# Project Pravega

Storage Reimagined for a Streaming World

ArchSummit 全球架构师峰会 [北京]

主办方 Geekbang 极客邦科技 InfoQ

# 技术创新的浪潮接踵而来，继续搬砖还是奋起直追？

云数据 | AI | 区块链 | 架构优化

高效运维 | CTO技术选型 | 微服务 | 新开源框架

会议：2018年12月07-08日 培训：2018年12月09-10日

地址：北京·国际会议中心

# Market Drivers

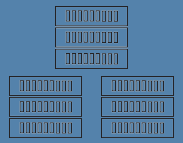

Massive Data Growth

Emergence of Real-Time Apps


Monetize Data with Analytics

Rapid Dissemination of Data to Apps

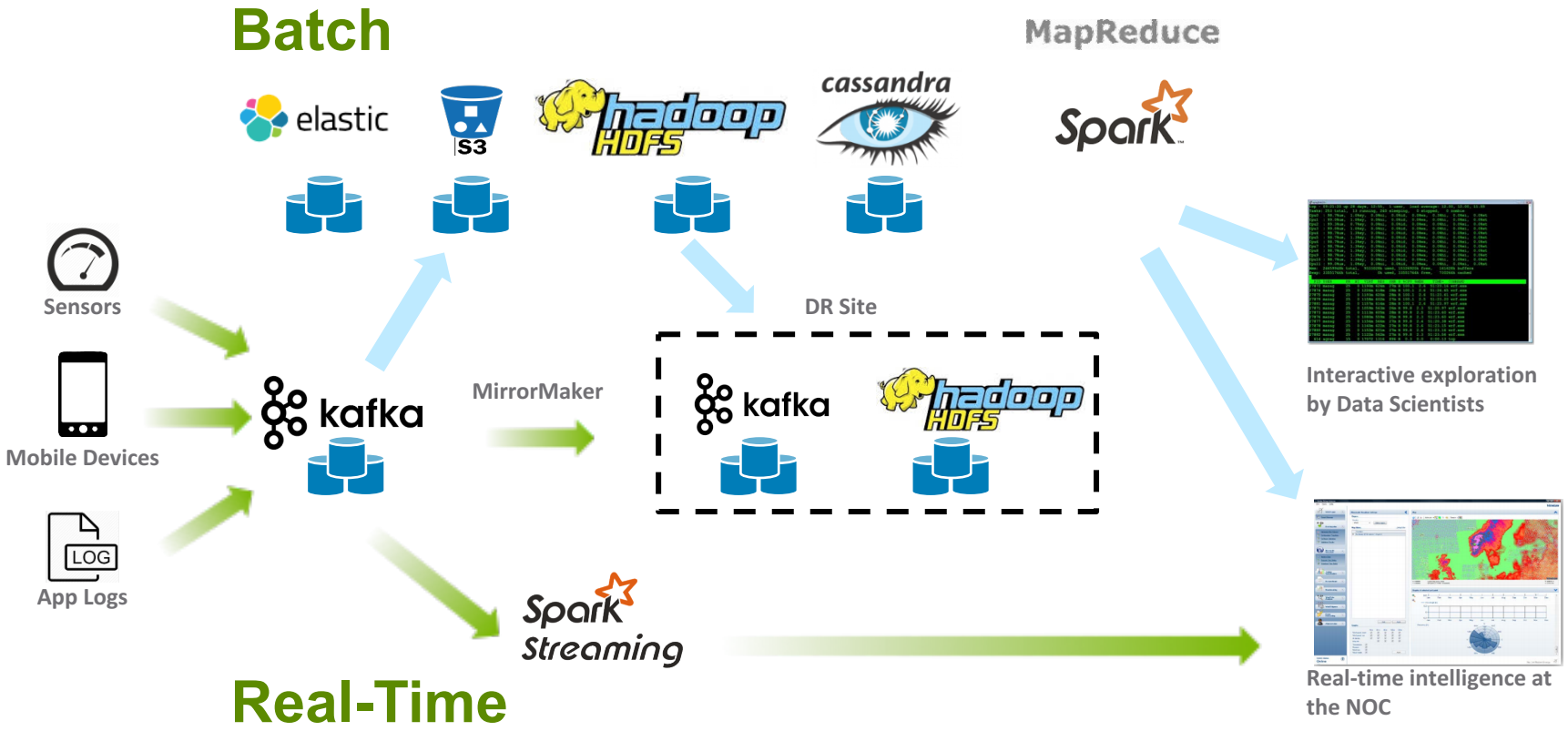
Data Velocity and Variety



Infrastructure Commoditization and Scale-Out

Open Source Community

# Today's "Accidental Architecture"



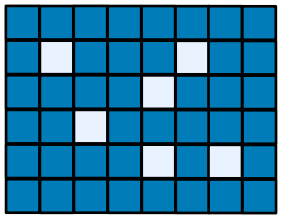
# A New Architecture Emerges: Streaming

- A new class of streaming systems is emerging to address the accidental architecture's problems and enable new applications not possible before
- Some of the unique characteristics of streaming applications
  - Treat data as continuous and infinite
  - Compute correct results in real-time with stateful, exactly-once processing
- These systems are applicable for real-time applications, batch applications, and interactive applications
- Web-scale companies (Google, Twitter) are beginning to demonstrate the disruptive value of streaming systems
- What are the implications for storage in a streaming world?

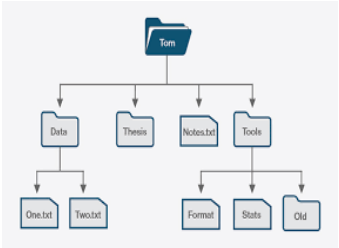
# Let’s Rewind A Bit: The Importance of Log Storage

