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DESIGN STUDY

Order and inventory events for a store-and-online retailer: off ZooKeeper, onto Kafka 4.2 on Amazon MSK

Complete design on current platforms

CAPABILITY	INDUSTRY	SETTING
Digital	Retail	Store-and-online retailer
DOCUMENT	VERSION	DATE
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WRITTEN BY

Avinash Dhinakaran, Principal Integration Architect

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Document control

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Sign-off	"An engagement under this design is signed by the practice lead before any build proceeds."		

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> CONVENTIONS
>
> **Source tags.** [S] figure read from the project's or vendor's own current page on Sep 24, 2026 · [S*] figure from the owner's page summary where the page itself could not be opened · [A] design assumption · [T] design target (the record's outcome figure and anything derived from it). Every figure carries one tag. No figure comes from any prior engagement, file or asset. A row with more than one tag is counted once: as a published figure if any tag is [S] or [S*], otherwise as an assumption if any tag is [A], otherwise as a design target.

Table 1. Revision history

Date	Version	Change
Sep 27, 2026	`1.0`	First issue.
Oct 7, 2026	`1.1`	One public deployment removed from §1c; no figure depended on it.
Oct 10, 2026	`1.2`	Approval line now reads: approved by the Founder, issued by Symbeeo. Avinash Dhinakaran remains the author.

1 · Scope

Who it is for. The head of integration or the e-commerce technology lead of a retailer whose order, stock and fulfillment events run on a managed Kafka cluster past its support date, still on ZooKeeper, and who must bring it back into support before the next peak season and move it off ZooKeeper after it, without losing an order.

Typical buyer [A]. A retailer with 300 stores, one web and app channel and 3 distribution centers. Events: orders, stock movements, click-and-collect picks, returns. Current platform: one Amazon MSK cluster on Apache Kafka 3.6.0 with ZooKeeper, 6 brokers, 220 topics, in one AWS Region [A]. Peak: 12,000 events/s at 2 kB during the late-November sales week [A].

What is in. Target Kafka release and broker type; the cluster; topic and contract rules; producer and consumer settings for zero acknowledged loss; migration with consumer offsets carried; one trace across the broker hop; lag alerts. **What is out.** Point-of-sale buffering when a store loses its link; the order management system's own logic; the warehouse system; network (SRA-NET-001).

Assumptions. Source and target clusters sit in the same AWS account and Region [A]. Producers and consumers use Apache Kafka Java clients that the team can upgrade [A]. No application uses the Kafka Streams API on this cluster [A].

Related documents, read Sep 24, 2026. SRA-DIG-001, SDD-DIG-001, STP-DIG-001 v1.0 (issued Sep 27, 2026) · Amazon MSK, Supported Apache Kafka versions (`https://docs.aws.amazon.com/msk/latest/developerguide/supported-kafka-versions.html`) · Amazon MSK Express brokers (`https://docs.aws.amazon.com/msk/latest/developerguide/msk-broker-types-express.html`) · Amazon MSK Replicator (`https://docs.aws.amazon.com/msk/latest/developerguide/msk-replicator.html`) · Apache Kafka 4.2.0 release announcement (`https://kafka.apache.org/blog/2026/02/17/apache-kafka-4.2.0-release-announcement/`) · Apache Kafka blog, release list (`https://kafka.apache.org/blog/`).

1c · Public implementations this design follows

Each row is labeled. **Public deployment**: a named operator's real deployment, published and dated by the operator, its vendor or a partner, used where one exists. **Our own design**: the dated vendor or standards documentation this design was built from, where no public deployment of the design exists. Labels and dates checked Sep 27, 2026.

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Table 2. Public implementations this design follows

Implementation	Who published it · date	What it settles for this design	URL
Our own design, built from published documentation. Apache Kafka 4.2 on MSK Express brokers; MSK supported Kafka versions	AWS What's New · Jul 15, 2026; versions page undated, read Sep 27, 2026	4.2.x on MSK since Jul 15, 2026, on Express brokers only; MSK 3.6.0 reached end of support on Jun 1, 2026, and a cluster past end of support may be upgraded by AWS at any time without notice; 3.9 is the last version with both ZooKeeper and KRaft	`https://aws.amazon.com/about-aws/whats-new/2026/07/aws-msk-express-version-42/` · `https://docs.aws.amazon.com/msk/latest/developerguide/supported-kafka-versions.html` · `https://docs.aws.amazon.com/msk/latest/developerguide/version-support.html`
Our own design, built from published documentation. Migrating from Standard to Express brokers with MSK Replicator	AWS Big Data Blog · Feb 13, 2025	§4.6: Replicator copies an existing MSK cluster to a new cluster of Express brokers, with topics, configuration and consumer offsets. Replicator quotas, read Sep 27, 2026: 750 topics and 1 GB/s ingress per Replicator; 220 topics and 24 MB/s sit inside both. The pages name no Kafka version ceiling; a 4.2.x Express target is confirmed in the non-production run of phase 2	`https://aws.amazon.com/blogs/big-data/migrate-from-standard-brokers-to-express-brokers-in-amazon-msk-using-amazon-msk-replicator/` · `https://docs.aws.amazon.com/msk/latest/developerguide/limits.html`
Our own design, built from published documentation. Apache Kafka 4.2.0	Apache Kafka project · February 17, 2026	Share groups ("Kafka Queues") production-ready upstream in 4.2; the design waits for MSK to support them rather than running them elsewhere	`https://kafka.apache.org/blog/2026/02/17/apache-kafka-4.2.0-release-announcement/`

