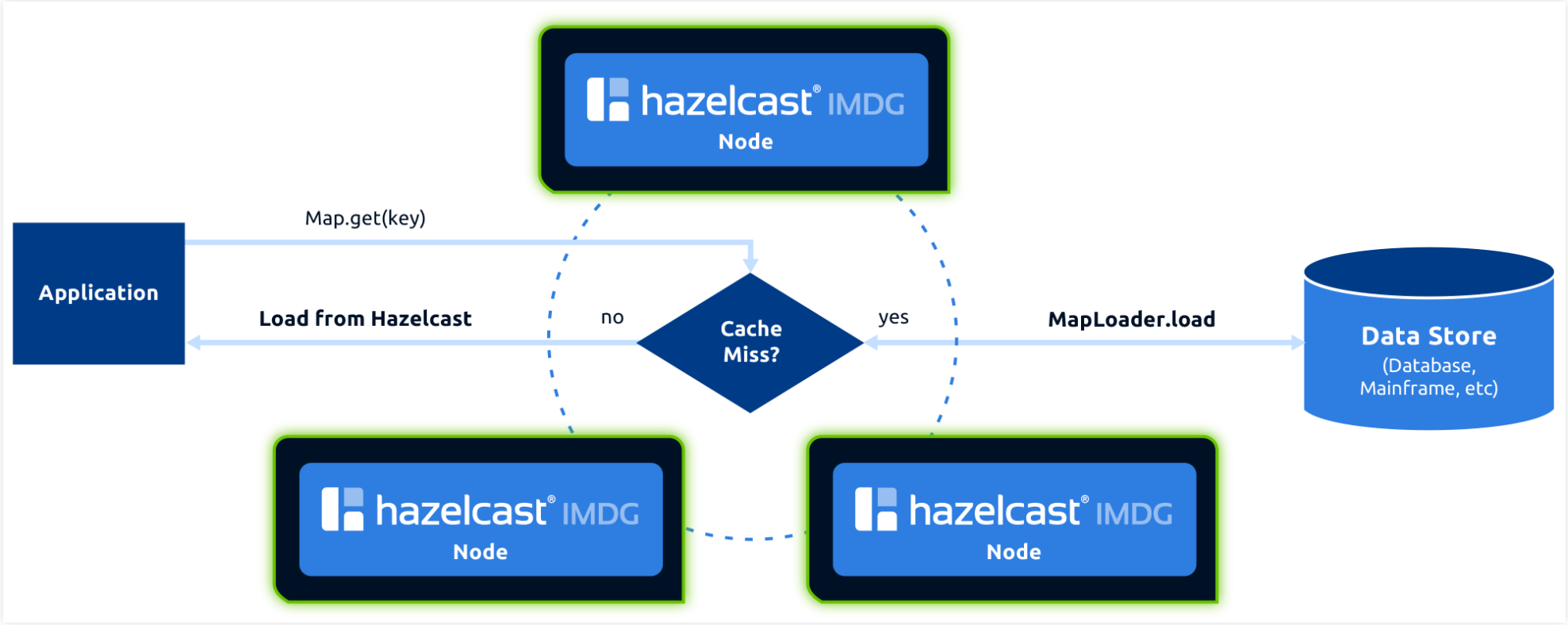
- In-Memory (no persistence)
  - Storage/Computation
- Multiple processes working as a group

- Embedded
- Client-Server

Cache Access Patterns

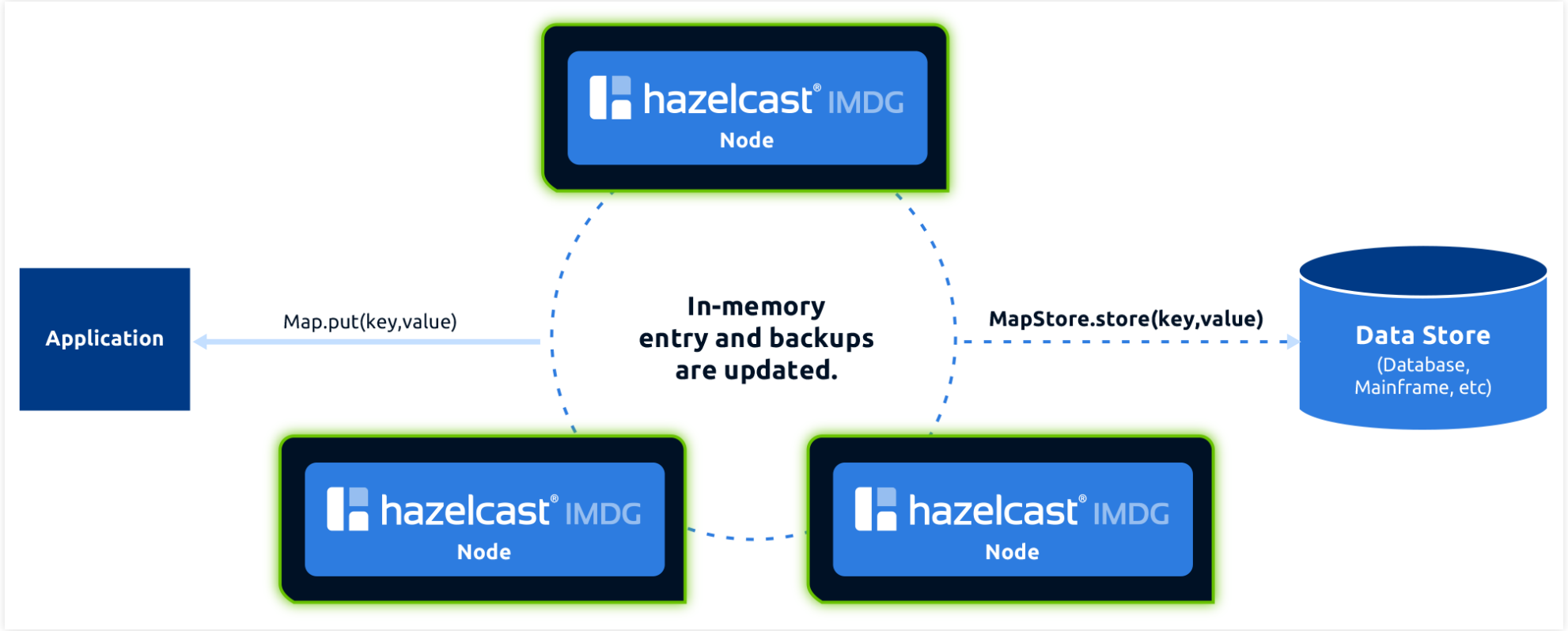
- Read-through
- Write-through
- Write-behind
- Near Cache