Traditional Apps/Middleware → Streaming Apps/Middleware

## BLOCKS
- Structured Data
- Relational DBs

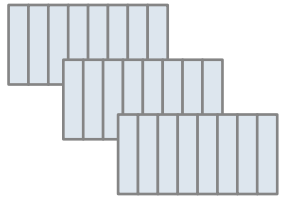


## FILES
- Unstructured Data
- Pub/Sub
- NoSQL DBs



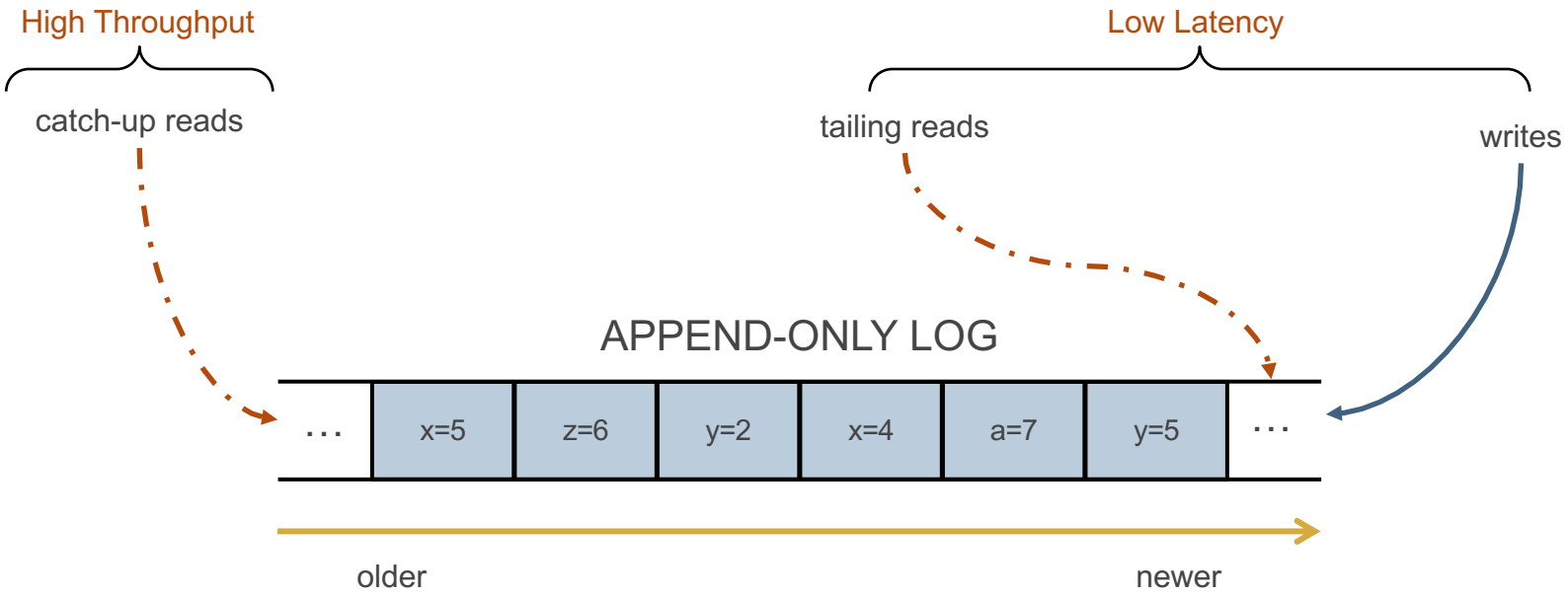

## OBJECTS
- Unstructured Data
- Internet Friendly (REST)
- Scale over Semantics
- Geo

## LOGS
- Append-only
- Low-latency
- Tail Read/Write

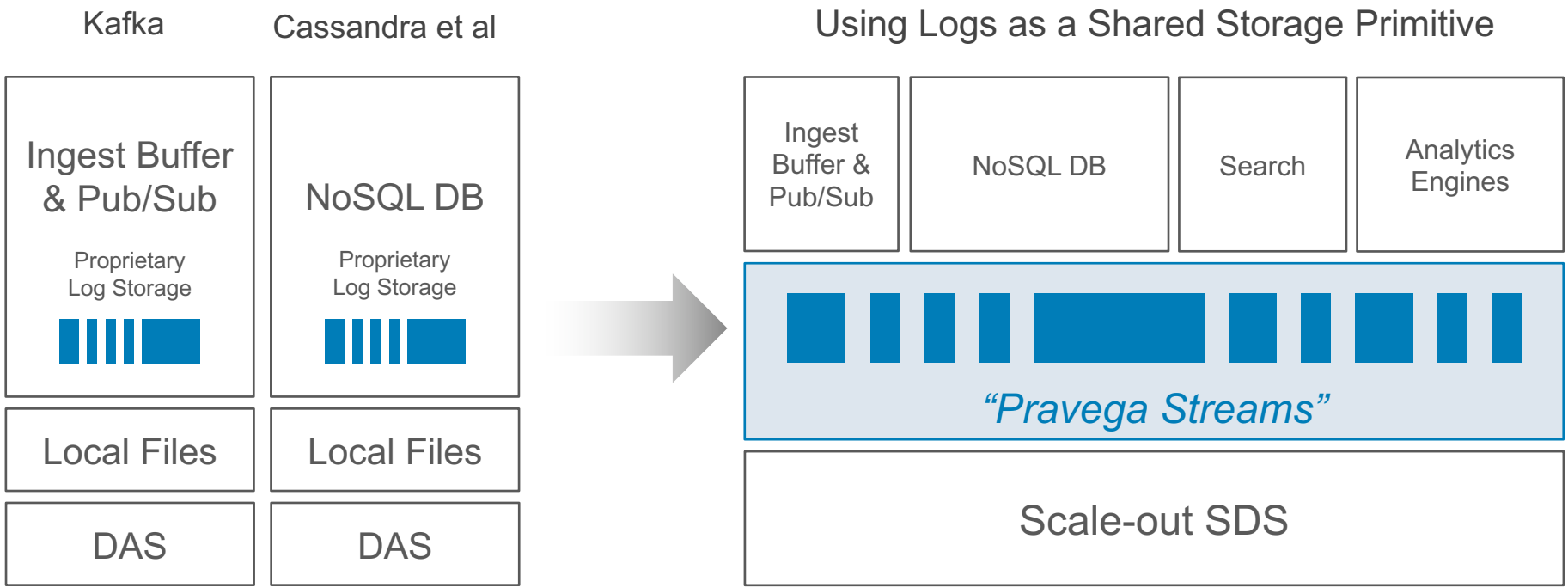


# The Importance of Log Storage

**The Fundamental Data Structure for Scale-out Distributed Systems**



# Our Goal: Refactor the “Accidental Storage Stack”



# Introducing Pravega Streams

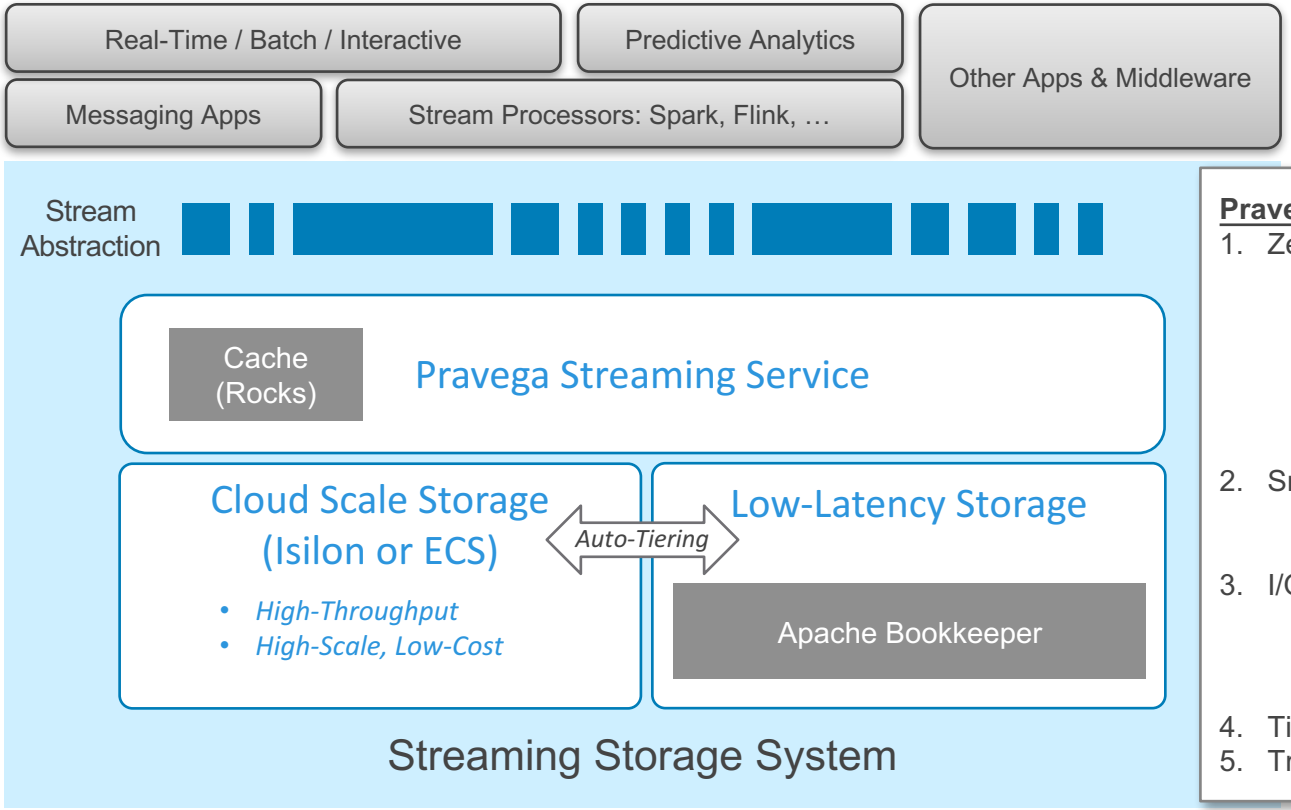
A New Log Primitive Designed Specifically For Streaming Architectures

- Pravega is an open source distributed storage service offering a new storage abstraction called a stream
- A stream is the foundation for building reliable streaming systems: a high-performance, durable, elastic, and infinite append-only log with strict ordering and consistency
- A stream is as lightweight as a file – you can create millions of them in a single cluster
- Streams greatly simplify the development and operation of a variety of distributed systems: messaging, databases, analytic engines, search engines, and so on

# Pravega Architecture Goals

- All data is durable
  - Data is replicated and persisted to disk before being acknowledged
- Strict ordering guarantees and exactly once semantics
  - Across both tail and catch-up reads
  - Client tracks read offset, Producers use transactions
- Lightweight, elastic, infinite, high performance
  - Support tens of millions of streams
  - Dynamic partitioning of streams based on load and throughput SLO
  - Size is not bounded by the capacity of a single node
  - Low (<10ms) latency writes; throughput bounded by network bandwidth
  - Read pattern (e.g. many catch-up reads) doesn't affect write performance

# Architecture



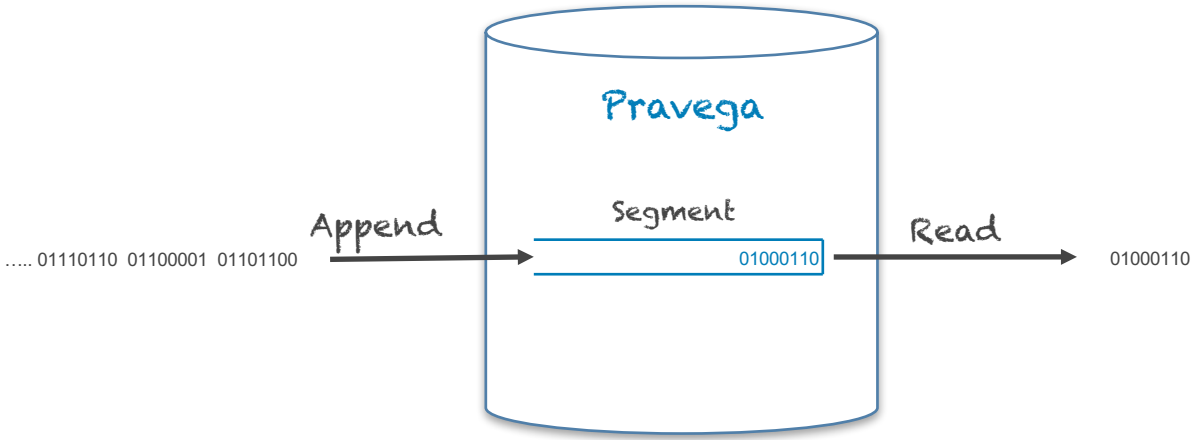

**Pravega Design Innovations**

1. Zero-Touch Dynamic Scaling
   - Automatically scale read/write parallelism based on load and SLO
   - No service interruptions
   - No manual reconfiguration of clients
   - No manual reconfiguration of service resources
2. Smart Workload Distribution
   - No need to over-provision servers for peak load
3. I/O Path Isolation
   - For tail writes
   - For tail reads
   - For catch-up reads
4. Tiering for “Infinite Streams”
5. Transactions For “Exactly Once”

