The BDI Event Layer Model: keeping the digital world aligned with reality

Why logistics chains need event-driven information sharing



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The BDI Event Layer Model: keeping the digital world aligned with reality

Why logistics chains need event-driven information sharing

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1 Logistics chains require continuous coordination

> *Event-driven information sharing is an architecture for distributed coordination between autonomous parties whose actions depend on changes in a shared operational reality.*

Logistics chains consist of sequences of physical, administrative and planned occurrences across many independently operating parties. An order is placed, goods are loaded, a declaration is filed, an estimated arrival time changes, a vehicle arrives or a shipment is handed over. Each occurrence changes the operational state of the chain and, as a consequence, what other parties involved in that chain may need to know or act upon.

By linking information exchange to these occurrences, a digital information environment can follow operational changes and inform parties when those changes matter to their work. This is the idea behind event-driven coordination: an occurrence in one part of the chain can trigger a relevant information update elsewhere, enabling independent organisations to adjust their own activities. A carrier may revise a plan, a terminal may reserve capacity, a shipper may respond to a delay and an authority may perform a compliance or risk check. Information sharing is thus organised around changes in the operational process, rather than solely around periodic requests or documents sent between parties.

The Basic Data Infrastructure (BDI) is a principles-based framework for controlled data sharing between entities in the physical economy. Its reference architecture sets out seven core principles, including Connect Physical to Digital and Event-driven Coordination. In a logistics chain, the latter is not primarily about faster message delivery. It is about synchronising distributed processes without requiring one organisation to control the whole chain. Here, "real-time" means that the digital view follows relevant operational changes in time to support decisions; it does not imply hard real-time computing.

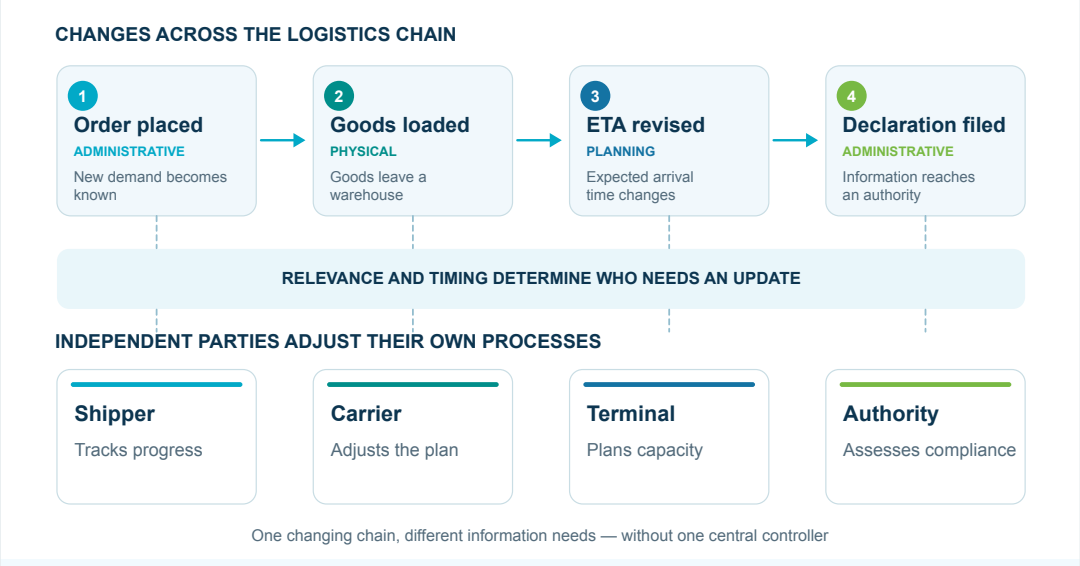


Figure 1: *Operational changes create different information needs across autonomous logistics parties.*

The Pharma Data Corridor (PDC) is a use case developed within the Digital Infrastructure Logistics (DIL) programme to demonstrate BDI principles in an international, public-private logistics setting. It follows shipments of medicines from India to the Netherlands through independently operating suppliers, logistics service providers, carriers, platforms and authorities. Because no single party holds the complete end-to-end process context, the PDC uses event notifications and a federated trust layer to help involved parties, including Dutch Customs, respond to relevant changes without replacing existing systems or centralising operational data. The example returns throughout this paper to illustrate the different event layers. A detailed account of the DIL use case is available in the Pharma Data Corridor whitepaper.

2 An event is more than a technical message

In IT discussions, the word event often quickly becomes a discussion about Kafka, Pulsar, MQ, brokers, topics or webhooks. These technologies can be valuable, but they address the technical distribution of a message rather than the full meaning of an event. In cross-organisational logistics, more fundamental questions come first: what changed, what does that change mean in a business context, for whom is it relevant, and who is allowed to know?