2 · Requirements register

Table 3. Requirements register

#	Requirement	Value	Source
R1	Current release	Apache Kafka 3.6.0 on MSK, end of support Jun 1, 2026	[S] AWS
R2	Target release	Apache Kafka 4.2.x, KRaft only, no ZooKeeper	[S] AWS; [S] Kafka
R3	Broker type	MSK Express, three Availability Zones	[S] AWS
R4	Peak event rate	12,000 events/s at 2 kB = 24 MB/s write	[A]
R5	Headroom	cluster write capacity ≥ 3 × peak	[T]
R6	Acknowledged events lost when one broker fails	0	[T] SRA-DIG-001 R6
R7	Topic contracts	220 of 220 topics with an AsyncAPI 3.1.0 document before cut-over	[S] SRA-DIG-001 R2
R8	Stock update visible to the web channel	≤ 5 s p95 from store scan at peak	[T]
R9	End-to-end trace	one trace from order API through broker to fulfillment consumer	[S] SRA-DIG-001 R11

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#	Requirement	Value	Source
R10	Consumer offsets	carried to the target; no event reprocessed twice by a consumer that commits	[T]
R11	Cut-over dates	phase 1: in-place upgrade of the existing cluster to 3.9.x by Oct 30, 2026, before the sales week; phase 2: production on the Express 4.2.x target by Feb 26, 2027, after peak and the January returns	[T]
R12	Work queues	consumer groups at go-live; share groups only once MSK Express supports them	[S] AWS

Twelve rows; six carry a vendor's or standard's figure, one is a design assumption, five are design targets.

3 · Architecture overview

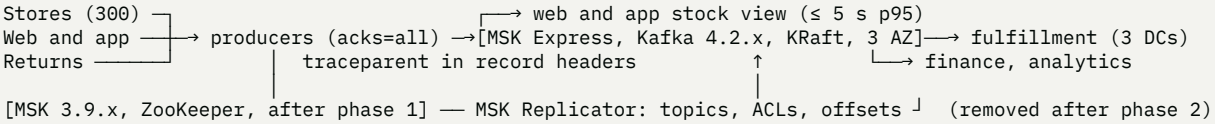


Figure 1. Event platform migration

Two phases: the old cluster is upgraded in place to 3.9.x before peak, then replicated to one new target after peak until the last consumer has moved. The parts table lists releases and settings rather than hardware.

Table 4. Architecture overview

Role	Component (exact name)	Qty	Capacity used	Why this unit
Event platform	Amazon MSK Provisioned, Express brokers, Apache Kafka 4.2.x	1 cluster, 3 brokers, 1 per AZ	24 MB/s write at peak [A]	4.2.x on MSK since Jul 15, 2026, Express only [S]; three AZs required [S]
Metadata	KRaft (no ZooKeeper)	managed by MSK	—	ZooKeeper removed in Kafka 4.0 [S] SRA-DIG-001 S9
Phase 1	MSK in-place Kafka version upgrade, 3.6.0 → 3.9.x	1 cluster	6 brokers	supported upgrade operation; the exact target list is read from GetCompatibleKafkaVersions at design [S] (`https://docs.aws.amazon.com/msk/latest/developerguide/version-upgrades.html`, read Sep 27, 2026)
Phase 2	Amazon MSK Replicator, same-Region replication	1	220 topics, all consumer groups	replicates data, topic configuration, ACLs and consumer offsets to an Express-broker cluster [S]; inside the 750-topic quota [S]
Contracts	AsyncAPI 3.1.0 document per topic	220	—	SRA-DIG-001 R2 [S]

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Role	Component (exact name)	Qty	Capacity used	Why this unit
Trace propagation	W3C Trace Context in Kafka record headers	every producer	—	SRA-DIG-001 §4.7 [S]

4 · Design by subsystem

4.1 Release and broker type.

Apache Kafka 4.2.x on MSK Express brokers (R2, R3) [S]. 3.9 on the existing Standard brokers is the phase-1 step, not the target: it brings the cluster back into support before peak, but a migration to 4.x would still follow [S]. Rejected: 4.1 on Standard brokers — a forward path, but disk sizing returns, which Express removes [S]. Broker size is chosen from the MSK pricing page at design so that three brokers carry 72 MB/s write, 3 × peak (R5) [T].