Read-through



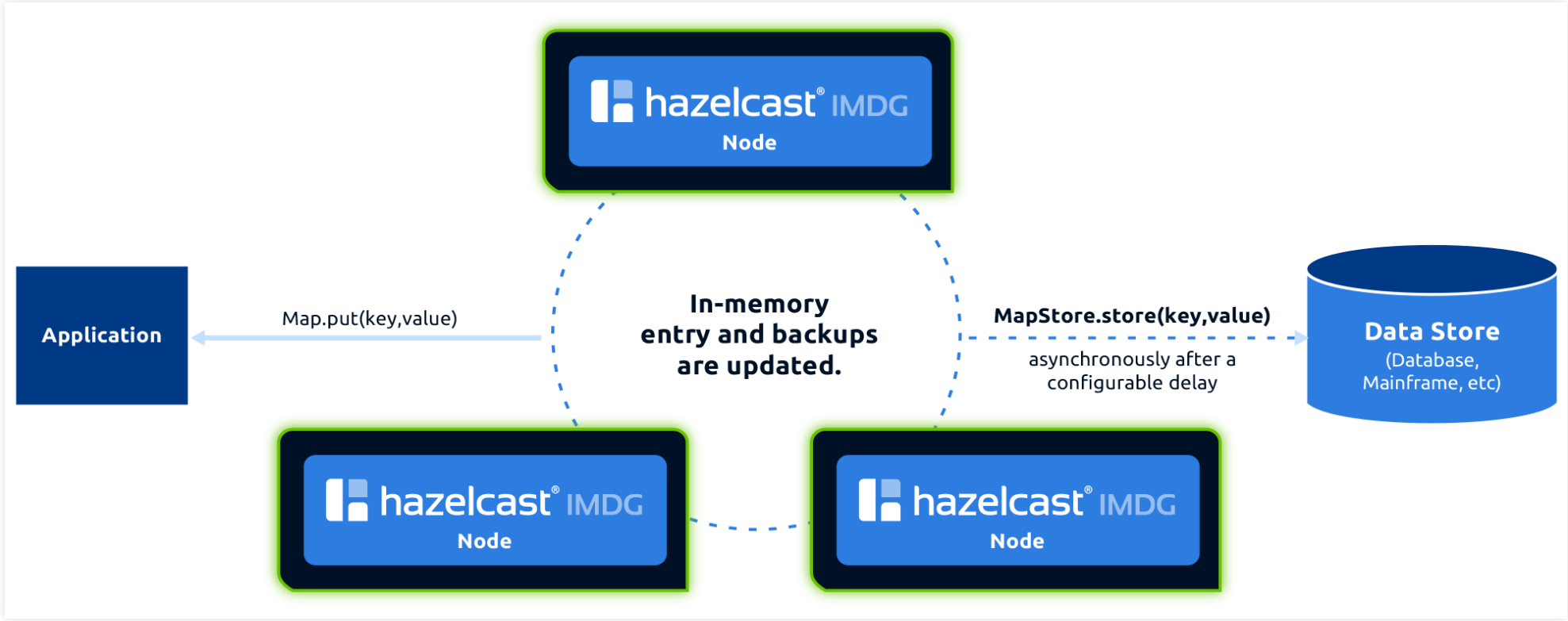
source: Hazelcast

Write-through



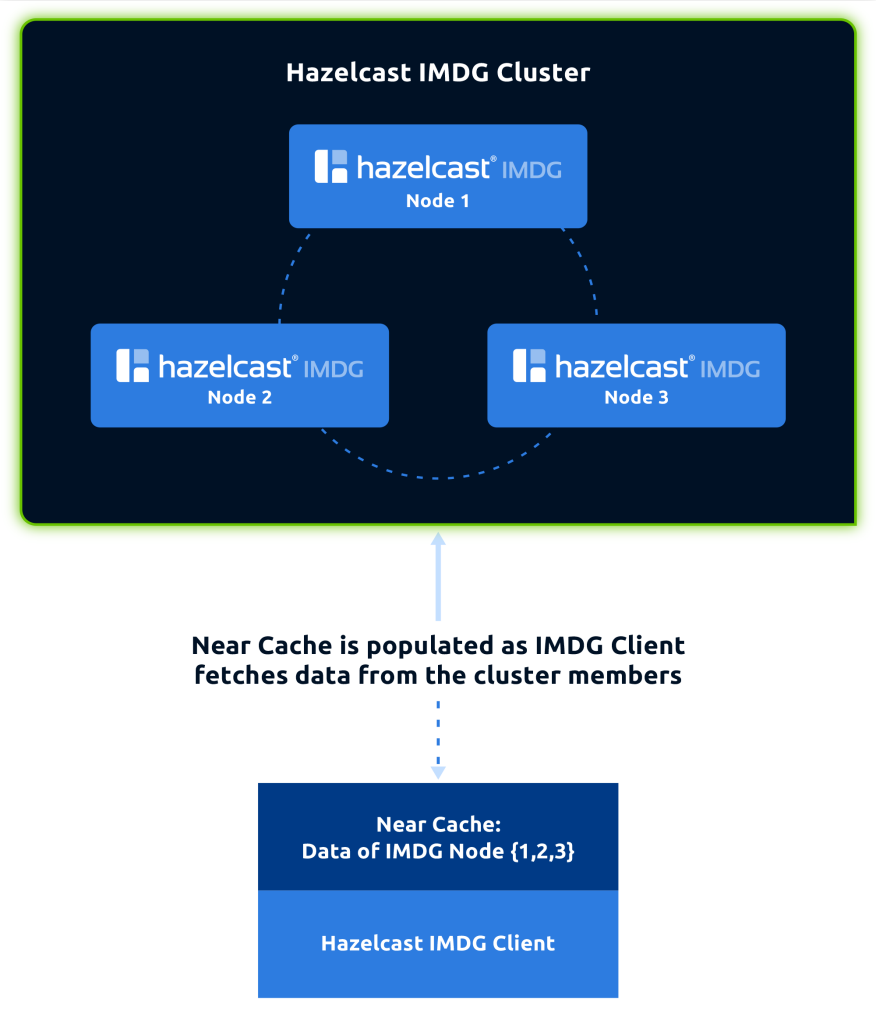
source: Hazelcast

Write-behind



source: Hazelcast

Near Cache



source: Hazelcast

```
<dependencies>
    <dependency>
        <groupid>com.hazelcast</groupid>
        <artifactid>hazelcast</artifactid>
        <version>5.1</version>
    </dependency>
</dependencies>
```

Shaded

Embedded

```
HazelcastInstance hazelcastInstance = Hazelcast.newHazelcastInstance();
```

Client-Server

```
HazelcastInstance hazelcastInstance = HazelcastClient.newHazelcastClient();
```

Clients

Binary Client Protocol

Java

Scala

C++

C#/.NET

Python

Node.js

Go

```
// import com.hazelcast.map.IMap;

HazelcastInstance hazelcastInstance = Hazelcast.newHazelcastInstance();

IMap<String, Integer> simpleMap = hazelcastInstance.getMap("simpleMap");

simpleMap.put("foo", 42);

simpleMap.get("foo"); // 42
```