The BDI Event Layer Model describes how changes in operational reality relate to meaningful business events, targeted notifications and the messages used to deliver them. It separates questions about business meaning and recipient relevance from questions about technology.

Two transitions deserve particular attention. First, occurrences in operational reality are interpreted and filtered into business events. Not every occurrence matters to every domain or intended audience, and different parties may interpret the same occurrence differently. Second, a business event does not automatically become a notification for everybody: recipient selection, subscription scope and authorisation determine who may and should be informed. Even a minimal notification can disclose that a particular shipment exists, is moving, has been delayed or is handled by a named partner. Such metadata may reveal commercial relationships, cargo volumes or operational plans without exposing the underlying documents. A party's permission to receive the notification therefore requires consideration in its own right, separate from permission to retrieve further data.

Only after these questions have been addressed is it useful to select the technical delivery mechanism. Kafka can be part of an event-driven BDI implementation. Webhooks, queues or other mechanisms may be better suited to a particular ecosystem. The choice depends on volume, latency, persistence, replay, connectivity, trust and the operating model of the participating organisations.

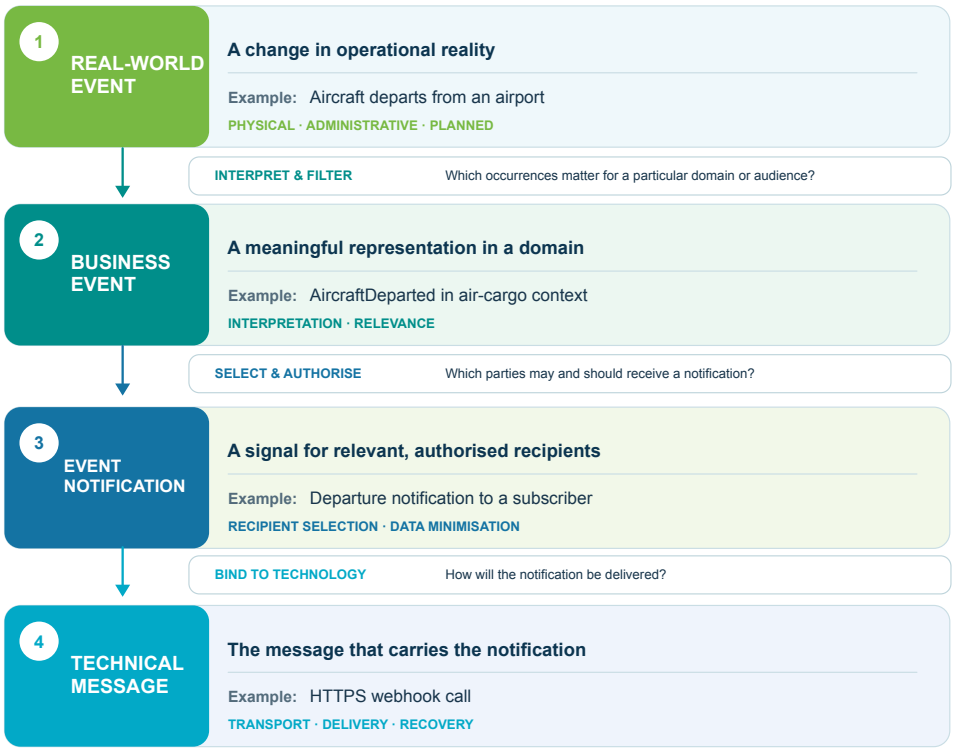


Figure 2: *BDI Event Layer Model (simplified): operational reality, business meaning, notification and technical delivery. For the complete BDI Event Layer model see Appendix 1.*

3 From change in reality to meaningful action

Consider an aircraft departure in the Pharma Data Corridor. At the real-world layer, an aircraft physically leaves the airport. In the air-cargo domain, this occurrence is represented as a business event, for example AircraftDeparted. That representation does not yet tell every other party what it means for its own operation. A party following a pharmaceutical consignment needs to connect the departure to its own logistics context: my consignment is on this aircraft; the aircraft has departed; therefore my consignment has left with it.

The PDC demonstrates why the location of this contextual interpretation matters in federated logistics. An event producer knows its own process, whereas recipients relate events to their own shipments, plans or compliance responsibilities. The PDC uses existing identifiers and their relationships to support that interpretation without making a single participant responsible for the complete end-to-end context. The business event can be published in the producer's domain while the receiving party establishes its own relevance.

The next distinction concerns notification. An event is not necessarily sent to all potential recipients: subscription conditions and authorisation define which parties may receive a signal. In the PDC, notifications are distributed through peer-to-peer webhook subscriptions, supported by association-based trust and authorisation. A recipient can then interpret the received information in its own context and decide whether further data or a subsequent action is needed. That action is a consequence of the event exchange, not another layer of the BDI Event Layer Model.