# Pravega Fundamentals

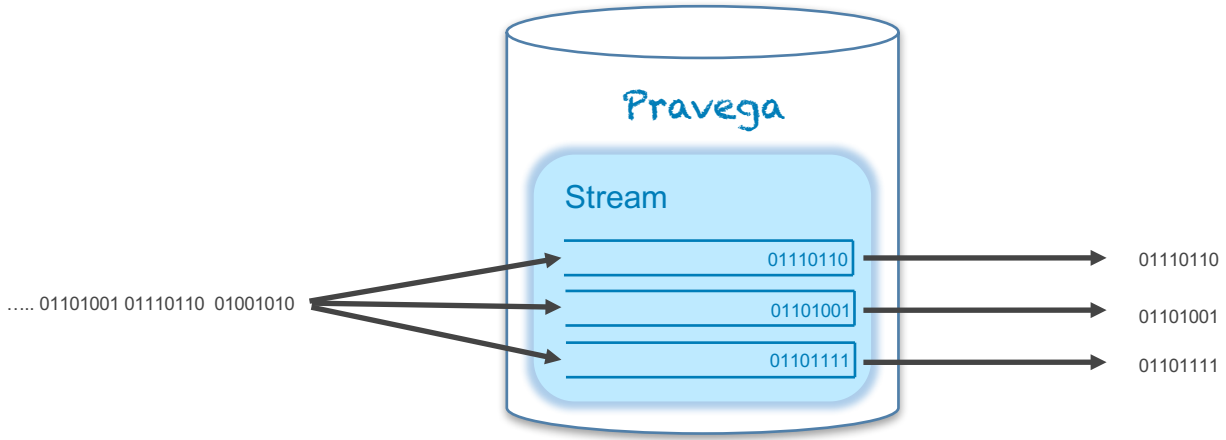
# Segments

- Base storage primitive is a segment
- A segment is an append-only sequence of bytes
- Writes durably persisted before acknowledgement



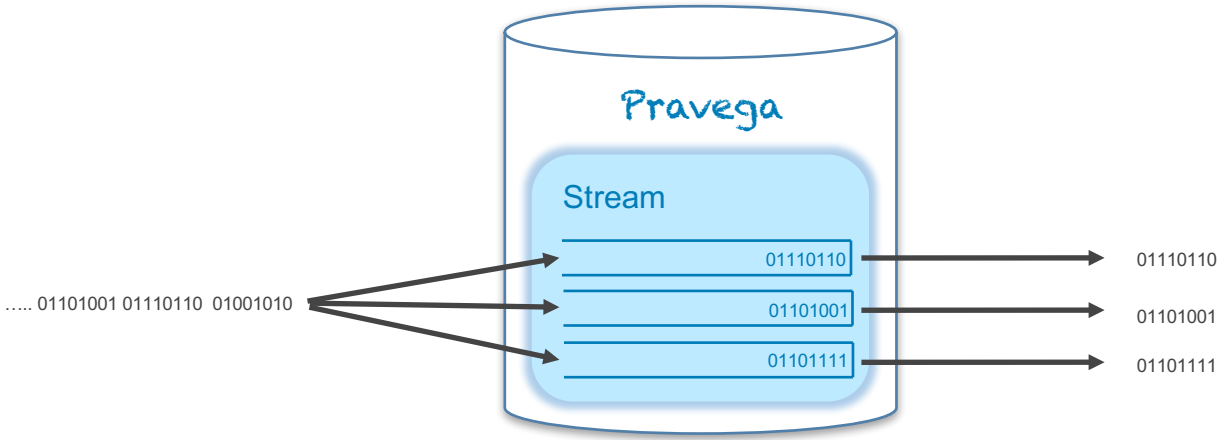
# Streams

- A stream is composed of one or more segments
- Routing key determines the target segment for a stream write
- Write order preserved by routing key; consistent tail and catch-up reads



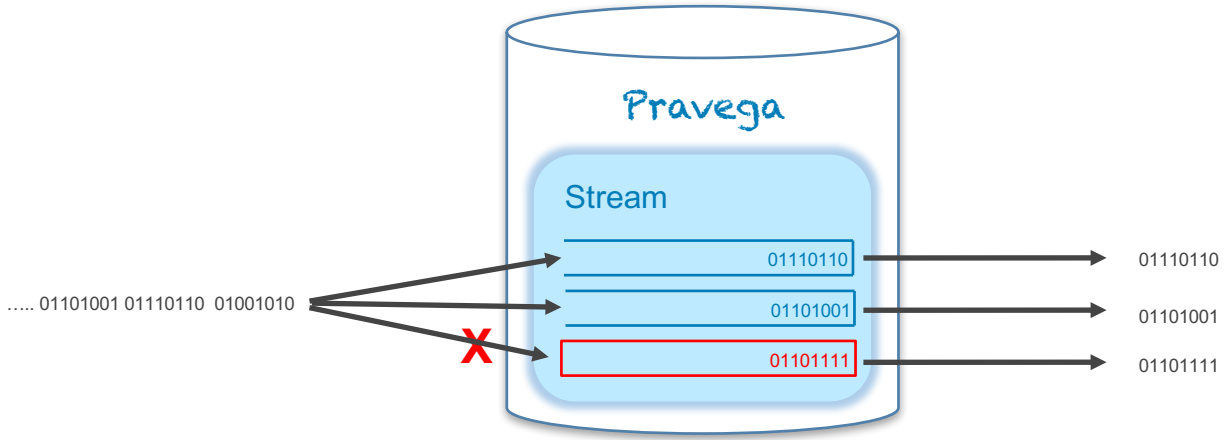
# Streams

- There are no architectural limits on the number of streams or segments
- Each segment can live in a different server
- System is not limited in any way by the capacity of a single server

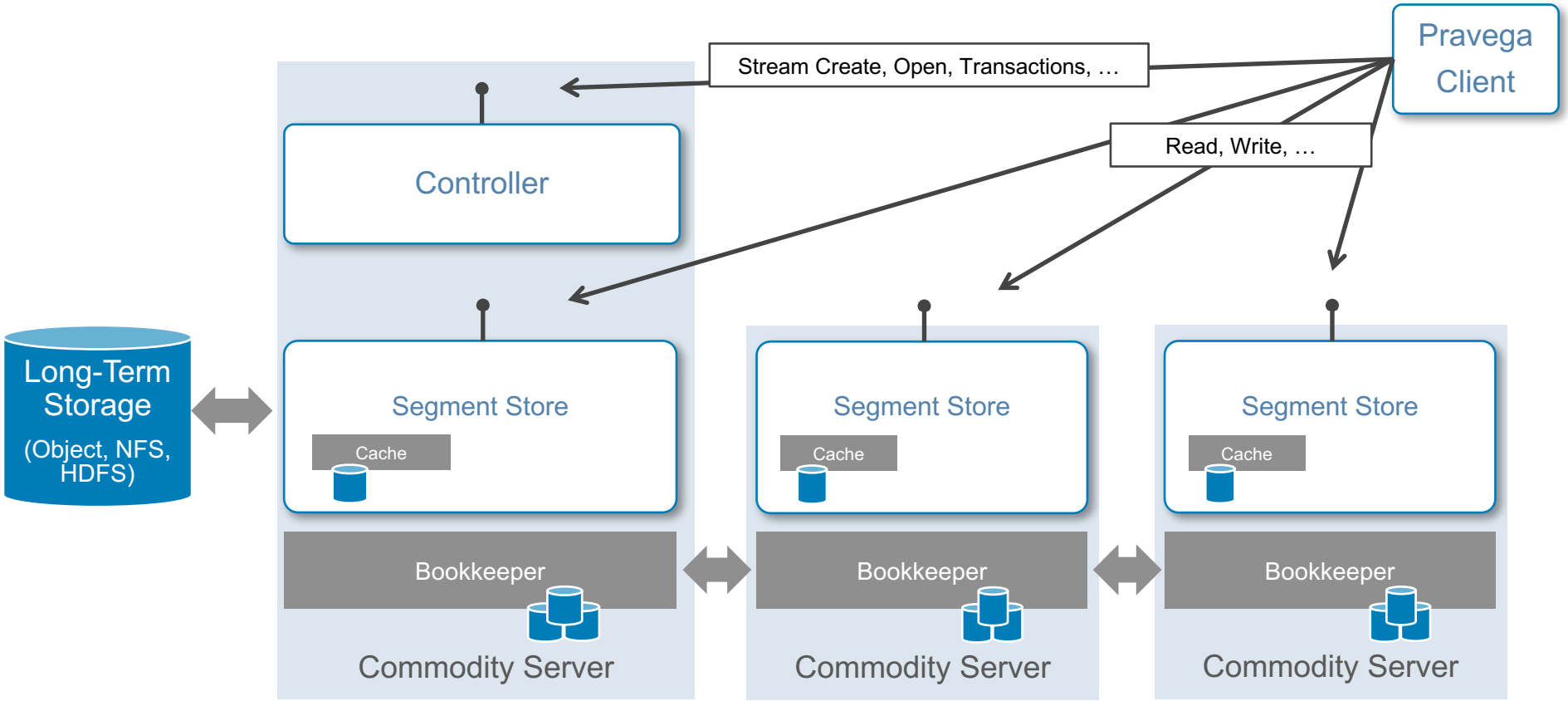


# Segment Sealing

- A segment may be sealed
- A sealed segment cannot be appended to any more
- Basis for advanced features such as stream elasticity and transactions



