Logistics Event Ontology

Supply chain visibility in the Basic Data Infrastructure Framework

basic data infrastructure

Topsector Logistiek

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Logistics Events Onthology
Supply chain visibility in the Basic Data Infrastructure Framework

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Summary

There is a growing demand from Beneficial Cargo Owners (BCO) to create more visibility in the supply chain: visibility of the operational planning and execution of all the steps between ordering goods and receiving the consignments in the distribution centre or warehouse of the BCO.

Each transport leg in the consignment journey results in one or more events which are to be communicated between parties directly involved in the transport leg. The event communication leads to data exchanges, typically using specific systems, platforms and data formats. The diversity of parties, systems and data formats are a barrier to automated exchanges.

The issue to be solved is the existence of a wide variety of data formats and semantic definitions in supply chains:

- beneficial cargo owners who want to track & trace their goods cannot adopt all the data standards in use;
- the logistics partners want to keep using their existing data standards;
- (global) unification of data standards is not a practical option for the near future.

The concept of an event envelope is introduced, named Logistics Event Ontology (LEO).

The BDI framework separates the envelope from the payload, separating event data from other operational data. The BDI envelope is a notification of an event with additional data and meta-data, combined with a link to the endpoint of the data owner where more (sensitive) data about the event may be requested. The data owner evaluates the request and the party requesting access, and transmits data on a 'need-to-know' basis.

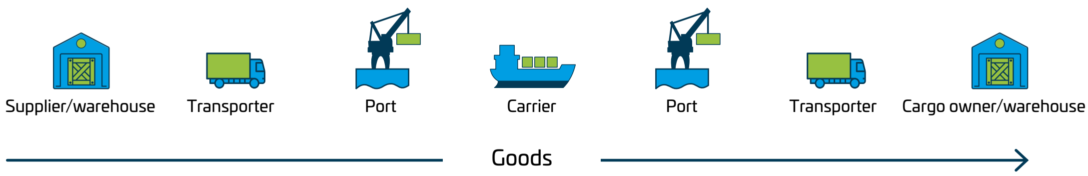
The Logistics Event Ontology (LEO) is derived from existing standards, especially the GS1 EPCIS standard. OpenEPCIS is an open-sourced fully compliant implementation version of the standard, allowing for extensions on the standard to support future events.

LEO supports the use of standard operational trip data by operators (such as carriers) to generate notifications of events to cargo owners or authorities, leading to efficiency and productivity increases.

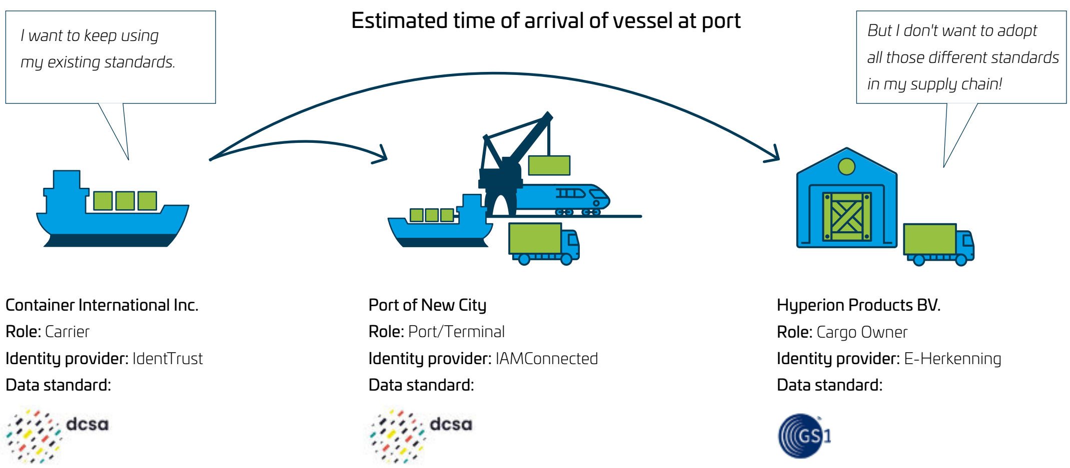
Contents

1 Supply Chain Visibility Barriers

There is a growing demand from Beneficial Cargo Owners (BCO) to create more visibility in the supply chain: visibility of the operational planning and execution of all the steps between ordering goods and receiving the consignments in the distribution centre or warehouse of the BCO.



Each transport leg in the consignment journey results in one or more events which are to be communicated between parties directly involved in the transport leg. The event communication leads to data exchanges, typically using specific systems, platforms and data formats. The diversity of parties, systems and data formats are a barrier to automated exchanges.