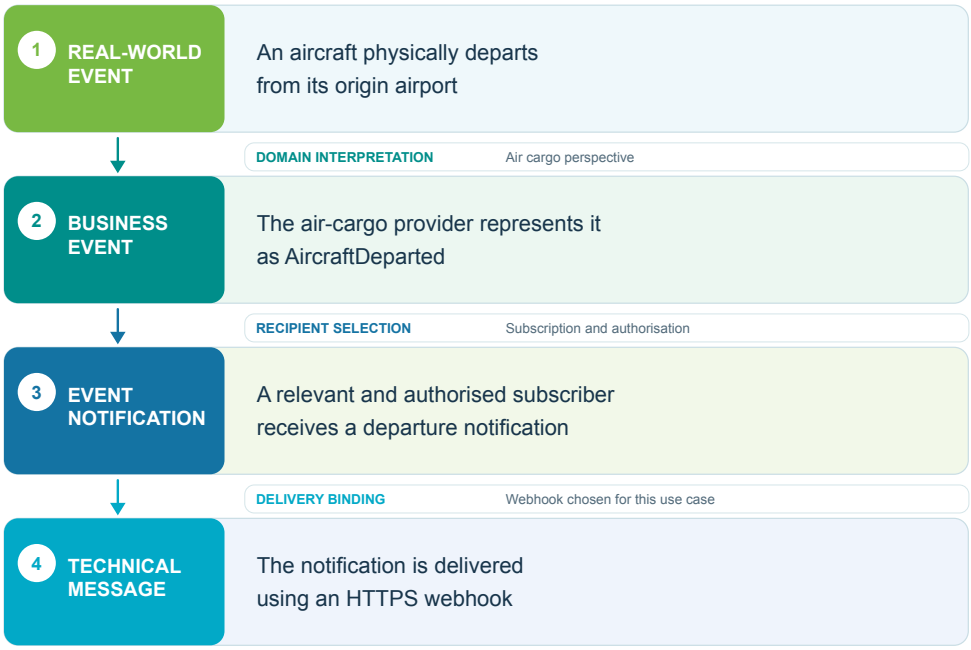


Figure 3: *Applying the four event layers to a departure in the Pharma Data Corridor.*

4 Event-driven does not mean pushing all the data

BDI combines event-driven coordination with data at the source. The natural starting point is therefore a meaningful but bounded notification that tells an authorised party that something relevant has changed and, where needed, points to authoritative data at the source. In the Pharma Data Corridor, event notifications contain a limited set of metadata and additional information can be retrieved after authentication and authorisation.

This creates a useful division of responsibility. Events help determine when information becomes relevant; trust and authorisation determine who needs to know and what they may access. In short: need-to-know, when-to-know. A party can react to a change without every data element being copied and propagated throughout the chain.

Richer event payloads or event-carried state may nevertheless be appropriate in some situations. Immediate automated processing, resilience during temporary source unavailability, recovery after missed events or the need to avoid repeated source calls can justify carrying more data with the notification. The trade-off must then be explicit. The more substantive business data is pushed, the further the implementation moves away from data at the source and the more questions arise about authorisation, provenance, retention, corrections and versioning. Full push should therefore remain a conscious exception rather than the default.

5 Use the Event KIT to design the coordination

Use the Event KIT to design the coordination, not just the transport

The Event Layer Model is a conceptual model for describing operational reality and how relevant occurrences become business representations, notifications and technical messages. It provides a share vocabulary and helps architects identify where interpretation, filtering and authorisation belong. Implementing that model still requires design choices. The BDI Event KIT provides guidance through nine design axes: payload and state; context building; subject, subscription scope and lifecycle; identifiers; authorisation and trust; event contracts and semantics; delivery technology; delivery semantics, recovery and audit; and choreography and operational network lifecycle.

These axes are deliberately technology-agnostic. A high-volume managed community may choose a broker with durable replay. A looser collaboration between independent parties may prefer authorised webhook delivery combined with a source-data API. Another use case may use event-carried state because consumer simplicity and recovery are more important than strict adherence to data at the source. The architecture should make those choices explicit before the technical implementation is fixed.

For BDI-based event-driven data spaces, the Event KIT should therefore be applied at the start of the architecture process. The Event Layer Model structures the description of operational reality and its event-based digital representations, while the design axes make the necessary architectural choices explicit. Together, they help connect the design of data-sharing services to the logistics coordination problem they are intended to address.