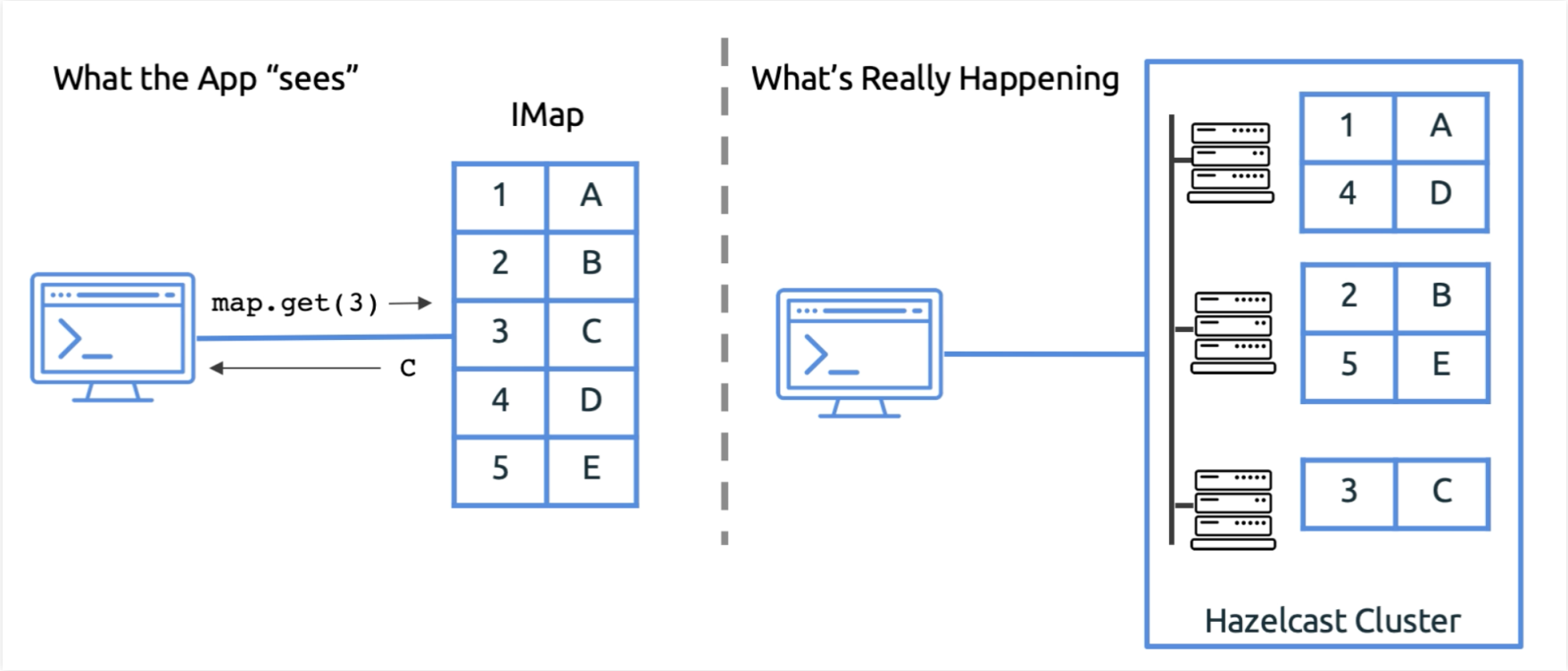
```java
// import java.util.Map;

HazelcastInstance hazelcastInstance = Hazelcast.newHazelcastInstance();

Map<String, Integer> simpleMap = hazelcastInstance.getMap("simpleMap");

simpleMap.put("foo", 42);

simpleMap.get("foo"); // 42
```



source: Hazelcast

Map is just the beginning

- MultiMap
- ReplicatedMap (non-partitioned Map)
- Set
- List

- Queue
- Topic

Data Structures is just the beginning

EntryProcessor

Instead of fetching the data, processing it and sending it back, let a cluster process it. A processed entry remains locked during processing

```
@BinaryInterface
@FunctionalInterface
public interface EntryProcessor<K, V, R> extends Serializable {
    R process(Entry<K, V> entry);
}
```

ExecutorService

```
public interface IExecutorService
  extends ExecutorService, DistributedObject {
    void execute(Runnable command, MemberSelector memberSelector);
    void executeOnAllMembers(Runnable command);
    // ...
}
```

Aggregation

```
IMap<String, Employee> employees = hz.getMap("employees");

double avgSalary = employees.aggregate(
  new Aggregator<Map.Entry<String, Employee>, Double>() {

    protected long sum;
    protected long count;

    @Override
    public void accumulate(Map.Entry<String, Employee> entry) {
        count++;
        sum += entry.getValue().getSalaryPerMonth();
    }

    // ...
 });
```

Queries

```
IMap<String, Employee> map = hazelcastInstance.getMap("employee");

Set<Employee> employees = map.values(new SqlPredicate("active AND age < 30"));
```

SQL

GA in 5.0

```
try (SqlResult result = hazelcastInstance.getSql()
  .execute("SELECT name FROM emp WHERE age < ?", 30)) {
    for (SqlRow row : result) {
        String name = row.getObject(0);
        System.out.println(name);
    }
}
```