# Pravega System Architecture

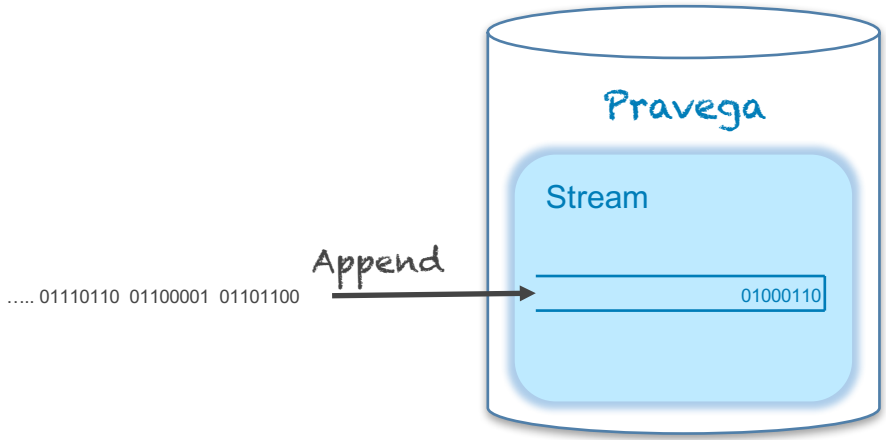


# Beyond the Fundamentals

*Stream Elasticity, Unbounded Streams, Transactions, Exactly Once*

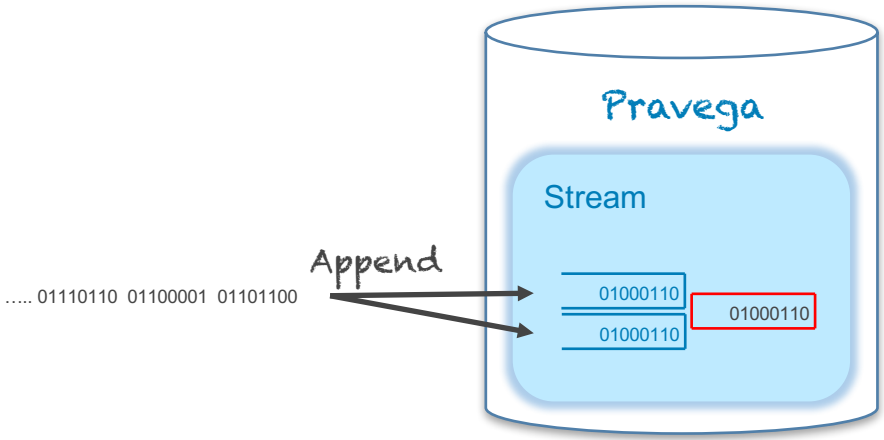
# Stream Elasticity

- Data arrival volume increases – more parallelism needed!

