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Postal services — Interface and data transfer format for capturing postal automation events IDT-PAE

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National foreword

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Postal services - Interface and data transfer format for capturing postal automation events IDT-PAE

Services postaux - Format d'interface et de transfert des données relatives à la capture des évènements sur des équipements postaux automatisés

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (CEN/TS 16919:2016) has been prepared by Technical Committee CEN/TC 331 “Postal services”, the secretariat of which is held by NEN.

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Introduction

This Technical Specification will be in the series of the Open Standard Interfaces defining manufacturer independent interface definitions where needed. All Sorting equipment of the different manufacturers in a sorting centre produce data which are relevant for service planning, machine and staff planning, optimization of machine utilization and other sorting centre management relevant data. On the other hand the major suppliers for postal IT systems have developed MIS systems for these or other purposes. In sorting centres with mixed machinery and one or more MIS systems, data need to be converted for integration. This Technical Specification will allow to define a common interface to avoid these multiple conversions and by this save costs in the postal business. See Figure 1.

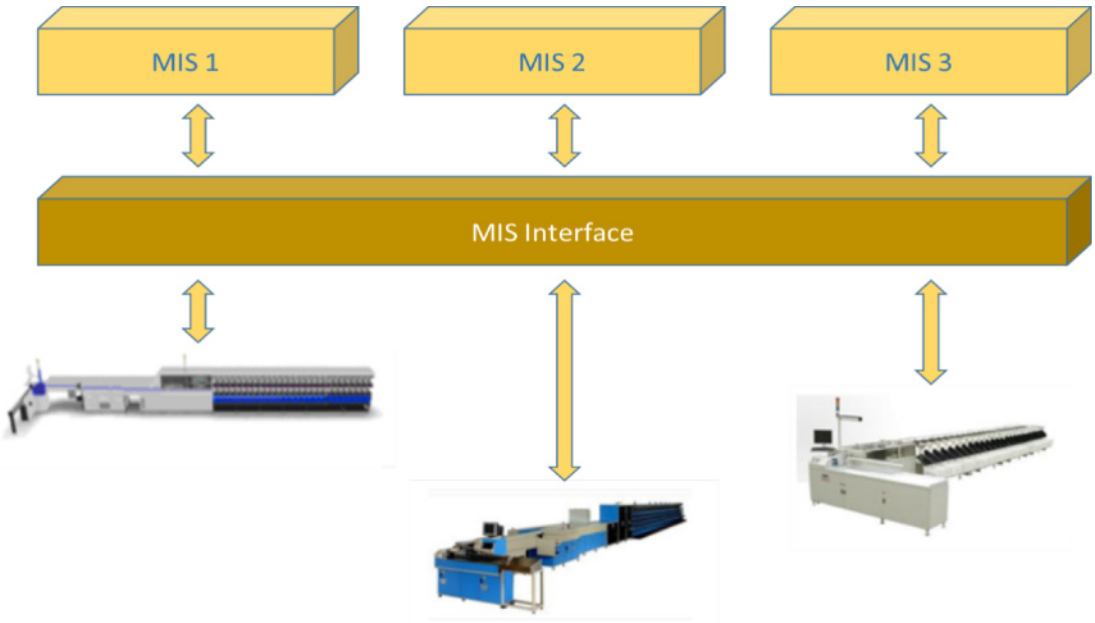

Figure 1 — Open Interface Illustration

As a conscious decision of the Project Team work it is assumed MIS standard will be an instance of EPCIS standard with specific application of this Technical Specification to the Postal Process that will be modelled in the chapters. The Technical Specification will then go through a number of significant events of the process that an MIS interface should contain in order to guarantee the interoperability of different proprietary MIS systems and different Postal Sorting equipment.

Focus of the development is:

— The specification will allow interfacing postal processes in order to gather information which shall be prepared for presentation/aggregation to higher-level systems;

— The specification will not be in favour of one vendor over another;

— The specification will not be specific to a programming language, operating system or hardware;

— The specification will be specific enough, to allow any standards-compliant equipment to be connected to standards-compliant higher level systems and get at least basic functionality without any customization;

— The Data Model will use well-established terms, e.g. taken from the UPU data model, which are suitable to describe postal processes accurately;

— The Data Model will categorize the information sent and received (e.g. into status, event, control-message) and define standards for each of these categories;

— The specification will allow for vendor-specific or equipment-specific variations. The scope of these variations will be limited (otherwise we would not have a standard at all);

— The specification will provide for future extensions and modifications, such that future versions do not break existing installations;

— It will have to be easy to implement an interface which is compliant with this standard;

— The specification will define how to prevent unauthorized access, preferably by referring to an existing security standard;

— The specification will use well-established technologies for Data Transport;

— The specification will use established standard for Data Format;

— The specification needs to state minimal requirements for data volume and frequency as well as the permissible latency which an implementation needs to comply to.

1 Scope

An IDT-PAE interface enables interoperability among several systems and processes by providing specifications to the following requirements:

a) Data Collection and Transfer: Specification of data transported from the devices to higher level systems. There may be more than one permissible protocol referring to different OSI layers. The standard will define where the communication requires polling and where asynchronous messages are used.

   The basis is messages triggered by events.

b) Data Storage and Format: Specification how data is formatted and structured. This concerns the choice between XML, CSV, EDI, JSON and other formats including possible binary representations.

c) Data Model: Specification of the semantics (meanings) behind the data. This is the most important part and the one of the most important objectives for the specification. This means that conceptual data model and its mapping to the Data Format will be developed. Major focus on specifications level of detail will be placed in order to provide a document that will provide detailed specification information without being too general or too specific.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply[1)].