+ a JDBC driver

https://hazelcast.com/blog/jdbc-driver-4-2-is-released/

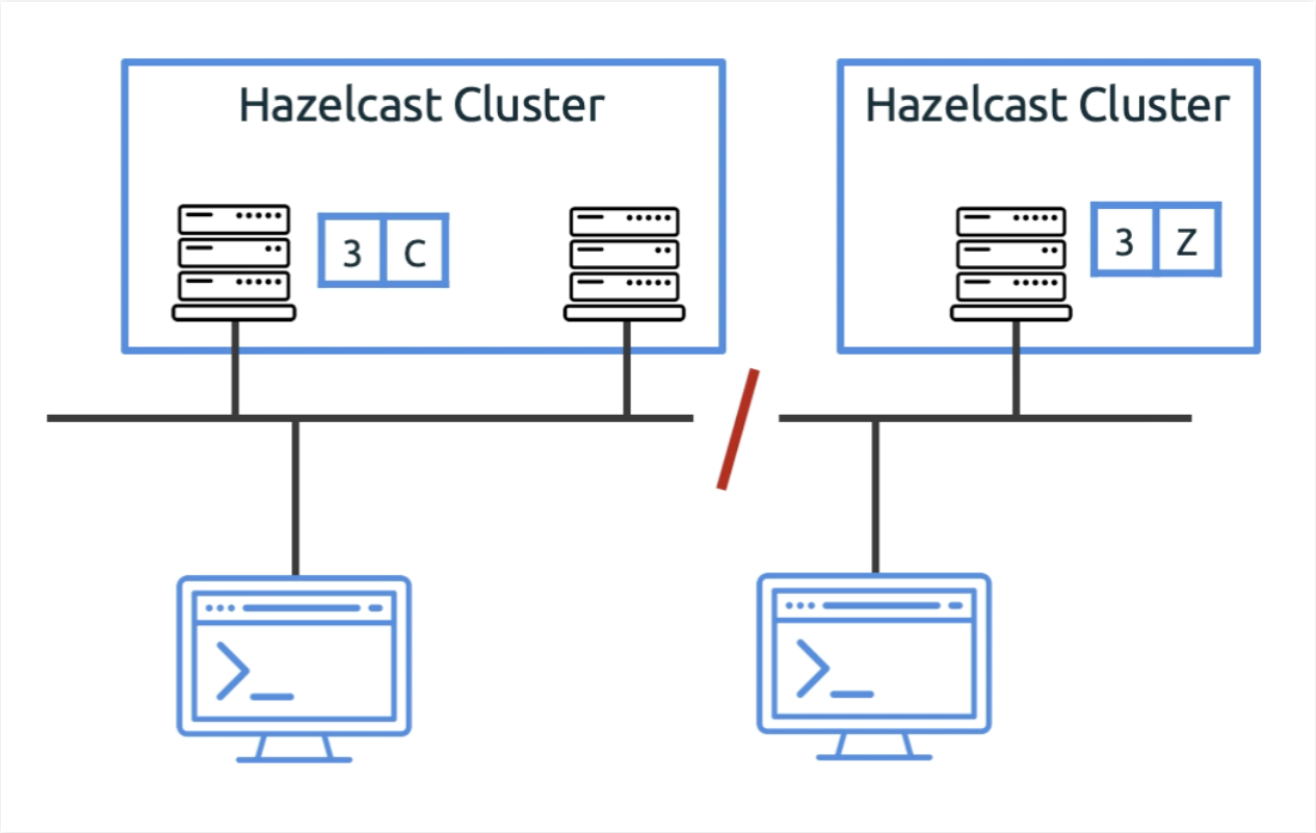
CAP Theorem

Consistency

Availability

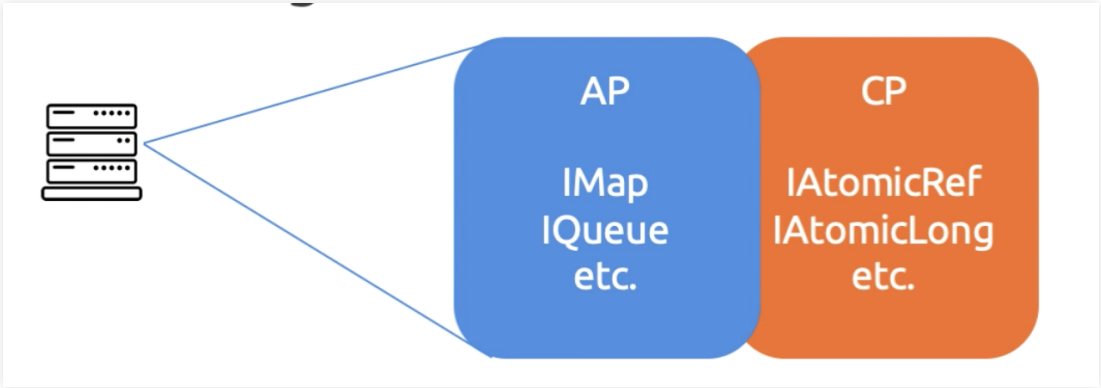
Partition Tolerance

Pick two ...but always make sure P is one of them



source: Hazelcast

CP Subsystem



source: Hazelcast

- Linearizable, distributed implementations of Java concurrency primitives
- Raft-based(http://thesecretlivesofdata.com/raft/)
- Jepsen-verified
- Requires minimum 3 members

- Semaphore
- CountDownLatch
- AtomicReference
- AtomicLong

Advanced Data Structures

RingBuffer

A fixed-capacity data structure that overwrites oldest elements when capacity is exceeded

HyperLogLog

A probabilistic data structure used to estimate the cardinality(number of unique elements) of a data set.

> *The HyperLogLog algorithm can estimate cardinalities well beyond 10^9 with a relative accuracy (standard error) of 2% while only using 1.5kb of memory.*
> *Fangjin Yang Fast, Cheap, and 98% Right: Cardinality Estimation for Big Data*

Flake Id Generator

Cluster-wide ordered and unique identifiers IDs without any coordination between members
safe even in split-brain scenario

CRDT PN Counter

A conflict-free alternative to AtomicLong

Other Integrations

Hibernate 2LC

Hazelcast provides a distributed second level cache for your Hibernate entities, collections and queries.

http://github.com/hazelcast/hazelcast-hibernate/

Spring Data

Spring Data Hazelcast Integration

https://github.com/hazelcast/spring-data-hazelcast

Quarkus Hazelcast Client

https://github.com/hazelcast/quarkus-hazelcast-client

Tomcat Session Manager

Each HttpSession object is kept in the Hazelcast Map

https://github.com/hazelcast/hazelcast-tomcat-sessionmanager

Apache Shiro

Apache Shiro is a security framework that performs authentication, authorization, cryptography, and session management. Shiro uses Hazelcast for caching and session clustering.