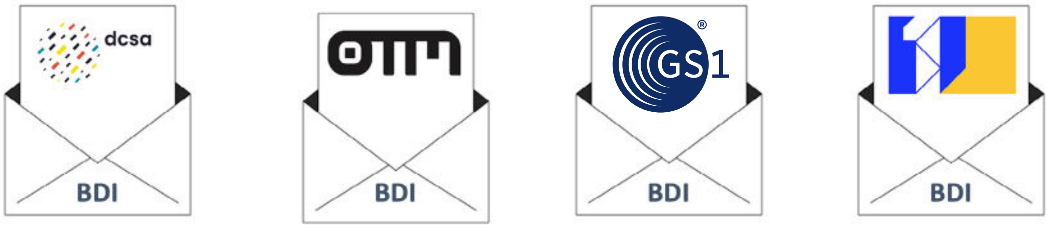
The BDI framework defines the mechanisms to automate trusted and controlled data exchanges between volatile networks of parties associated with a particular consignment.

The issue to be solved is the existence of a wide variety of data formats and semantic definitions in supply chains:

- beneficial cargo owners who want to track & trace their goods cannot adopt all the data standards in use;
- the logistics partners want to keep using their existing data standards;
- (global) unification of data standards is not a practical option for the near future.

2 Event envelope as a concept

To support these needs and trade-offs of all parties involved in the logistics supply chains the concept of an event envelope is introduced.



An envelope is in principle the carrier of communication between logistics supply chain parties, using their existing data exchange standard as the payload within the envelope. The minimal data set to support track & trace is written 'on the envelope'.

This minimal data set has to be standard across the supply chain partners, so each and every party in the chain, including the cargo owner can interpret and use the event data. The standard to define this event envelope is named Logistics Event Ontology (LEO).

A straightforward implementation of the envelope would have serious drawbacks. Embedding the payload in existing data standards in an envelope would break existing interfaces and adapters. Second, by combining the track & trace event data with the payload data some parties might get access to much more detailed information which would normally only be exposed to only one party in the supply chain: the leak of sensitive data is to be prevented.

The BDI framework separates the envelope from the payload, separating event data from other operational data. The BDI envelope is a notification of an event with additional data and meta-data, combined with a link to the endpoint of the data owner where more (sensitive) data about the event may be requested. The data owner evaluates the request and the party requesting access, and transmits data on a 'need-to-know' basis.

This implementation does not interfere with the existing data exchanges, creates the highest level of trust and is a small add-on to the existing communication.

3 Logistics Event Ontology (LEO)

The Logistics Event Ontology (LEO) is derived from existing standards.

Several existing data exchange standard frameworks offer a specific track & trace standard. Most of these are limited to the scope of the domain that is covered by the standard itself.

A cross industry track & trace standard is UN/CEFACT BUSINESS REQUIREMENTS SPECIFICATION (BRS) Integrated Track and Trace for Multi-Modal Transportation. The BRS links the Trade view (of sellers and buyers of goods) with the Transport view. The BRS document (Appendix 4 of this document) defines how an existing GS1 standard can support trade identifiers and transport identifiers, linked as part of existing/current processes already widely adopted throughout the industry. This GS1 standard is called EPCIS.

EPCIS was not intended to exchange information about future events (events that are being planned to occur but may in fact not occur or at least not exactly as originally anticipated). The GS1 EPCIS standard has, however, a formal supported and documented extension mechanism to add these future events.

Fortunately there is an open-sourced fully compliant implementation version of the GS1 EPCIS standard, which is OpenEPCIS. The design decision has been to create an EPCIS compliant extension on OpenEPCIS that can be used to support future events.

To avoid inventing a new way of defining future events the Digital Shipping Container Association (DCSA) Track & Trace standard definition and setup for future events is copied into OpenEPCIS in compliance with the extension mechanism.

The What dimension of an EPCIS event identifies the physical or digital objects that were involved in the event. Identifiers of objects can be GS1 identifiers or Absolute Uniform Resource Locators (URLs) [RFC1738]. This makes it possible to use LEO independent of GS1 acquired identifiers.

Many events in road transport need to relate to the license plate of a truck: this requirement led to a second extension which is included in LEO in relation to standard OpenEPCIS.

The resulting schema of LEO in JSON-LD format can be found at https://dil.semantic-treehouse.nl.