4.2 Durability.

Replication factor 3, min in-sync replicas 2, producers `acks=all` and idempotence on (R6) [A]. With one broker per Availability Zone, one zone lost leaves two in-sync replicas and producers keep writing [A].

4.3 Topics and contracts.

Names `<domain>.<entity>.<event>.v<n>`, e.g. `stock.item.moved.v1` [A]. Each topic has an AsyncAPI 3.1.0 document in the catalog before cut-over (R7) [S]. The 220 existing topics are mapped one to one; renames wait until after the sales week [A].

4.4 Work queues.

Click-and-collect picking is a work queue. Share groups are production-ready upstream in 4.2 [S] but not yet supported on MSK Express [S], so pickers stay a consumer group with one partition per picking station, 48 partitions [A]. Re-checked at each MSK release (R12).

4.5 Tracing.

The order API writes `traceparent` into each record's headers; consumers continue the trace, so a web order and its fulfillment pick are one trace (R9) [S]. Telemetry to the retailer's existing OpenTelemetry pipeline (SRA-DIG-001 §4.7) [A].

4.6 Migration, in two phases.

Phase 1, before peak: the 3.6.0 cluster is past end of support, and AWS may upgrade such a cluster at any time without notice [S]; the retailer takes that upgrade itself, in place to 3.9.x, non-production first, by Oct 30, 2026 (R11) [T], so no unplanned upgrade lands in the sales week. Client compatibility is checked first; downgrades are not supported [S]. Change freeze from Nov 1, 2026 to the end of the January returns [A]. Phase 2, after peak: MSK Replicator copies topics, configurations, ACLs and consumer offsets from the 3.9.x cluster to the Express 4.2.x target in the same Region [S]. Consumers move first, one consumer group per window, reading replicated offsets (R10) [T]; producers move last, per channel, stores first; production on the target by Feb 26, 2027 (R11) [T]. The old cluster is removed when its produce rate reads zero for 24 h [A]. A single-step migration before peak is not used: six weeks for 220 contracts, client upgrades and every consumer move, ending two weeks before peak, would leave no room for a rollback.

4.7 Lag and alerts.

Consumer lag per group exported as a metric; the stock-view group alerts when lag implies more than 5 s (R8) [T].

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5 · Failure behavior

Table 5. Failure behavior

Failure	Behavior	Source
One broker or one Availability Zone down	partition leaders move; producers continue with 2 in-sync replicas; 0 acknowledged loss	[A] SRA-DIG-001 F5
Replicator falls behind during migration	consumer move paused; lag alarm; no group moves until lag is under 60 s	[A]
Consumer moved with a stale offset	group rolled back to the old cluster; offsets re-synced; move repeated	[A]
Store link down	point-of-sale buffers locally (out of scope); events arrive late, in order per partition	[A]
Producer on an old client rejected	producer stays on the old cluster until its client is upgraded	[A]
Phase-1 upgrade fails on one broker	MSK operation stops; cluster stays on 3.6.0 serving traffic; AWS case opened; peak run on 3.6.0 under the freeze	[A]

6 · Limits

- AWS documents Replicator with an Express-broker target (blog of Feb 13, 2025) and names no Kafka version ceiling; a 4.2.x target specifically is not named on any page read on Sep 27, 2026, so the phase-2 non-production run confirms it before any production group moves, with Apache Kafka MirrorMaker 2 as the fallback.
- AWS also announced in-place ZooKeeper-to-KRaft migration for clusters on 3.9.x (What's New, Aug 10, 2026) [S]; it keeps Standard brokers and 3.9, so it is not the target here, but it is the fallback if the Express move slips (`https://aws.amazon.com/about-aws/whats-new/2026/08/aws-msk-zk-kraft-migration/`).
- Share groups are out until MSK Express supports them; the picking queue carries the consumer-group rebalance behavior until then.
- Express brokers "don't yet fully support" the Kafka Streams API [S]; an application found using it at inventory stays on a Standard-broker cluster.
- Broker size and cost are chosen from the pricing page at design; no per-broker throughput figure is used as a sizing basis here.
- No figure here has been measured; every rate, lag and date is an assumption or a target.

7 · Lessons learned

None yet — this is a design study; populated after the first build against it.

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8 · The author

WRITTEN BY

Avinash Dhinakaran

Principal Integration Architect

iSAQB Certified Professional for Software Architecture – Advanced Level (CPSA-A), Oracle Certified Consultant – Value Chain Planning, Master Data Management, SCM Cloud

Signed off by Edwin Ozer, Founder.

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