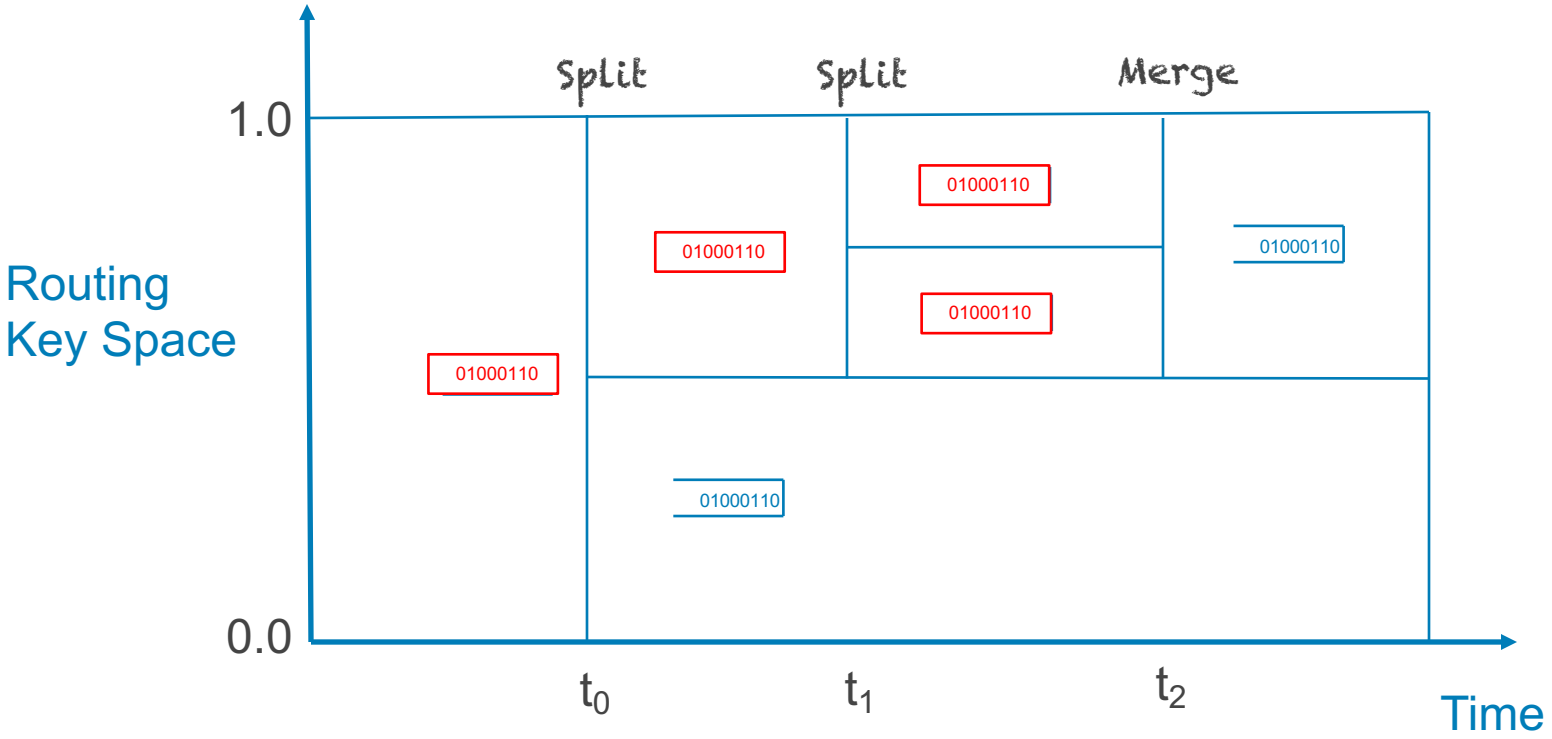


# Stream Elasticity

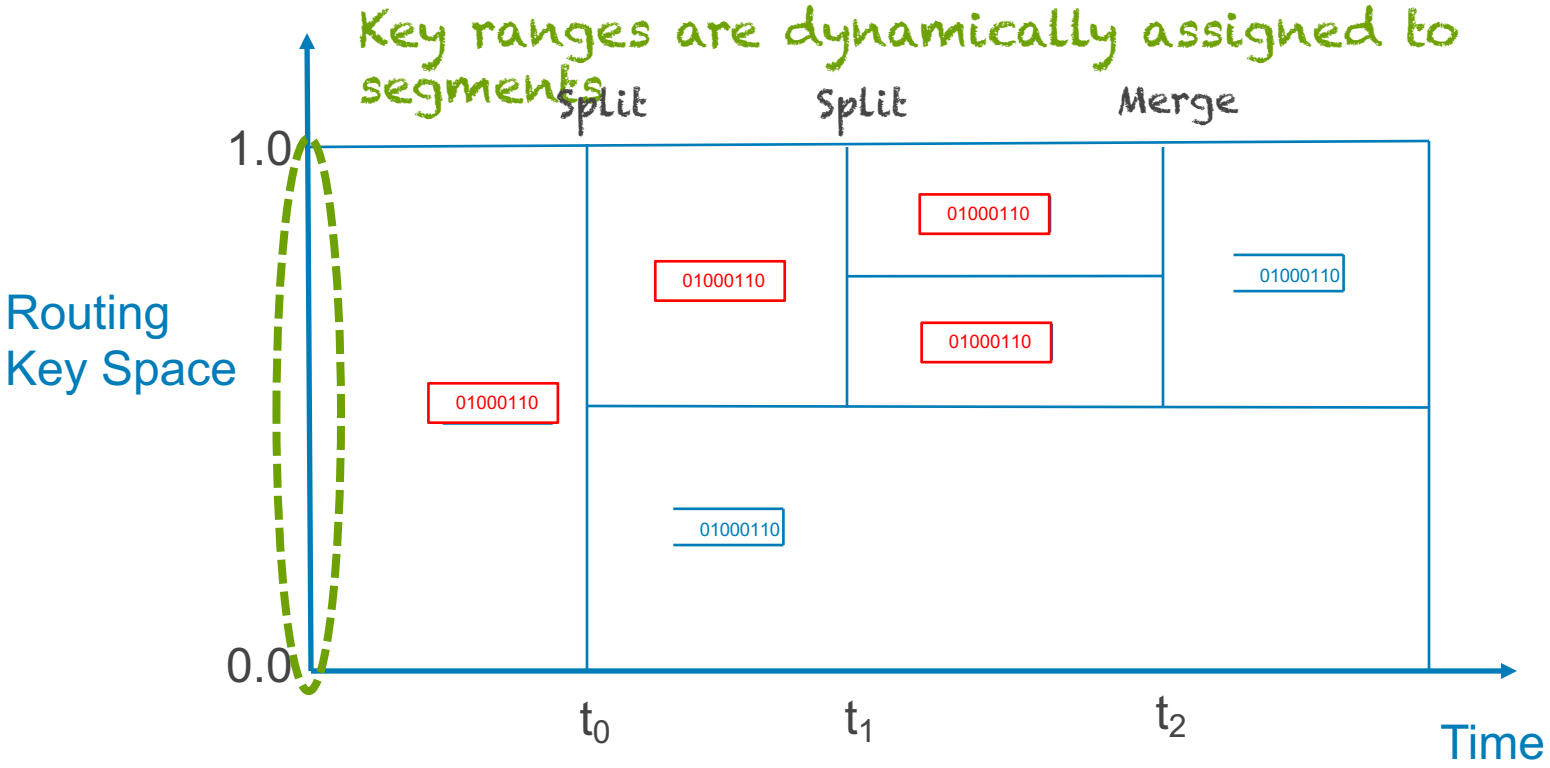
- Seal original segment
- Replace with two new ones!
- New segments may be distributed throughout the cluster balancing load