2.1
acceptance
process of examining a mail induction unit at the acceptance location, to ensure that the mail is acceptable for postal processing and that the postal operator may take responsibility for it

2.2
acceptance location
location at which responsibility for a mail induction unit is handed over from the mail submitter to the mail service contractor

2.3
acceptance of postal processing
completion of the process of ensuring that mail can legally be conveyed by post, fulfils postal system requirements, regarding size, addressing, etc. and that correct postage has been paid or is chargeable under normal contractual arrangements

2.4
activity
work performed by people, equipment, technologies or facilities

2.5
addressee
party that is the intended ultimate recipient of a postal item

1) The terms and definition in this document are defined in the UPU Standard glossary, Date of approval 26 February 2014, in the bibliography and in this document.

2.6
aggregate assignment (packaging)
assignment of an item or (lower-level) aggregate to a (higher-level) aggregate of mail which is to be handled as a unit during the next processing or transportation step(s)

2.7
aggregate break-up (unpacking)
decomposition of an aggregate into its component mail items and/or lower-level aggregates

2.8
application identifier
numeric prefix to a data structure that defines the content, format and intended interpretation of the data

2.9
attribute
named characteristic of an entity which can be expressed by a data value

2.10
bar code
symbol consisting of a series of printed bars representing values

2.11
business information system
business information systems represent a system of controls and processes which a business uses to analyze information needed to effectively manage their business

2.12
bundle
mail unit whose physical constraint is a band or wrapper

2.13
clearance
operation of collecting postal items deposited at access points

2.14
control protocols
provides reliable, ordered, error-checked delivery of a stream of octets between programs running on computers connected to a local area network, intranet or the public Internet

2.15
code
value, taken from a particular code list, which is used in messages to represent one of the possible data values forth data element covered by the code list

2.16
collection
method of mail induction in which customers deposit mail in unmanned depositories (posting boxes) which are periodically emptied by the mail service contractor or its agent

2.17
consignment
set of one or more receptacles of a particular mail category, using a common transport on a particular occasion, from a specific place of loading to a specific place of final destination

2.18
containerization
process or act of packaging one or more mail units into a receptacle to simplify handling and transportation

2.19
data element
smallest logical unit of data, about a postal item, aggregate or receptacle, which might need to be communicated between postal applications

2.20
data captured
automatically identifying objects, collecting data about them, and entering that data directly into computer systems

2.21
data collection and transport
collection and distribution of information to virtually any device or system

2.22
data format
standard way that information is encoded for storage in a computer file

2.23
data model
used in two related senses. In first sense it is a description of the objects represented by a computer system together with their properties and relationships; these are typically "real world" objects such as products, suppliers, customers, and orders. In the second sense, it means a collection of concepts and rules used in defining data models: for example the relational model uses relations and rules, while the network model uses records, sets, and fields

2.24
data storage
technology consisting of computer components and recording media used to retain digital data

2.25
data transfer
physical transfer of data (a digital bit stream) over a point-to-point or point-to-multipoint communication channel

2.26
delivery operators
postal enterprise which delivery the postal items on addressee of recipient

2.27
distribution
process from sorting at the distribution centre to delivery of postal items to their addressees

2.28
data identifier (DI)
smallest logical unit of data, about a postal item, aggregate or receptacle, which might need to be communicated between postal applications

2.29
data identifier category
grouping of related data identifiers

2.30
date
characteristic of an event which defines, to an appropriate level of accuracy, the point in time at which it occurred or is or was forecast to occur

2.31
delivery
postal process in which a postal item leaves the responsibility of the postal operator through being handed over to, or left for collection by, the addressee, the mailed or an authorized representative, or deposited in a private letter-box accessible to one or other of these

2.32
delivery address
postal address specified by the mailer to which the postal operator is requested to deliver the postal item

2.33
delivery attempt
(so far) unsuccessful attempt to deliver an item or entity

2.34
delivery failure
event corresponding to conclusion, by a postal handling organisation, that it is definitely unable to deliver the entity concerned and (if the entity is still available to it) intends to dispose of it in accordance with its contractual obligations

2.35
delivery completion
successful delivery of an item, including the obtaining of proof of delivery where this is required

2.36
delivery events
cover events related to the final delivery of mail

2.37
delivery point
physical location recognized by a postal operator as a valid location at which delivery of a postal item may occur

2.38
delivery post
postal operator, or other postal handling organisation, entrusted with delivery of a postal item

2.39
delivery routes
route followed by a delivery postman

2.40
dispatch
mail aggregate for which, under the terms of a single despatch agreement, responsibility is (to be) handed over from one mail processing centre to another and which is accounted for as a unit between the operators involved

2.41
despatch agreement
agreement under which mail is exchanged between mail processing centres operated by different postal handling organizations

2.42
distribution
delivery of postal items to the home or business address of the final recipient

2.43
entity
distinct physical or logical object of interest in the context of a postal application

2.44
event; postal handling event
occurrence of a significant change in the actual or predicted values of one or more attributes of an entity

2.45
flat
letter-post item which is too large, too thick or too stiff to qualify as a small letter, but which has a size of 229 mm by 324 mm or less; a maximum thickness of 20 mm and a maximum weight of 500 g or can otherwise be automatically processed on the flat sorters used by the delivery post

2.46
flat sorter
sorter which is designed for and capable of processing items of size up to at least C4 (229 mm by 324 mm) with a thickness of up to at least 20 mm and weight of at least 500 g

2.47
forming
process by which individual postal items, bundles and/or postal receptacles are assembled into mail aggregates

2.48
handover events
events associated with the transferor responsibility of mail between parties

2.49
holding start
commencement of a (temporary) suspension in the processing of an entity

2.50
holding continuation
continuation of a (temporary) suspension in the processing of an entity

2.51
holding end
resumption of processing of an entity after a period of suspension

2.52
identifier
attribute of an entity that distinguishes that entity from any and all other entities existing, within a specified domain, during a specified time

2.53
ID-tag
globally unique postal item identifier allocated in accordance with UPU standard S18, a machine readable encoded representation of which is placed on the item concerned by, or on behalf of, a mail service contractor