Cloud Integrations

Zone-awareness + autodiscovery

- AWS
- GCP
- Azure

Hazelcast Cloud

Hazelcast IMDG cluster as a service

https://cloud.hazelcast.com

Enterprise Features

- Management Center
  - Security Suite
- Disaster Recovery
- WAN Replication
- Rolling Upgrades
- HD Memory

Disaster Recovery

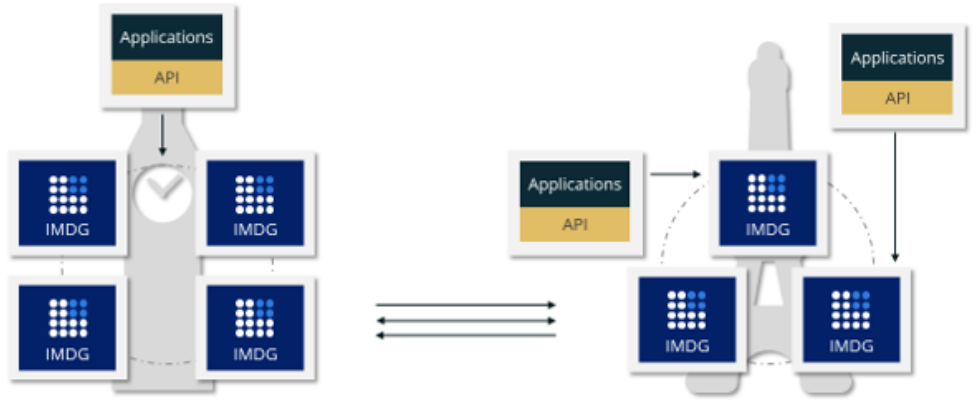
Automatic Disaster Recovery Failover

Automatic disaster recovery fail-over provides clients connected to Hazelcast® Enterprise IMDG clusters with the ability to automatically fail-over to a Disaster Recovery cluster should there be an unplanned outage of the primary production Hazelcast cluster.

source: Hazelcast

WAN Replication

WAN Replication: Deployment Options



Independent clusters, sharing selected data to maintain alignment

One-way or two-way

Choose which data to share, select by type, can de-select records by attributes

One-way -- keep DR site populated and ready-to-go

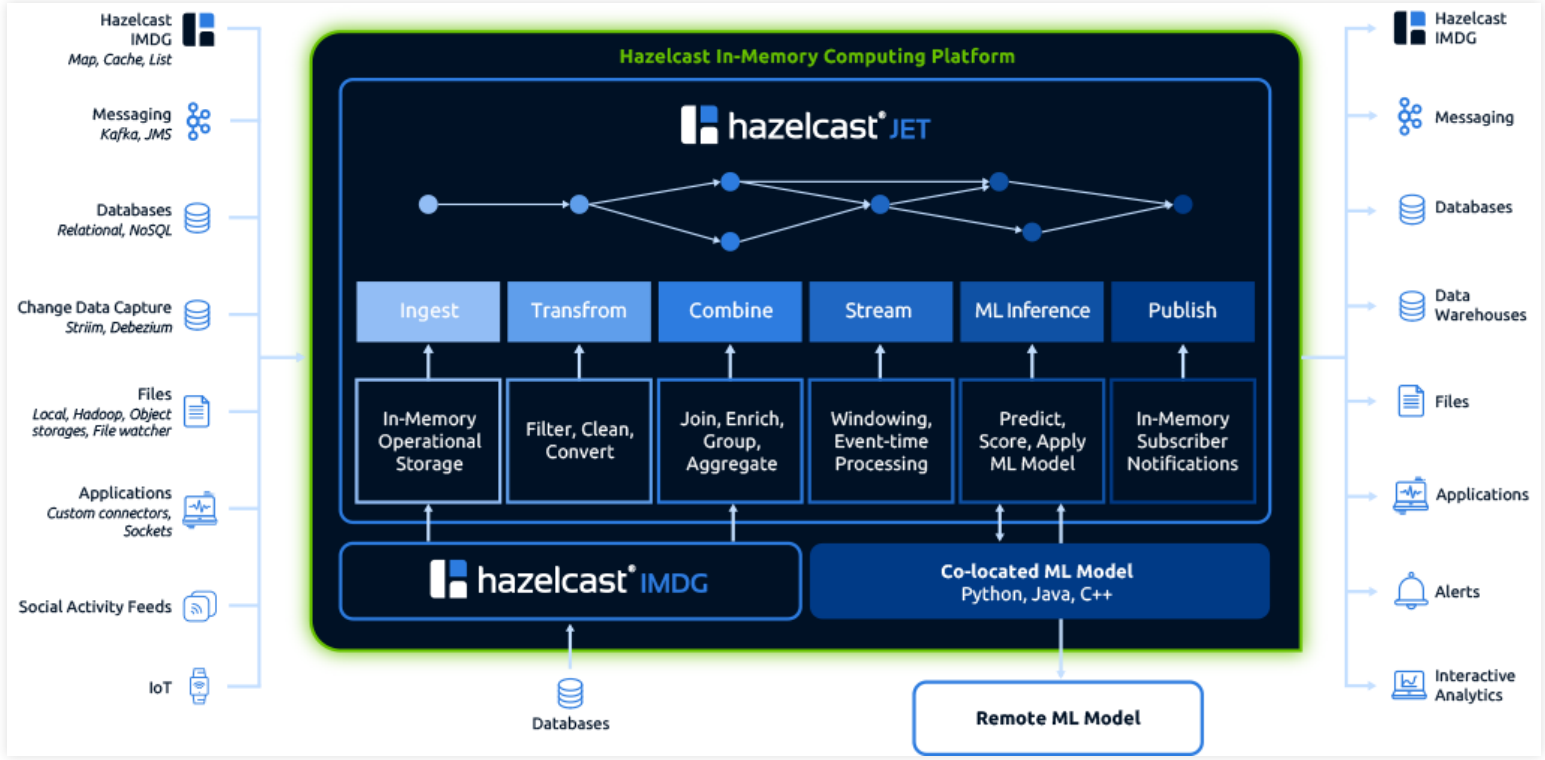
Two-way -- worldwide operations, access your nearest data copy