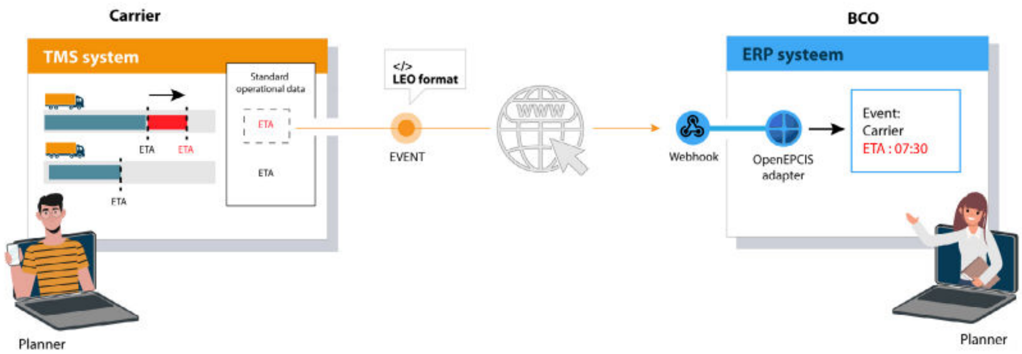
4 Application of LEO for supply chain visibility

4.1 Standard open trip data generates events

Most existing logistic data standards are trade and consignment oriented, much less so on operational trip or voyage data. The so-called Open Trip Model (OTM) for road transport is the inspiration for a standard operational trip (multimodal, voyage) data format that supports future planning and execution of trips:

- Pre-trip planning.
- On-the-fly modifications of the execution.
- Post-trip compliance proof.

The design of LEO enables operators such as carriers to format a LEO event notification directly from this standard operational trip data format. The (Open)EPCIS extension adapter allows cargo owners and others to automate the import of these notifications.



(Open)EPCIS data and therefore LEO data comprises a series of 'events'. Each event documents at business-level something that happened in the physical supply chain.

Each EPCIS event has at least four dimensions of information:

- WHAT (object identified).
- WHERE (event location identified).
- WHEN (date & time of event).
- WHY (business context and object status).

An optional fifth dimension is HOW (sensor data).

Chapter 3 of the EPCIS and CBV Implementation Guideline https://ref.gs1.org/guidelines/epcis-cbv/2.0.0/ describes the anatomy of an (Open)EPCIS event (and therefore a LEO event) and the primary data supported. LEO currently adds two extra features, the support of events in the future, e.g. Estimated Time of Arrival and a property for a vehicle license plate number.

The What dimension of an EPCIS event identifies the physical or digital objects that were involved in the event. Identifiers of objects can be GS1 identifiers or Absolute Uniform Resource Locators (URLs) [RFC1738]. The owning authority for a particular URL is the organization that owns the Internet domain name in the authority portion of the URL.

4.2 Efficiency in declarations to Authorities (Customs)

Consignments that need to cross a border require often multiple declarations to Authorities: customs control requires checks on taxes, health, safety, environment and economy (like trade restrictions).

Transit goods, customs warehousing, temporary importation and inward processing lead to a multitude of declarations regarding the same consignment, often with a lot of redundancy in the data submitted.

LEO based notifications could significantly reduce the amount of data to be processed by Authorities, leading to an efficiency and productivity increase.

- LEO based notifications are sent to Authorities.
- Authorities evaluate the events and decide if (new) data is required.
  - If so: the link embedded in the notification is used to access the data at the source.
  - If not: the notification is stored for later analysis and logging.

5 LEO message examples based on synthetic data

The next section shows some LEO message examples based on synthetic data. The following LEO example message shows an estimated arrival time for a container with identification OPDU205271422G1 at warehouse1 of Securestorage. This example uses URLs for all identifiers and no GS1 identifiers, except for the container itself.


```
"@context": [
    "https://ref.gs1.org/standards/epcis/2.0.0/epcis-context.jsonld",
    {
        "leo": "https://bdinetwork.org/voc/leo/",
        "leo:eventClassifierCode": {
            "@context": {
                "PLN": "leo:EventClassifierCode-PLN",
                "ACT": "leo:EventClassifierCode-ACT",
                "EST": "leo:EventClassifierCode-EST"
            },
            "@id": "leo:eventClassifierCode",
            "@type": "@vocab"
        }
    }
  ],
  "type": "EPCISDocument",
  "schemaVersion": "2.0",
  "creationDate": "2024-07-11T15:03:17.32+02:00",
  "epcisBody": {
    "eventList": [
      {
        "type": "ObjectEvent",
        "eventTime": "2024-07-11T15:24:15Z",
        "eventTimeZoneOffset": "+02:00",
        "eventID": "ni:///sha-1;d38c4adc56affffbf842322d8414a6ad6e86d30a?ver=CBV2.0",
        "epcList": [
          " urn:epc:id:bic: OPDU205271422G1"
        ],
        "action": "OBSERVE",
        "bizStep": "arriving",
        "disposition": "in_transit",
        "sourceList": [
          {
            "type": "owning_party",
            "source": "https://epcis.gib.com/eori/sd/NL00734122"
          },
          {
            "type": "possessing_party",
            "source": "https://epcis.transporteur.nl/eori/sd/NL0012345"
          }
        ],
        "destinationList": [
          {
            "type": "owning_party",
            "destination": "https://epcis.fa.asfalt.nl/eori/sd/NL0000002"
          }
        ],
        "bizLocation": {
          "id": "https://securestorage.nl/warehouse1"
        },
        "bizTransactionList": [
          {
            "type": "po",
            "bizTransaction": "https://smartphone.nl/po12345"
          }
        ],
        "leo:eventClassifierCode": "EST",
        "leo:eventDateTime": "2029-08-11T15:24:15Z",
        "leo:eventDateTimeZoneOffset": "+02:00"
      }
    ]
  }
}
```