2.54
ID-assignment
allocation of an identifier to an entity

2.55
image controller
system designed to handle the flow of images and data issued by the Image Supplies and sent to the Enrichment Devices

2.56
internet protocol
set of rules to send and receive messages at the Internet address level

2.57
interoperable
ability of information and communication technology (ICT) systems and of the business processes they support to exchange data and to enable the sharing of information and knowledge

2.58
induction
process whereby mail is handed over to a postal operator by a mail submitter and which 8culminates in the postal operator taking responsibility for the induction unit concerned

2.59
interchange
single instance of electronic data involving the sending from one party (the interchange sender) to another party (the receiver) of an identified set of one or more messages

2.60
inward processing facility
postal processing facility in which mail is sorted by delivery office or route

2.61
item identifier
unique feature of a postal item that distinguishes that item from any and all other items handled within the postal system during a period of time that is long in comparison with the normal period of time spent by an item within the system

2.62
layers
way of hiding the implementation details of a particular set of functionality

2.63
loading (containerisation)
placement of mail items, aggregates or lower-level containers into a (higher-level) container or into the conveyance (aircraft, ship, train, truck, …) to be used for (one of the legs of) a journey the mail concerned is to undergo

2.64
mail aggregate
set of mail units that satisfy specific criteria defined in the context of a particular application

2.65
mail category
specification of the traffic class and handling priority of a consignment or despatch of mail, expressed as a UP code list 115 value

2.66
mail processing
event corresponding to the undergoing, by an entity, of processing

2.67
mail class
indication of the class or type of mail, expressed as a UPU code list 116 value

2.68
mail processing centre; international mail processing centre (IMPC)
mail processing facility, identified in accordance with UPU standard S34 [15], in which inter-administration mail is processed

2.69
mail recipient
individual who actually receives a postal item at delivery, or who first accesses the postal item if it is left for collection

2.70
message
collection of data communicated as a single unit, between a sender and a recipient, using a single **specific means of communication**

2.71
network protocols
system of digital rules for message exchange within or between computers

2.72
online services
referred only to a commercial computer communication service in which paid members could dial via a computer modem the service's private computer network and access various services and information resources such a bulletin boards, downloadable files and programs, news articles, chat rooms, and electronic mail services

2.73
open file formats
open file format is a published specification for storing digital data, usually maintained by a standards organization, which can therefore be used and implemented by anyone

2.74
operations information system (OIS)
specification that enables users to freely choose and switch between suppliers, creating a free and open competition between suppliers

2.75
OSI model
layered, abstract description for communications and computer network protocol design, developed as part of the Open Systems Interconnection initiative by ISO

2.76
outward processing facility
postal processing facility in which mail is first sorted, usually to separate it into aggregates which are to be transported to different inward processing facilities

2.77
postal address
set of information which, for a postal item, allows the unambiguous determination of an actual or potential delivery point, usually combined with the specification of an addressee and/or a mailee

2.78
postal item
indivisible mail able entity in respect of which a mail service contractor accepts an obligation to provide postal services

2.79
parcels
postal item with determined dimensions and weight containing merchandise with or without a marked value

2.80
postal operator
public or private entity providing postal services

2.81
postal facility despatch
despatch of an entity from a mail processing facility

2.82
postal services
postal services: services involving the clearance, sorting, transport and delivery of postal items

2.83
pre-sortation
cover events related to evaluate the postcode level and assign standard selection codes

2.84
primary activities
receive, sorting for further transportation, transport, sorting for distribution and distribute product item end-to-end

2.85
processing data
collection and manipulation of items of data to produce meaningful information

2.86
processing events
events related to the processing of mail entities

2.87
protocol
set of rules and formats that govern the communication between parties (set of valid messages; meaning of each message)

2.88
receptacle; postal receptacle
physical device which can be used to contain or carry mail so as to assist in its handling or transportation as a unit

2.89
returned item
postal item which is being returned to the mail service contractor or by the latter to the mailer, because it is not possible to deliver it in accordance with the contractual arrangements applicable to the item concerned

2.90
route-code-based sorting
method of sorting and/or sequencing mail items which is based on the use of a routing code

2.91
sorting
manual, mechanical, etc., separation of items according to destination, addressee, etc.

2.92
sorting for distribution
sorting and distribution of postal items per delivery regions

2.93
sorting centres
office specializing in sorting operations

2.94
sorting machines
mechanical, electrical, etc., device used for sorting

2.95
stamp
mark imprinted or otherwise applied to individual items as evidence of postage accounting or payment; for service identification and for support of mail processing applications

2.96
storage events
relate to the suspension of processing of mail

2.97
suppliers
enterprise that contributes goods or services in a supply chain

2.98
support activities
measure, analyse and improve the process, plan, lead, allocate costs and resource management supporting the primary activities in the postal process

2.99
technical standardisation
established norm or requirement in regard to technical system s. uniform engineering or technical criteria

2.100
traditional postal value chain
process of collection, sortation, transport, and delivery of addressed postal items

2.101
transmission control protocol (TCP)
set of rules to exchange messages with other Internet points at the information packet level

2.102
tracking
process of recording the occurrence of significant events in the processing and transportation of an entity, in order to provide a historical record of such events and to support tracing of the entity

2.103
tracking
determination, from processing records, of the last known physical location and status of an entity

2.104
transit entity
postal item, aggregate or receptacle which is despatched to an intended destination via an intermediate mail processing facility whose only task is to forward the entity to its intended destination

2.105
transport
ordered sequence of transport legs executed under the responsibility of a single postal handling organization which, taken together, result in a consignment being conveyed from a specified place of departure to a desired destination location

2.106
transport assignment
(re-)assignment of an entity to a conveyance for (one of the legs of) the transport it is to undergo

2.107
transport departure
commencement of (one of the legs of) a transport being undergone by an entity