source: Hazelcast

HD Memory(off-heap store)

Hot Restart Store (persistence)

Hazelcast Jet



Hazelcast Jet Whitepaper

Computer Science > Distributed, Parallel, and Cluster Computing

[Submitted on 18 Mar 2021]

Hazelcast Jet: Low-latency Stream Processing at the 99.99th Percentile

Can Gencer, Marko Topolnik, Viliam Ďurina, Emin Demirci, Ensar B. Kahveci, Ali Gürbüz Ondřej Lukáš, József Bartók, Grzegorz Gierlach, František Hartman, Ufuk Yılmaz, Mehmet Doğan, Mohamed Mandouh, Marios Fragkoulis, Asterios Katsifodimos

Jet is an open-source, high-performance, distributed stream processor built at Hazelcast during the last five years. Jet was engineered with millisecond latency on the 99.99th percentile as its primary design goal. Originally Jet's purpose was to be an execution engine that performs complex business logic on top of streams generated by Hazelcast's In-memory Data Grid (IMDG): a set of high-performance, in-memory, partitioned and replicated data structures. With time, Jet evolved into a full-fledged, scale-out stream processor that can handle out-of-order streams and exactly-once processing guarantees. Jet's end-to-end latency lies in the order of milliseconds, and its throughput in the order of millions of events per CPU-core. This paper presents main design decisions we made in order to maximize the performance per CPU-core, alongside lessons learned, and an empirical performance evaluation.

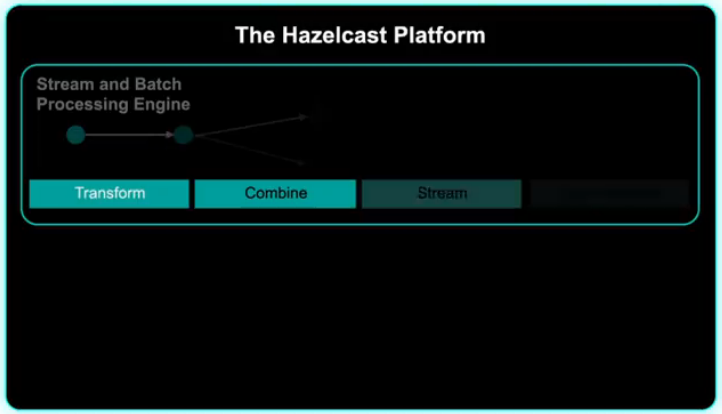
Subjects: **Distributed, Parallel, and Cluster Computing (cs.DC)**; Databases (cs.DB)
Cite as: arXiv:2103.10169 **[cs.DC]**
(or arXiv:2103.10169v1 **[cs.DC]** for this version)