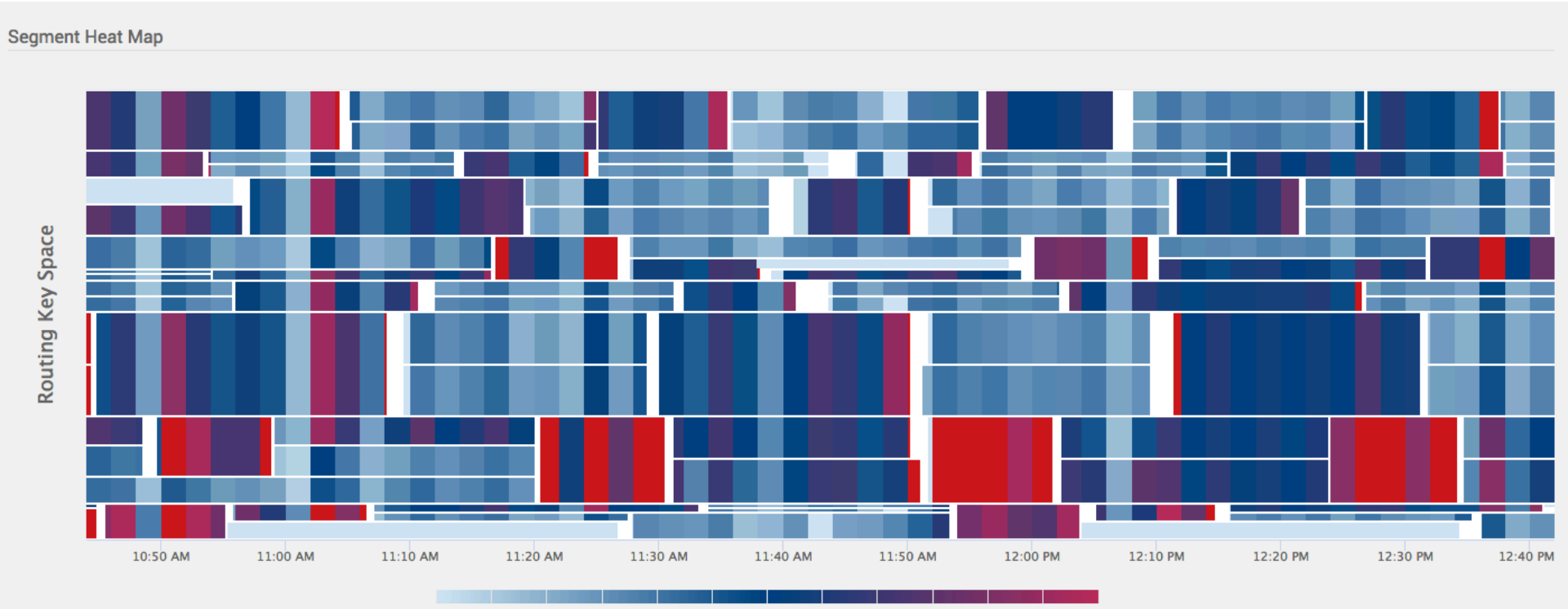
# Stream Elasticity



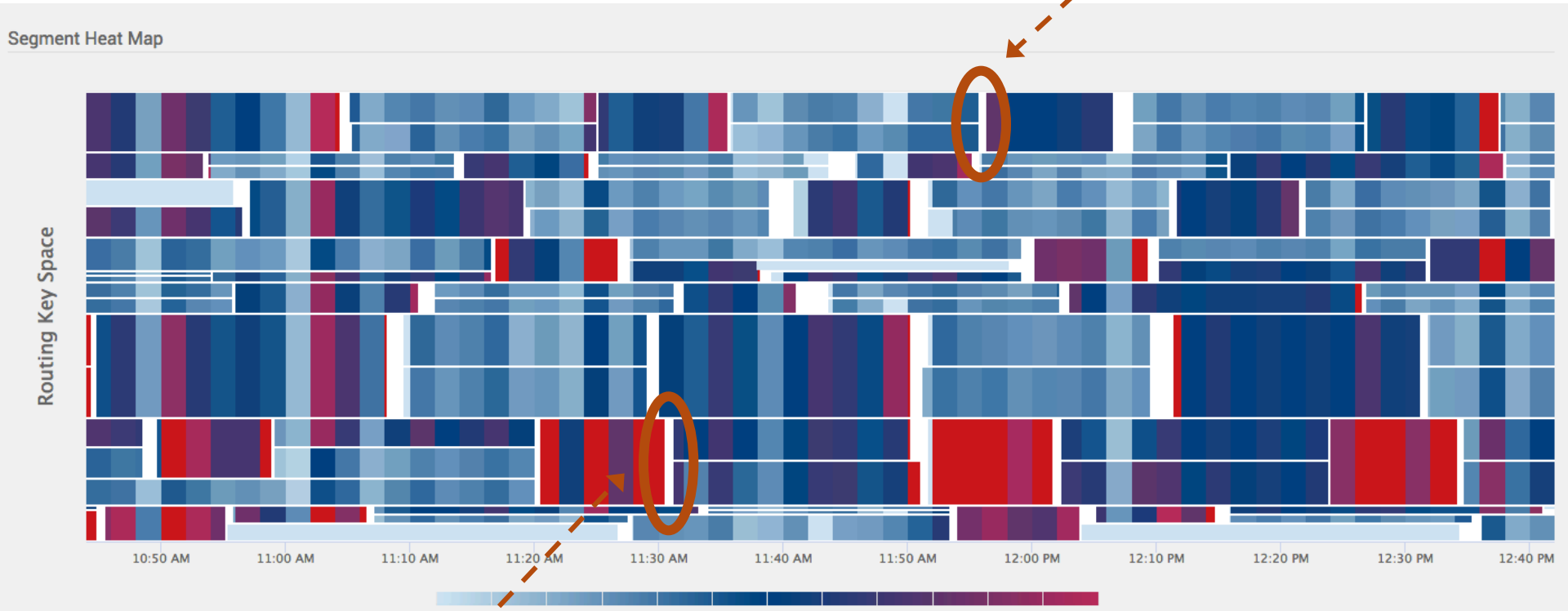
# Stream Elasticity



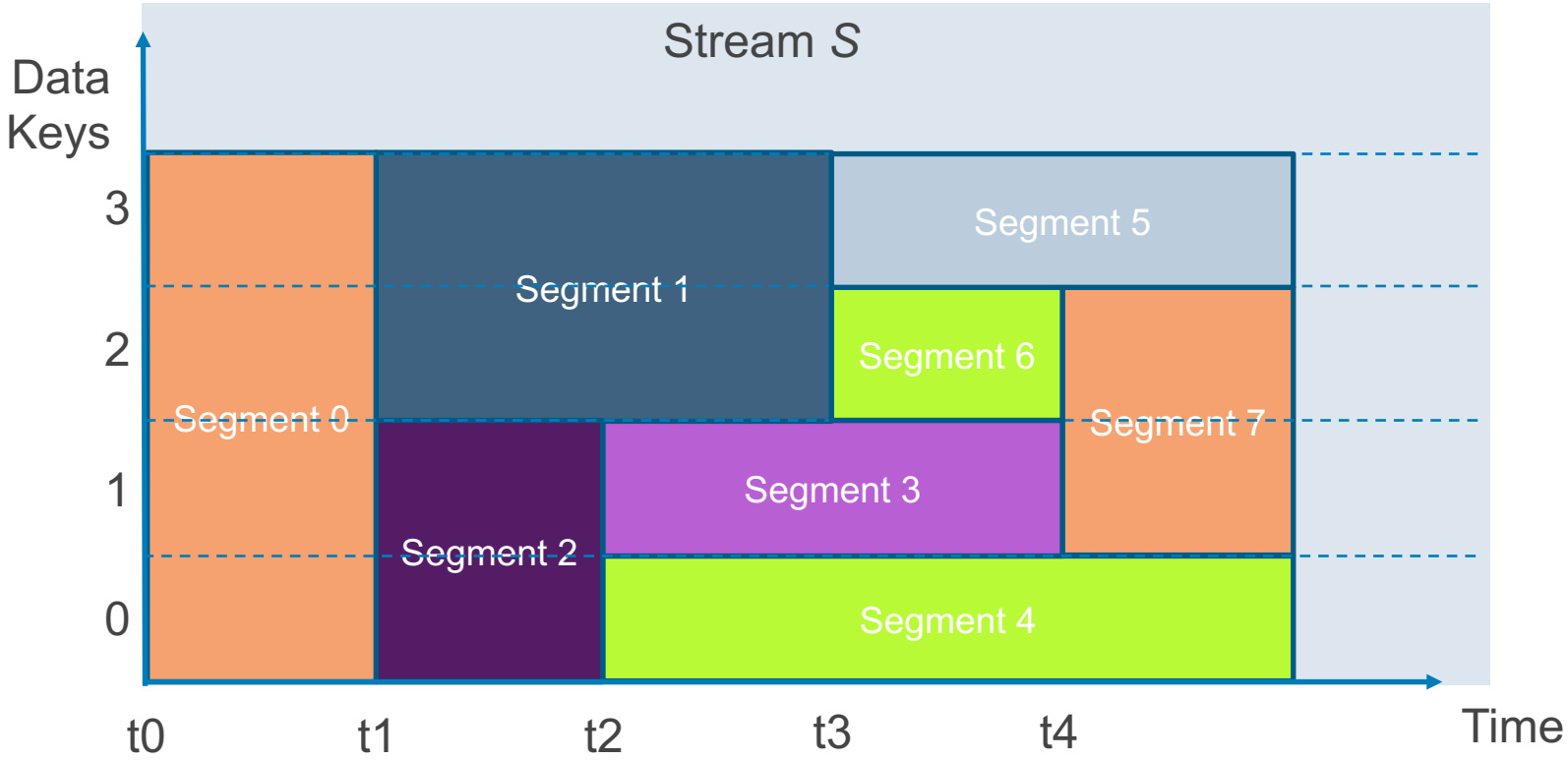
# Stream Elasticity



# Stream Elasticity

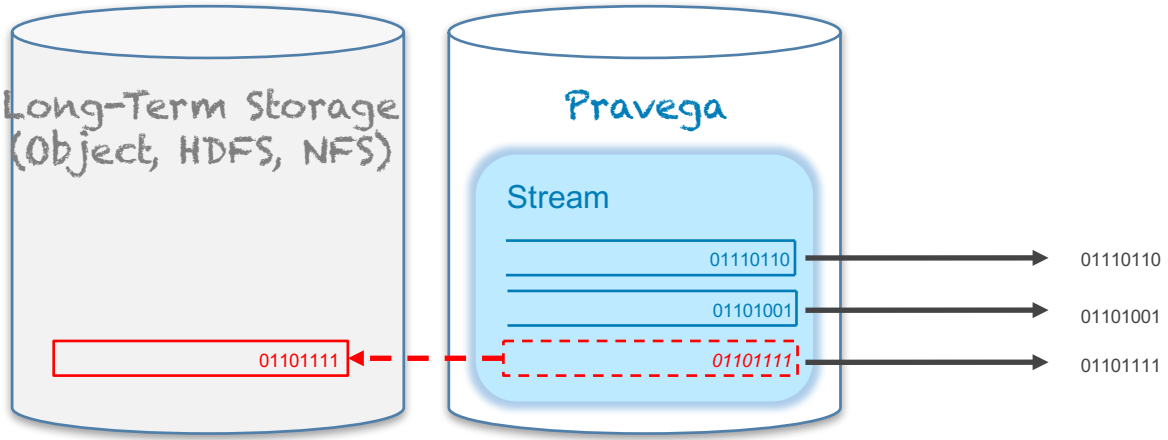


# Zero-Touch Scaling: Segment Splitting & Merging

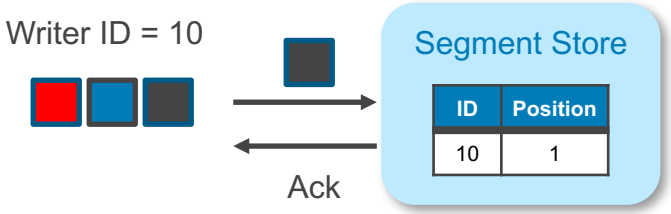


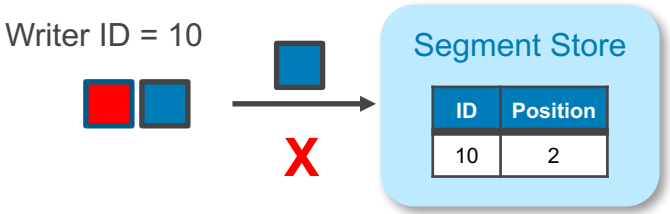
# Unbounded Streams

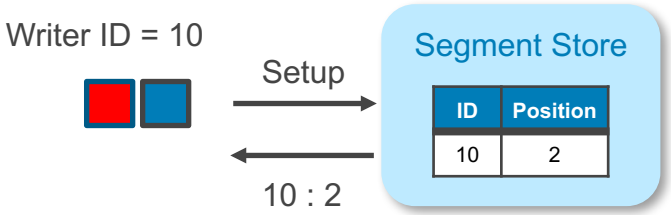
- Segments are automatically tiered to long-term storage
- Data in tiered segments is transparently accessible for catch-up reads
- Preserves stream abstraction while lowering storage costs for older data