2.108
transport event
event which occurs during physical transportation of an entity (possible need for periodic reporting of geographic coordinates and for the reporting of significant events, such as shocks or excessive temperature or pressure variations, occurring during actual transportation)

2.109
transport arrival
arrival of the conveyance transporting an entity at the end of (one of the legs of) the transport

2.110
transport leg
component of a transport corresponding to the scheduled conveyance of a consignment from one location to another by a specific carrier, using a specific mode of transportation

2.111
unforming
process by which a mail aggregate is unpacked into its constituent parts i.e. lower level aggregates and/or individual postal items

2.112
unloading (decontainerisation)
removal, from a container or conveyance, of mail items, aggregates or lower-level containers

2.113
unpacking
dis-aggregation of transported items into the elementary components of the aggregation to be processed in the following steps of the postal process

2.114
vendor
system which can determine the most appropriate result for a mail piece using data and/or an image of a mail piece

3 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

ARP	Address Resolution Protocol
ASCII	American Standard Code for Information Interchange
B2B	Business to Business
B2C	Business to Consumers
CEN	European Committee for Standardization

CORBA	Common Object Request Broker Architecture.
CSV	Comma Separated Values
DC	Distribution Centre
EBCDIC	Extended Binary Coded Decimal Interchange Code
EC	European Commission
EFTA	European Free Trade Association
EIA/TIA-232	The Electronic Industries Association/ Telecommunications Industry Association
EPCIS	Electronic Product Code Information Services (GS1 standard)
FTP	File Transfer Protocol
HSSI	High-Speed Serial Interface
HTTP	Hypertext Transfer Protocol
ICMP	Internet Control Message Protocol
ICS	Industrial Control System
IDT-PAE	Interface and Data Transfer format for capturing Postal Automation Events
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPC	International Post Corporation
IPX	Internetwork Packet Exchange
ISO	International Standardisation Organisation
IT	Information Technology
IS	Information System
JPEG	Joint Photographic Experts Group
JSON	Java Script Object Notation
MHS	Material Handling System
MIDI	Musical Instrument Digital Interface
MIS	Management Information System
MPEG	Moving Picture Experts Group
NEN	Nederlands Normalisatie – instituut
NetBIOS	Network Basic Input/output System
NFS	Network File System
NLM	Network Lifecycle Management
OCR	Optical Character Recognition
OIS	Primary Operation information - systems that generally concentrate on operational process control and customer service measures.
OOP	Object Oriented Programming
OPSM	Oracle Pedigree and Serialization Manager

OSPF	Open Shortest Path First
PO	Postal Operator
PIP	Process Integration Platform provides a unique basis for easy development pf already existent and new business applications.
Post Europ	PostEurop is the association which represents the interest of European public postal operators.
PPP	Point-to-Point Protocol
PTJ	Project Team J
RARP	Reverse Address Resolution Protocol
RFID	Radio Frequency Identification
RFID tagging	An ID system that uses small for identification and tracking purposes.
RIP	Routing Information Protocol
RPC	remote procedure call
SKU	Stock Keeping Unit
SLIP	Serial Line Internet Protocol
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SPX	Internetwork Packet Exchange/Sequenced Packet Exchange.
SQL	Structured Query Language
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
Telnet	network protocol
TFTP	Trivial File Transfer Protocol
TIFF	Tagged Image File Format
ToR	Terms of Reference
UDP	User Datagram Protocol
UPU	Universal Postal Union
VCS	Video Communication Server
X.21	interface specification for differential communications
XML	Extensible Markup Language

4 Generic Postal Process

4.1 General

In order to conduct the generic postal process, all activities of the postal operators can be split into primary and support activities. Primary activities are those that are related with product services, while support activities are those that provide the background necessary for the effectiveness and efficiency of the postal operators, such as measure, analyses, plan, lead, allocate recourses etc. See Figure 2.

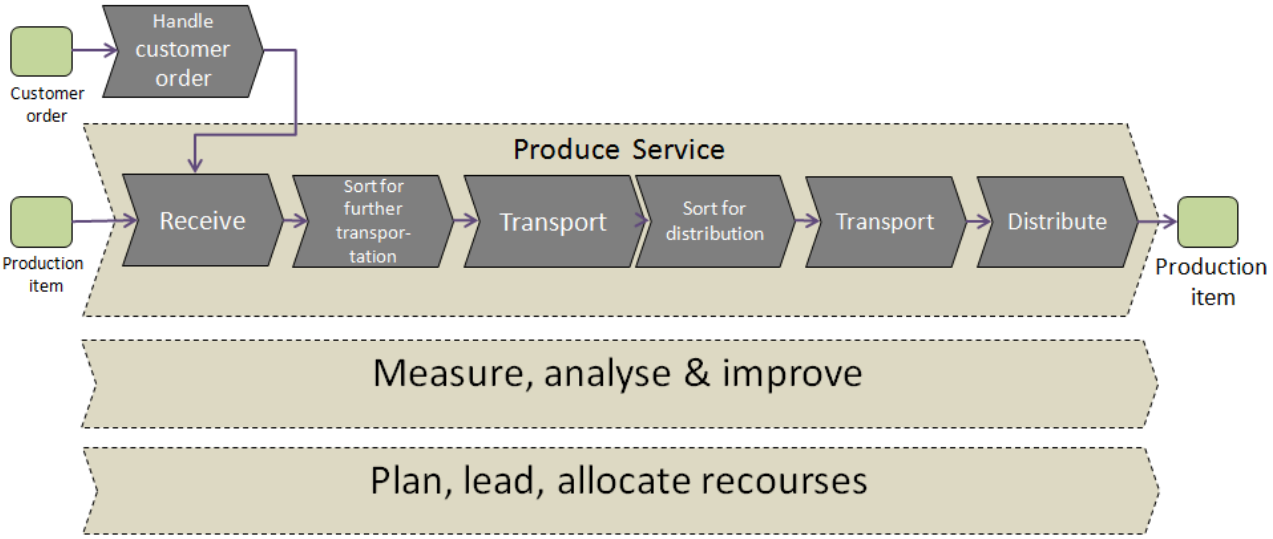

Figure 2 — Generic Postal Process

All activities in the generic postal process can be divided into:

— Primary activities:

receive, sorting for further transportation, transport, sorting for distribution and distribute product item end-to-end.