In the second example below container OPDU205271422G2 is loaded on a truck with license plate number BDI-1-24 of transporting company with EORI NL0012345.

```
{
    "@context": [
        "https://ref.gs1.org/standards/epcis/2.0.0/epcis-context.jsonld",
        {
            "leo": "https://bdinetwork.org/voc/leo/",
            "leo:eventClassifierCode": {
                "@context": {
                    "PLN": "leo:EventClassifierCode-PLN",
                    "ACT": "leo:EventClassifierCode-ACT",
                    "EST": "leo:EventClassifierCode-EST"
                },
                "@id": "leo:eventClassifierCode",
                "@type": "@vocab"
            }
        }
    ],
    "type": "EPCISDocument",
    "schemaVersion": "2.0",
    "creationDate": "2024-07-11T15:03:17.32+02:00",
    "epcisBody": {
        "eventList": [
            {
                "type": "ObjectEvent",
                "eventTime": "2024-07-11T15:24:15Z",
                "eventTimeZoneOffset": "+02:00",
                "eventID": "ni:///sha-1;d38c4adc56affffbf842322d8414a6ad6e86d30a?ver=CBV2.0",
                "epcList": [
                    "urn:epc:id:bic:OPDU205271422G2"
                ],
                "action": "OBSERVE",
                "bizStep": "departing",
                "disposition": "in_transit",
                "sourceList": [
                    {
                        "type": "owning_party",
                        "source": "https://epcis.gib.com/eori/sd/NL00734122"
                    },
                    {
                        "type": "possessing_party",
                        "source": "https://epcis.transporteur.nl/eori/sd/NL0012345"
                    }
                ],
                "destinationList": [
                    {
                        "type": "owning_party",
                        "destination": "https://epcis.fa.asfalt.nl/eori/sd/NL0000002"
                    }
                ],
                "bizLocation": {
                    "id": "https://securestorage.nl/warehouse1"
                },
                "bizTransactionList": [
                    {
                        "type": "po",
                        "bizTransaction": "https://smartphone.nl/po12345"
                    }
                ],
                "leo:eventClassifierCode": "EST",
                "leo:eventDateTime": "2029-08-11T15:24:15Z",
                "leo:eventDateTimeZoneOffset": "+02:00",
                "leo:licensePlate": "BDI-1-24"
            }
        ]
    }
}
```

The third example below shows a gate-out (EXIT GATE) event for container OPDU205271422G3 from the Hutchison Ports ECT Euromax terminal.


```
{
  "@context": [
    "https://ref.gs1.org/standards/epcis/2.0.0/epcis-context.jsonld"
  ],
  "type": "EPCISDocument",
  "schemaVersion": "2.0",
  "creationDate": "2024-11-29T12:01:49.58Z",
  "epcisBody": {
    "eventList": [
      {
        "type": "ObjectEvent",
        "eventTime": "2024-11-29T12:50:50+01:00",
        "eventTimeZoneOffset": "+01:00",
        "epcList": [
          " urn:epc:id:bic: OPDU205271422G3"
        ],
        "action": "OBSERVE",
        "readPoint": {
                                        "type": "gs1:Place",
            "id": "https://ect.nl/euromax/gate-out",
            "gs1:physicalLocationName": "Hutchison Ports ECT Euromax Exit Gate",
            "gs1:locationRole": "gs1:LocationRoleType-EXIT_GATE",
                                        "gs1:containedInPlace": {
              "type": "gs1:Place",
              "id": "https://ect.nl/euromax",
              "gs1:physicalLocationName": "Hutchison Ports ECT Euromax",
              "gs1:locationRole": "gs1:LocationRoleType-TERMINAL"
                                        }
        }
      }
    ]
  }
}
```


OpenEPCIS/LEO supports a lot of detailed features like aggregations, e.g. products in cases, cases on a pallet, pallets in a container, dispositions, in-(ware)house relocations, ownership or custody of a product and sensor data.

OpenEPCIS/LEO does not support out-of-the box communication of e.g. a sequence of stops and vehicle properties. If this is perceived as a necessity, this can be added to LEO by the OpenEPCIS extension mechanisms.

6 References

DCSA
https://dcsa.org/

OpenEPCIS
https://openepcis.io/

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basic data infrastructure