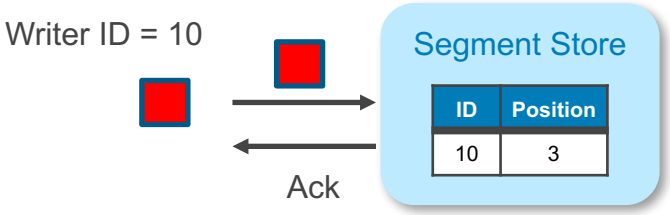


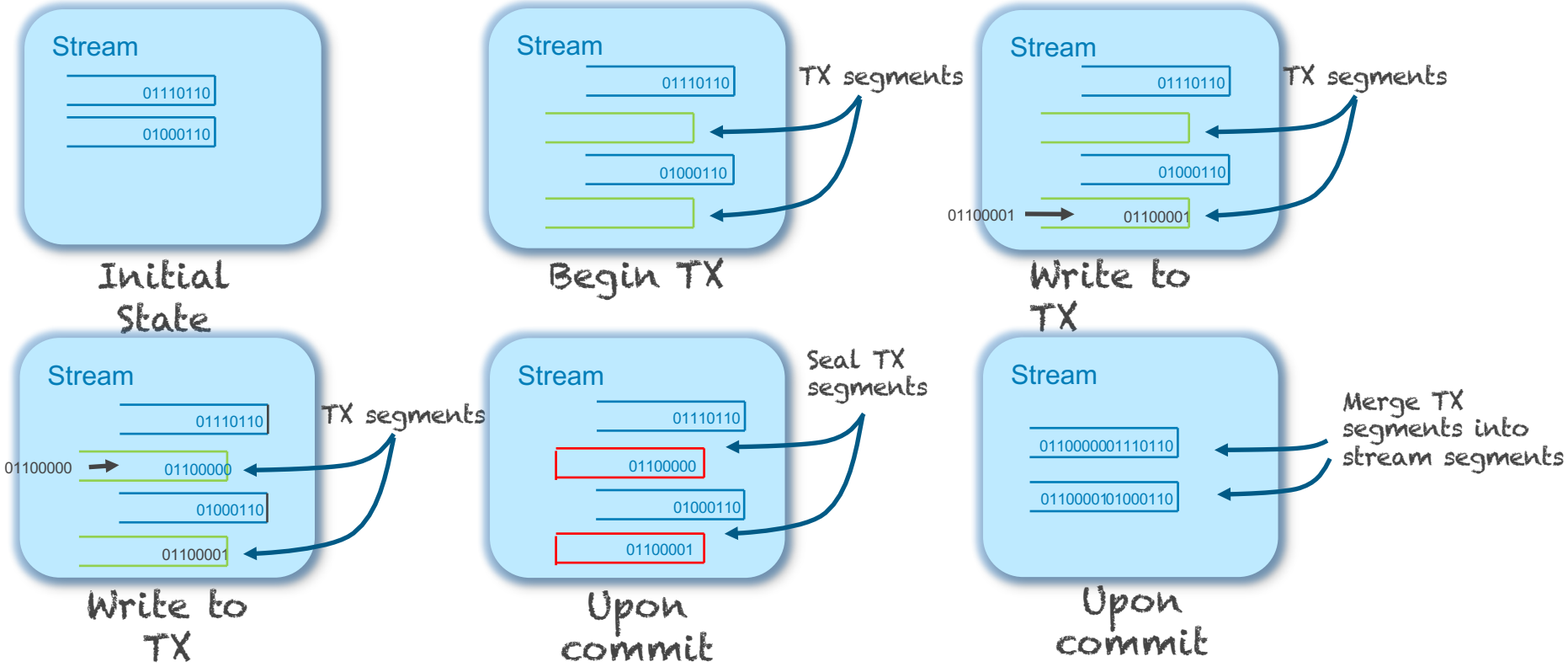
# Exactly Once

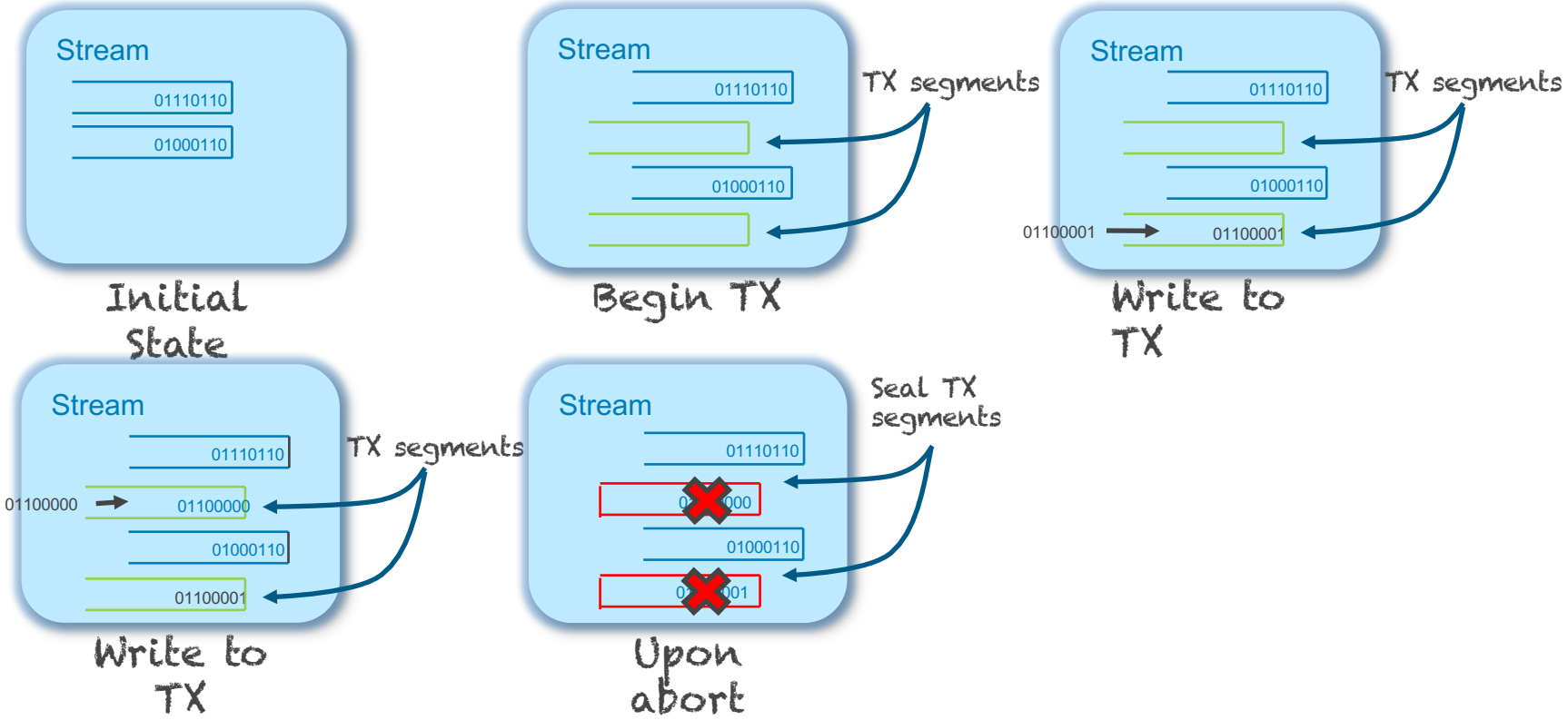



Stream
01110110
01000110
Initial State
Stream
01110110
01000110
TX segments
Begin TX
Stream
01110110
01000110
01100001
01100001
TX segments
Write to TX
Stream
01110110
01100000
01100000
01000110
01100001
TX segments
Write to TX
Stream
01110110
01100000
01000110
01100001
Seal TX segments
Upon commit
Stream
0110000001110110
0110000101000110
Merge TX segments into stream segments
Upon commit


Stream
01110110
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Initial State
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TX segments
Begin TX
Stream
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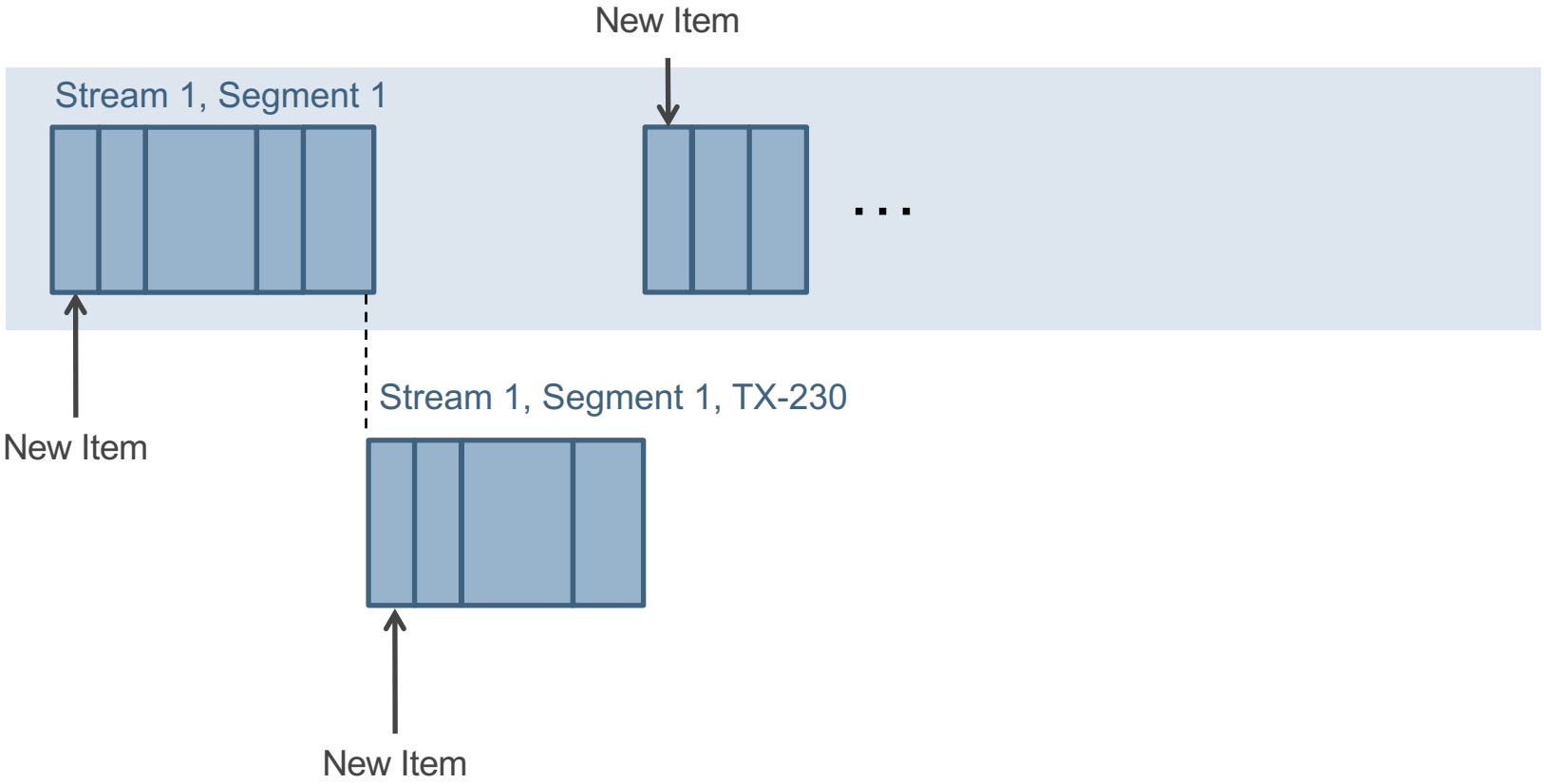
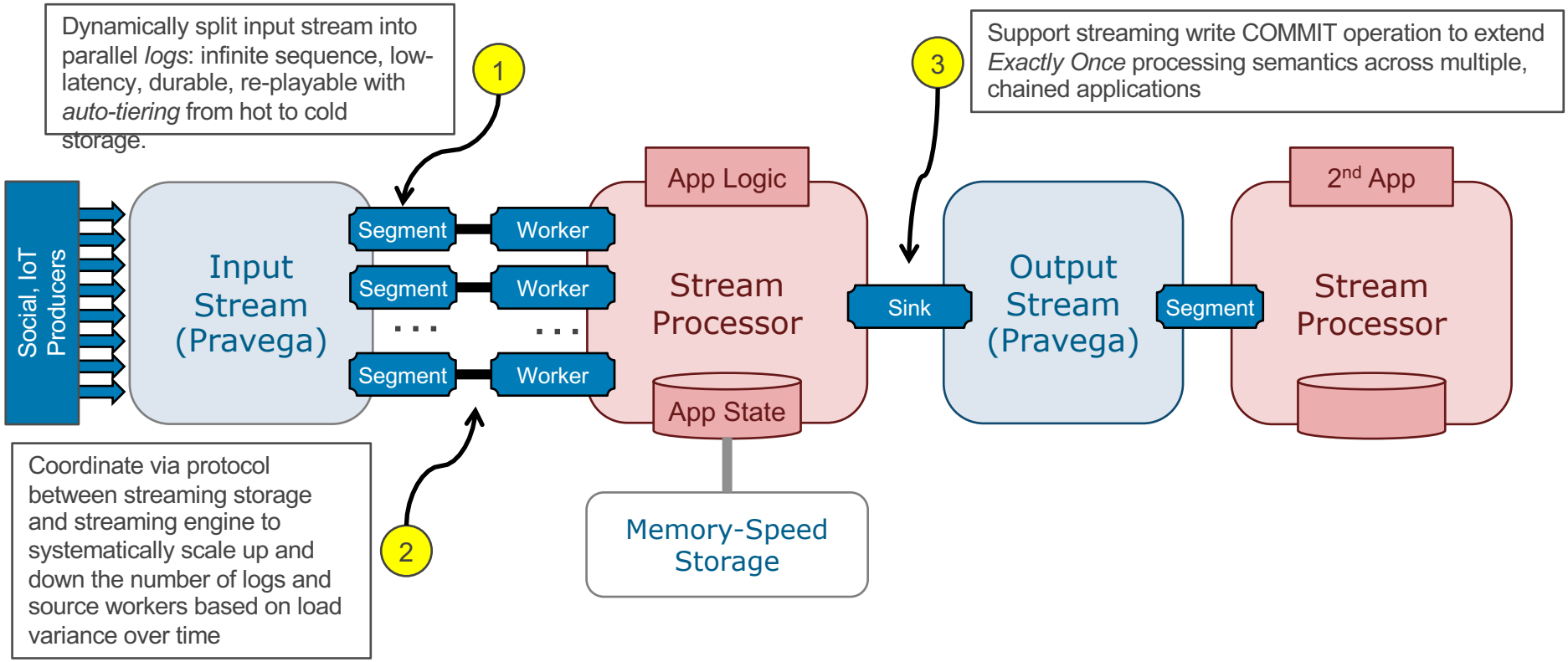
01100001
01100001
TX segments
Write to TX
Stream
01110110
01100000
01100000
01000110
01100001
TX segments
Write to TX
Stream
01110110
01000110
Seal TX segments
Upon abort