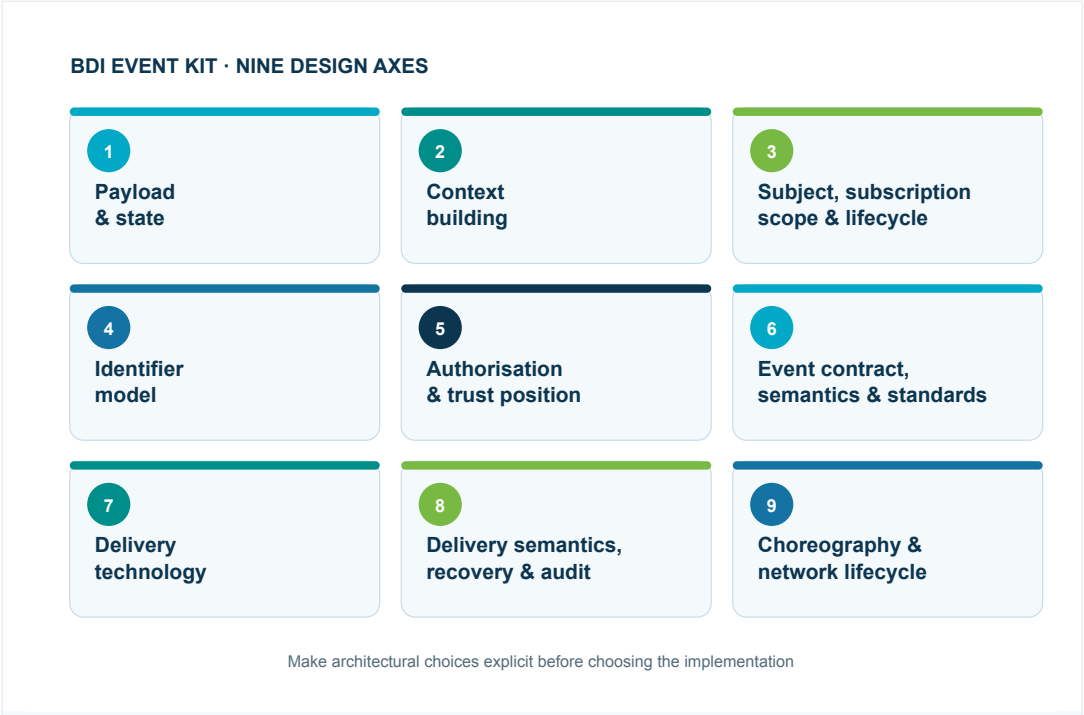


Figure 4: The nine design axes of the BDI Event KIT.

> *Start with the change in operational reality.*
> *Determine its business meaning and intended audience.*
> *Select and authorise the recipients.*
> *Then choose the technology that delivers the notification.*

Appendix 1 The Event Layer Model

LAYER	WHAT IS IT	EXAMPLES IN LOGISTICS		PURPOSE/MEANING	CHARACTERISTICS
1 **REAL-WORLD EVENT** Event in reality	Something happens in the physical, administrative or planning environment. The event exists independently of the event infrastructure.	 Container arrives at terminal	 Aircraft departs	Occurrence in the physical, administrative or planning reality. May be observed or registered by systems of participating parties.	▪ Physical or administrative ▪ Exists independently ▪ Exists independently of the event-distribution infrastructure.
2 **BUSINESS EVENT** Digital representation with domain meaning	An occurrence or set of source signals is represented as a meaningful event in the language and context of the domain and recipient.	**For a forwarder** Container arrival may be represented as: shipment ABC has arrived.	**For an air cargo party** Aircraft departs translates into status of AWB 1 or HAWB 2 is now “departed”.	Selected events gain meaning for a specific role or process in the chain.	▪ Event selection/filtering ▪ Domain semantics ▪ Context dependent ▪ May vary per recipient ▪ Translation / interpretation required
3 **EVENT NOTIFICATION** Signal that a business event has become relevant	The signal that a business event has become relevant for the recipient. May contain minimal metadata with a link to a source, or a payload or even state.	**Payload** eventType: shipmentArrived subject: ABCD1234 source: http://api...	**Payload** eventType: AircraftDeparted subject: AWB 123-4567890 status: Departed flight: KL123	The recipient is informed and may decide what action to take. Information is structured and controlled.	▪ Trigger / notification ▪ Can refer to source ▪ May contain metadata, a source reference, event data or state
4 **TECHNICAL MESSAGE** Technical message for distribution	The message, record or HTTP request used to encode and transport the event notification through a technical delivery mechanism (Kafka, webhook, etc).	**Kafka record** Topic: events.containers Key: ABCD1234 ...	**Webhook (HTTP)** POST https://.../callback-url { eventType: AircraftDeparted, subject: AWB 123-4567890, ... }	Implements the agreed transport and delivery behaviour, such as routing, acknowledgement, retry and ordering.	▪ Transport / delivery ▪ Technical format ▪ Various technologies possible



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