— Support activities:

measure, analyse and improve the process, plan, lead, allocate costs and resource management supporting the primary activities in the postal process.

Primary activities: The primary activities of the postal operators include the following:

— Receive/Collect items from customers - receiving the postal items from sender, storing, and handling them within the receiving post office;

— Packing – aggregation of items (postal mail or another aggregated item) into one (or multiple) object/s for transportation;

— Sorting for further transportation – sorting of postal mail for distribution centres and further transportations;

— Transportation – transport mail from the sorting centres points to points of distribution centres;

— Unpacking - dis-aggregation of transported items into the elementary components of the aggregation to be processed in the following steps of the postal process;

— Sorting for distribution – sorting and distribution of postal items per delivery regions. The transport of postal items from distribution centres to the delivery post offices is included at this stage;

— Distribution – delivery of postal items to the home or business address of the final recipient.

Support activities: The support activities of postal operators include the following:

— Measure, analyse & improve – in order to improve pursuit the postal process. This activities should be able to obtain the highest quality of the postal services with lowest prices;

— Plan, lead, allocate recourses and costs – provide the background necessary for the effectiveness and efficiency of the postal administrations.

4.2 Postal operations

4.2.1 General

Within the Generic Postal Process a MIS is focused on support activities, primary in the area of measure and analyzes available to organize the IS system. In line with the principles of the Postal Process mentioned above, IS can be divided into two categories of IT systems that support management decision making:

— Primary Operation information (OIS) systems that generally concentrate on operational process control and customer service measures;

— Management Information System (MIS), which focuses primarily on the area of process measure and analyzes.

The data interfaces are needed for interoperability, between different event types in postal operational system.

4.2.2 Collection

Postal items are collected from post boxes (only mail), postal outlets or mailers' premises and transported to the initial sorting centre. In some countries, mailers or their agents (consolidators and mailing houses) take mail in bulk to the outward sorting centre or to the inward sorting centre.

4.2.3 Sorting centre- for further transportation (Outward sorting)

Sorting centres are used to consolidate mail and perform outward and inward sorting activities.

The outward sorting centre accepts the mail from the collections, and undertakes the first phase of processing of mail for dispatch and transport to destination mail sorting centres or, in case of local mail, to delivery offices.

Mail collected from post boxes and postal outlets has to be pre-processed including revenue protection, stamp cancellation and segregation of mail i.e. by format, product (priority/non-priority), major destinations (e.g. domestic and international mail).

Mail from post boxes is prepared either manually or by pre-processing machines (Culler-facer-canceller (CFC) machines) to prepare letters for automatic mail sorting. The pre-processing machines position the letters correctly, check the postage and cancel the stamps.

Sorting starts with reading the postcode (at least) or the full street address by optical character reading (OCR). If automatic reading fails the missing information (at this stage it is normally the postcode) is added via online or offline video coding. In this case, an image of the address is sent to a computer in order to enter the missing information manually.

If it is possible for this to be completed within the time the item is in the machine, the barcode is applied and the item is sorted to the correct destination (online video coding). If this is not possible, the information is manually entered and the item has to be put through the sorting machine a second time (offline video coding), particularly if the number of items which are not fully coded is small.

There is in practice an alternative – following a non- successful automatic read-process. To put the item directly into the manual sorting section (that may depend on the amount of non-readable items). But these manually sorted items will not really be considered in MIS.

Many postal operators use barcodes that are printed on the mail item to transpose the address information in an easily readable code. Alternative technologies, e.g. “fingerprints” (Siemens) or “virtual ID codes” (Solystic), allow the machine to read and save the complete image of the exterior part of the envelope and convert the content of the address into a unique code to support processing the mail. The information read by the sorting machine is matched with database entries (an up-to-date address database is a “must” in postal operations).

Depending on size and thickness, distinct machines are used for letters and flats. Postal items that cannot be processed by sorting machines (“rest mail”) are manually sorted.

In the sorting centres letter post items are usually packed in trays that are either transported in trolleys and/or by automatic conveyor systems to the next processing step. After sorting activities a postal items are prepared for transportation to the destination sorting centre or in case of local mail – remain in the sorting centre.

Parcel operations: Depending on daily parcel volume, parcels are either manually handled or processed by conveyor belts and/or parcel sorting machines.

4.2.4 Transport

Transport are used for transportation to transport postal item between sorting centres and sometime between distribution sorting centre and delivery offices. Transportation between sorting facilities is important for the speed and the level of quality in postal service provision. Which transportation device will be used is depend of service standards and geographical distance. Postal item usually are transported in postal dispatches (it can be used different tip of assets: postal bag, containers, postal box etc. in one or more receptacles.

4.2.5 Sorting centre-distribution (Inward sorting)

Inward sorting usually takes place in the same sorting centres used for outward sorting but during a different time slot. Postal items are prepared for the final handling in the delivery offices at the mail centre that is closest to the delivery office. This may include sorting of postal items according to

— postal codes;

— delivery offices;

— group of delivery routes;

— delivery routes;

— delivery order (per route).

The sorting level depends on the sorting equipment and the IT system (including address databases) that vary among postal operators.

Finally, the mail is prepared for transport to the delivery offices.

4.2.6 Distribution (Delivery office / in office activities)

In delivery offices, the mail is prepared for final delivery. Depending on the mail preparation level provided in the sorting centre, this comprises the following processing steps:

— separation of postal items to delivery routes;

— sorting of items in delivery order (manually or by machine, if installed in the delivery office);

— Preparation of delivery bags / trolleys / other vehicles (e.g. bicycles, motor and electric bikes or cars);

— Handling of returned items after delivery.