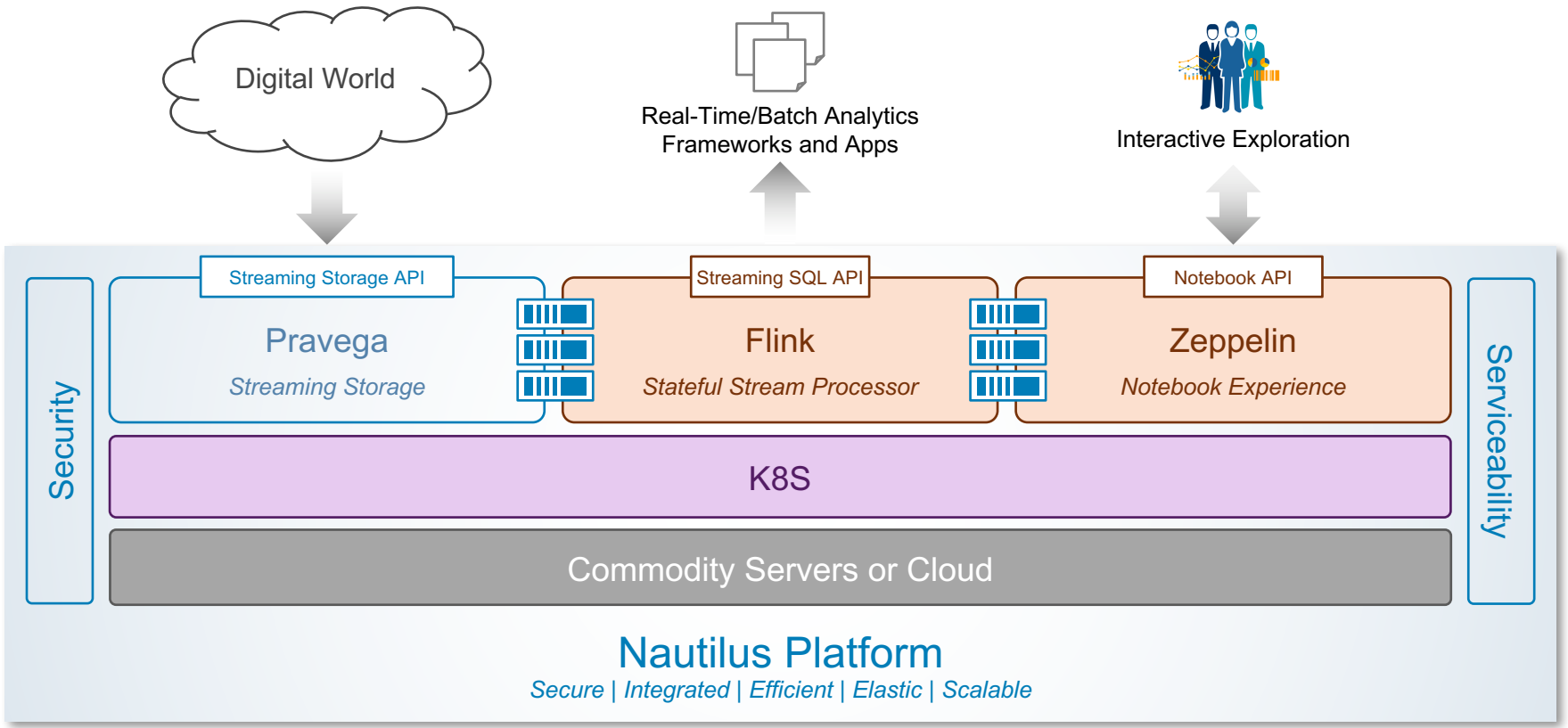
# Transactional Semantics For “Exactly Once”



# Pravega Optimizations for Stream Processors



# A Turn-Key Streaming Data Platform



# Summary

1. “Streaming Architecture” replaces “Accidental Architecture”
   - Data: infinite/continuous vs. static/finite
   - Correctness in real-time: Exactly once processing + consistent storage
2. Pravega Streaming Storage Enables Storage Refactoring
   - Infinite, durable, scalable, re-playable, elastic append-only log
   - Open source project
3. Unified Storage + Unified Data Pipeline
   - The New Data Stack!


DELL EMC

# Comparing Pravega and Kafka Design Points

Unlike Kafka, Pravega is designed to be a durable and permanent storage system

| Quality | Pravega Goal | Kafka Design Point |
|---|---|---|
| Data Durability | Replicated and persisted to disk before ACK | Replicated but not persisted to disk before ACK ✗ |
| Strict Ordering | Consistent ordering on tail and catch-up reads | Messages may get reordered ✗ |
| Exactly Once | Producers can use transactions for atomicity | Messages may get duplicated ✗ |
| Scale | Tens of millions of streams per cluster | Thousands of topics per cluster ✗ |
| Elastic | Dynamic partitioning of streams based on load and SLO | Statically configured partitions ✗ |
| Size | Log size is not bounded by the capacity of any single node | Partition size is bounded by capacity of filesystem on its hosting node ✗ |
| | Transparently migrate/retrieve data from Tier 2 storage for older parts of the log | External ETL required to move data to Tier 2 storage; no access to data via Kafka once moved ✗ |
| Performance | Low (<10ms) latency durable writes; throughput bounded by network bandwidth | Low-latency achieved only by reducing replication/reliability parameters ✗ |
| | Read pattern (e.g. many catch-up readers) does not affect write performance | Read patterns adversely affects write performance due to reliance on OS filesystem cache ✗ |