https://arxiv.org/abs/2103.10169

Performance of Modern Java on Data-Heavy Workloads: Real-Time Streaming

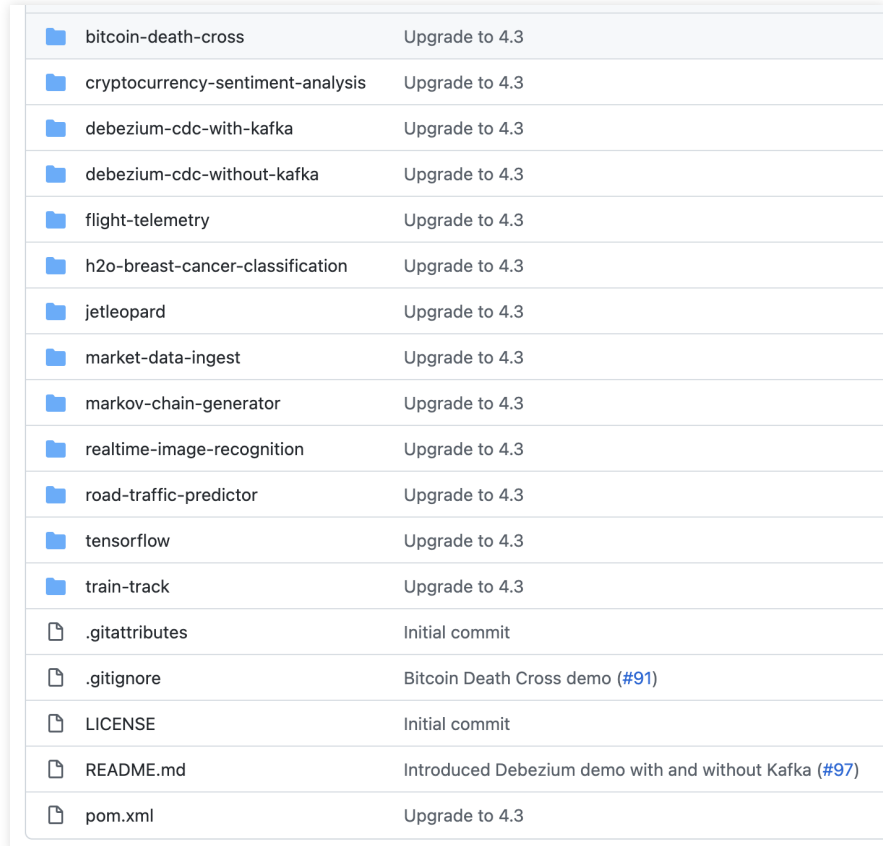
Processing 10M queries / second on a single node using Jet and gRPC

Real-Time starts with
fast compute and storage



source: Hazelcast

```
private static Pipeline buildPipeline() {
    Pipeline p = Pipeline.create();
    p.readFrom(TestSources.itemStream(100, (ts, seq) -> nextRandomNumber()))
      .withIngestionTimestamps()
      .window(WindowDefinition.tumbling(1000))
      .aggregate(AggregateOperations.topN(TOP, ComparatorEx.comparingLong(l -> l)))
      .map(WindowResult::result)
      .writeTo(Sinks.observable(RESULTS));
    return p;
}
```



bitcoin-death-cross	Upgrade to 4.3
cryptocurrency-sentiment-analysis	Upgrade to 4.3
debezium-cdc-with-kafka	Upgrade to 4.3
debezium-cdc-without-kafka	Upgrade to 4.3
flight-telemetry	Upgrade to 4.3
h2o-breast-cancer-classification	Upgrade to 4.3
jetleopard	Upgrade to 4.3
market-data-ingest	Upgrade to 4.3
markov-chain-generator	Upgrade to 4.3
realtime-image-recognition	Upgrade to 4.3
road-traffic-predictor	Upgrade to 4.3
tensorflow	Upgrade to 4.3
train-track	Upgrade to 4.3
.gitattributes	Initial commit
.gitignore	Bitcoin Death Cross demo (#91)
LICENSE	Initial commit
README.md	Introduced Debezium demo with and without Kafka (#97)
pom.xml	Upgrade to 4.3

https://github.com/hazelcast/hazelcast-jet-demos

Hazelcast Jet Design Documents

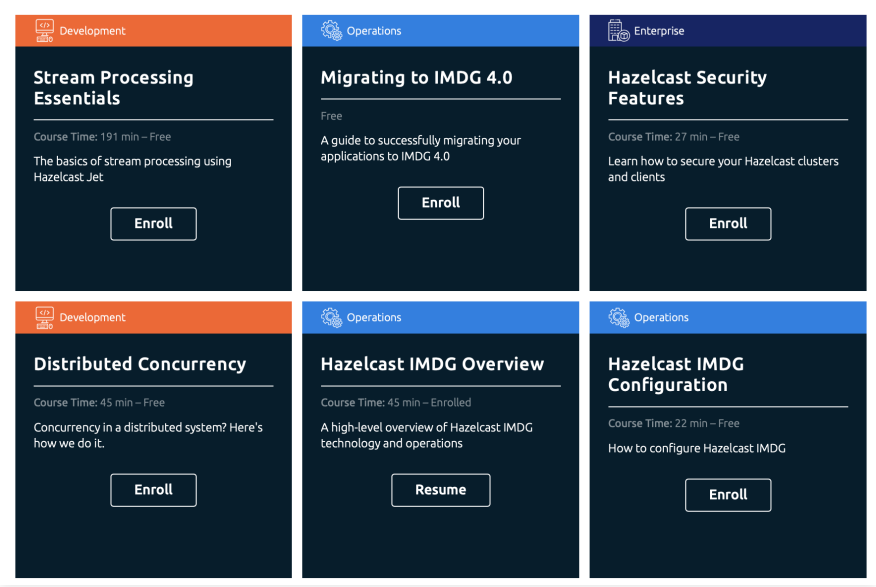
https://jet-start.sh/docs/design-docs/

Hazelcast Jet Architecture

https://jet-start.sh/docs/architecture/distributed-computing

Tutorials

https://training.hazelcast.com



Thank You!

Q/A time!

https://pivovarit.github.io/talks/hazelcast

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