The delivery route comprises the journey of the postman from the delivery office to their delivery district, the basic track, the stops to drop postal items into letter boxes or to hand over postal items to a person (e.g. in case of postal items that require a confirmation of delivery or are too bulky to be placed in the letter box).

Mail is delivered to residential and business customers by foot, bicycle, car or van. The delivery mode depends on the density of delivery points and mail volume delivered. Postal operators sometimes deliver mail to selected business customers by van on distinct delivery routes. Parcels are usually delivered by car or delivery van. In rural areas, in particular, parcels and letter post items are often delivered jointly.

4.3 Postal activities in postal operations

The postal market comprises the following 'postal items':

— addressed letters, large letters and packets which are small enough to be posted through letterboxes.

— unaddressed items which can be posted through letterboxes but do not contain an address, such as leaflets, catalogues and brochures.

— express and courier items which are guaranteed to arrive on a particular day or time, and / or which require a signature on delivery or "track and trace" facility.

— Standard parcels. These items are not guaranteed to be delivered by a specific time and cannot be posted through letter boxes.

— Mail Aggregates. Hybrid Mail Operators, Consolidators and Print Service Bureaus sometime normalise, pre sort and pre-pack mail in a way that selected and ordered group of items can be collected and sent directly to further steps of the postal processing chain, according to rules that are exposed for particular postal products. (As an example, in some Hybrid Mail systems, the Postal operator accepts pallets of cartons of email labelled to shipped directly to an outbound sorting centre, without crossing the sort phase of the inbound centre)

Handling of mail within the postal process flow is carried out through significant steps such as hand-over between parties, processing, storage, transportation, and delivery.

One step of particular significance takes place when an item is handed from the mail sender to the Post Operator. This is the exact moment in which an incoming, undetermined item is recognized as a "postal" item by matching some pre-defined characteristic of physical dimension, weight, and address specification.

Considering the example of addressing single letters (see figure), a sender has knowledge of the rules that configure an object to be recognized (and accepted) by the Post Operator as a postal item of a specific product class.

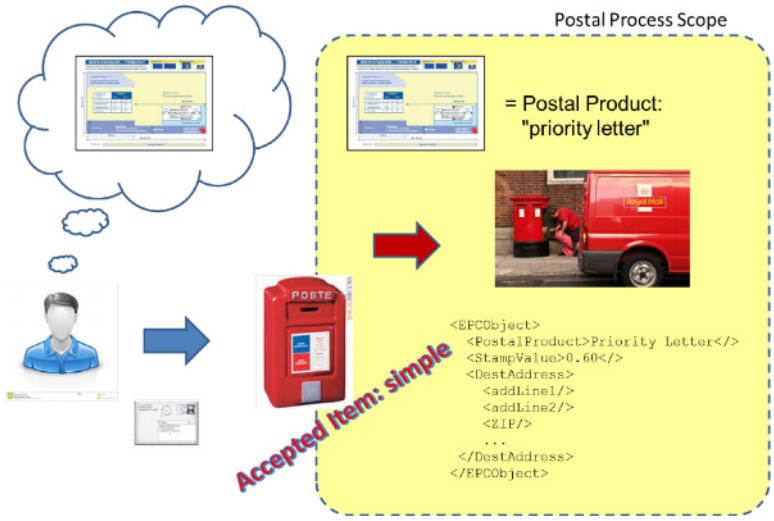

Figure 3 — Example of Delivery of a single Postal Item

This allows us to identify an event of "Posting" and create an instance of a Postal Object, which is observed in the Postal Process Scope, monitored by a MIS.

Delivery of mail aggregates (i.e. structured and packed group of pre-sorted items) makes no exception to this abstract concept, with the only difference that the accepted item is not an atomic element, but a structured hierarchy of objects of type "Container" that can contain other types of objects.

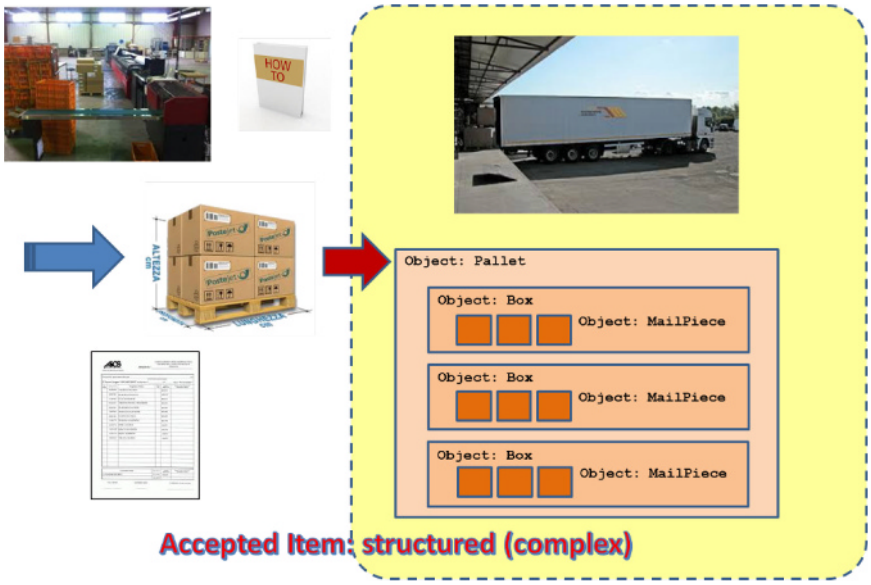

Figure 4 — Example of Delivery of an Aggregated Item

The business step can occur to individual postal items, to mail aggregates, to mail containers (receptacles), to conveyances and delivery to the addressee. Events correspond to the reaching of significant business step. Each event is characterised by a code describing the nature of the event (event code) and by a number of attributes which specify the particular entity (item, aggregate, container or conveyance) concerned, where and when the event occurred, how and by whom it was detected and the resulting status of the entity.

The events defined are intended to cover all possible steps in the handling of mail items, aggregates and postal receptacles (entities).

4.4 Postal events

4.4.1 General

Major relevance for an MIS system is collecting and determining information through a number of events that occurs in e postal process.

Events divided across five event categories: handover, processing, storage, transport and delivery as detailed in Figure 5.

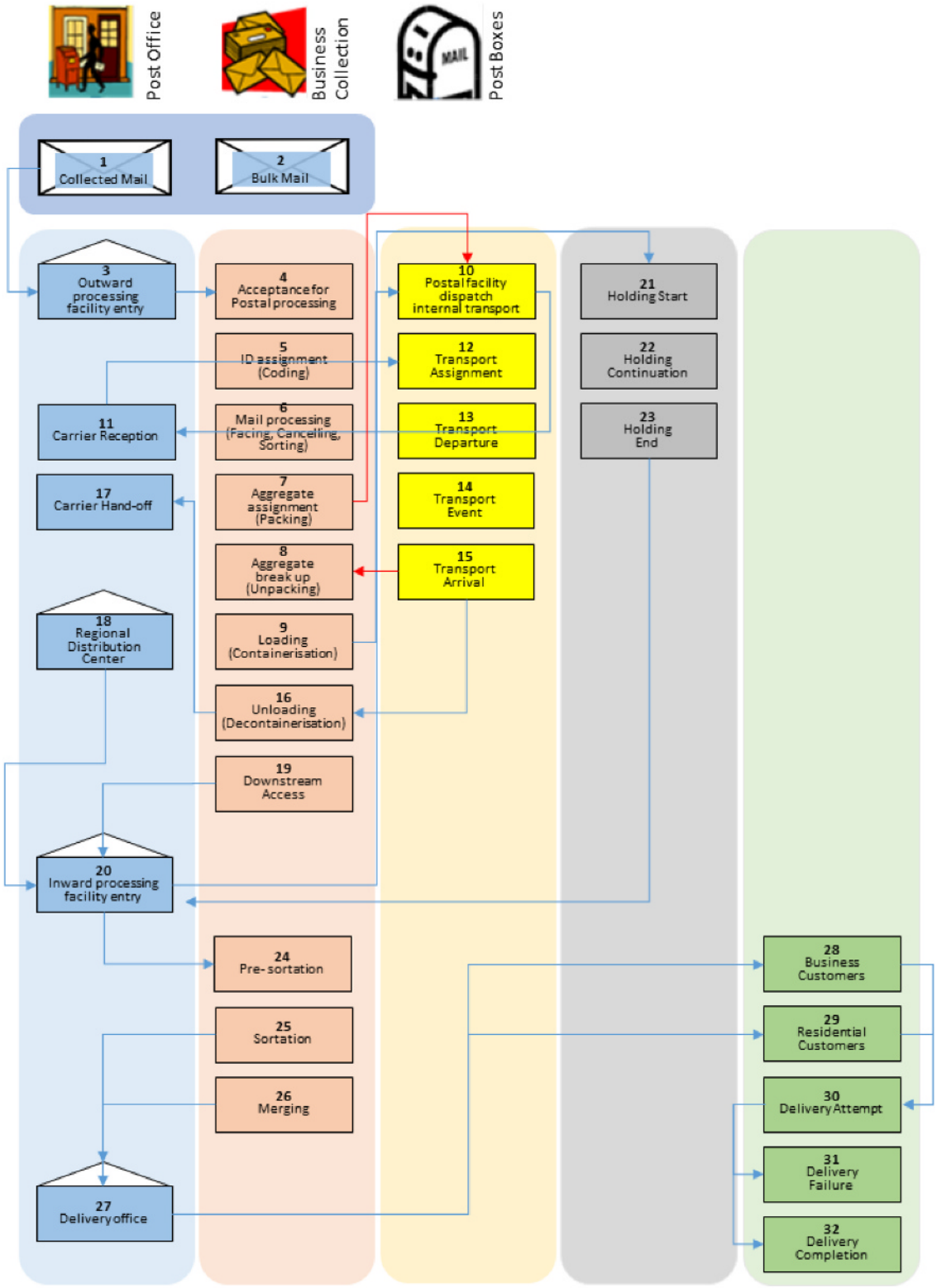

Figure 5 — Events Classification over Mail Piece Process Flow

Source: Adapted from Hooper, R, D Hutton and I Smith (2008) "Modernise or decline: Policies to maintain the universal postal service in the United Kingdom", p28.

— Handover events - are events associated with the transfer of responsibility of mail between parties. Two of these events cover the acceptance and hand-off of mail by a transport service provider; two to entry to and despatch from a postal processing facility and one to the induction of mail into the postal system (posting). Apart from posting, which can occur only once for a given item, these events can occur many times in the passage of an item or other entity through the postal system. The distinction between different cases is based on the location and type of location at which they occur.

— Processing events - are events related to the processing of mail entities. They include acceptance of mail items, the allocation of identifiers, sortation, assignment to an aggregate, containerization, the unloading of containers and the break-up of aggregates. Most of these events can occur several times and can apply to a variety of different entity types (items, aggregates, containers,).

— Storage events - relate to the suspension of processing of mail. One code corresponds to the start of a period of suspension; one to its ending and the third is used to explicitly report continuation of the suspension period.

— Transport events (Inner centre transports) support the reporting of events associated with the transportation of mail. One covers the assignment of a mail entity to a specific conveyance; two cove departure and arrival respectively, whilst the fourth supports the reporting of events which occur during actual transportation.
Apart from the long-distance-transports, there are also transports within a centre. These are performed with forklifts, an MHS and things like that. There is not much difference to the long-distance transports, except that the notion of a product for the transport gets a bit questionable. While the inter-centre-transport from Zurich to Eclépens is a negotiated thing (you can say things like "it was cancelled today") it appears like an overkill to associate product names with every transport within a sorting centre. It may be best to identify such transports simply by origin and destination.

— Delivery events - cover events related to the final delivery of mail. The first covers delivery attempts which are not successful but are due to be repeated; the second covers successful delivery whilst the third covers definite failure to deliver an item.
Mail sent to individual local Delivery offices (27), and typically to individual routes (the "inward sort") either to Business customers (28) or Residential customers (39).

4.4.2 Handover Events

1) Collected Mail Posting - deposition of mail at a post office or into post boxes or from business collection.

Private mail gets posted in Letterboxes. There is usually no way to monitor these events. Mail men picks up this mail and collect them in bags. The bags get transported to a Collection Office. When they arrive there, there is a chance to weigh or count them. This will create the first Events in the history of this mail. Occasionally mail will already be split up into local, out-of-town or foreign mail in cases where you have split letterboxes.

MIS would need to know:

— What mail (local, out-of-town, foreign) – this is the "product" here;

— The packaging ("bag");

— How much of it (how many bags);

— Where it was observed (which collection office);

— When it was observed.

2) Bulk Mail Posting

Bulk mail gets posted right at a Sorting Centre - Regional distribution centres (18).

The customer is often given the choice to post unsorted mail or pre-sorted mail, where the letter is cheaper. If it is pre-sorted, the customer shall indicate "by what" it is pre-sorted. Often this means pre-sorting by zip-code. However, ideally pre-sorting is done by "product", i.e. which services shall be used to further process that mail. The difficulty with the latter is that these services can change over time, whereas zip-codes remain stable for a long time. A given zip-code can always be associated with a single service (think "inward run") that won't hurt, except the customer may end up with a more fine-grained pre-sorting than strictly necessary.

In contrast to private mail, information about bulk mail can often be made available by the customer. This information can be either on item-level or just a count of mail pieces, possibly classified by the service they intend to use.

MIS would need to know:

— What mail (unsorted, or product name like "For Inward run 201")

— The packaging ("bag")

— How much of it

  — how many bags – or –

  — how many mail pieces – or –

  — each Mail piece individually

    — destination

    — mail class

    — size

— Where it was observed (which collection office)

— When it was observed

3) Outward processing facility entry - entry of an entity into a postal processing facility, where it falls under the responsibility of the operator of that facility.

4) Carrier reception - reception, by the carrier concerned, of an entity which is to be transported to a mail processing or transit facility, between one facility and another, or between the last mail processing facility (the delivery office) and the delivery point; confirmation that the entity is under the control of the carrier charged with such transportation

5) Carrier hand-off - completion or cancellation of (one of the legs of) a transport being undergone by an entity; notification that the entity concerned has been delivered to or is available for collection

by the carrier responsible for the next leg of the transport or by the operator of the mail processing or transit facility to which the mail has been transported or returned

6) Bulk mail entry at Regional Distribution Centre

7) Inward processing facility entry - entry of an entity into a postal processing facility, where it falls under the responsibility of the operator of that facility

8) Delivery office entry

4.4.3 Processing Events

4.4.3.1 General

1) Acceptance of postal processing - completion of the process of ensuring that mail can legally be conveyed by post, fulfils postal system requirements, regarding size, addressing, etc. and that correct postage has been paid or is chargeable under normal contractual arrangements

2) ID-assignment - allocation of an identifier to an entity.

Bags / trays are labelled - identification solution is based on:

— Bar codes.

— Active RFID tags.

— Passive RFID tags.

— Delivery units with bar codes

  — Truck – Serial Shipment Container Code (SSCC) on a GS1 Logistic Label using a GS1-128 bar code

    — Roll containers with barcode

    — Pallets with barcode

  — Roll Container with bags - a barcode

    — Bags with barcodes

  — Pallet with Trays

    — Trays with barcode

— Delivery units with an RFID tag (passive / active)

  — Truck

- An automatic consignment system associates the mail items to the containers carrying these items and to the trucks transporting these.

- documentation of times of arrival and departure of vehicles, which postal containers are loaded/unloaded, vehicle load space management, real-time information on types of mail, quantities, times of arrival, delays or changes in transport times etc

- Roll Container

  - System of the monitoring and managing roll cages includes tag (active or passive, it depends of application), that is placed on a side or on the bottom of the container

  - also includes a handheld terminal solution for consignment of roll container, product and destination enabling load control on all roll containers

- Tray

  - each letter tray has a tag that communicates and transmits information to the reader in Real-time load control

- Bag

  - each mail bag has a passive RFID tag that contains information about letters, which are inside the bag and some other additional information useful for sorting and other postal processes

3) Mail processing - event corresponding to the undergoing, by an entity, of processing. Processing involves operations such as facing, cancelling and sortation of mail. Sorting is performed in order to group mail according to the next required processing or transportation step.

During outward sorting, mail is sorted in a way so it is acceptable by the next party (typically inward sorting). Similar considerations apply when considering bulk mail: it has to be delivered in a way so it is acceptable by the receiving party.

This principle of preparing mail, so it is acceptable by the receiving party pervades the entire postal chain. It is very similar to exchanging intermediate goods in the manufacturing business, where each intermediate shall comply with the specifications expected by the receiver.

The criteria for being acceptable jointly define a “product” and include the following:

- The possible destinations;

- Mail class, weight and other non-address attributes;

- The packaging (usually nested);

- Whether or not it is sequence sorted;

- Minimum and maximum volume;

- Time of arrival;

- Location of arrival

- Service-level-agreement (SLA).

Knowing a product tells you a lot about mail, even long before the physical mail items are known. Particularly you know what you get when you unpack a container. Unpacking usually reveals new (smaller) products which were "inside" the unpacked product.

Products are always negotiated between sender and receiver. Products come with a price, though in the real world the price may not be known. One may even say, that a "product" is the price, i.e. that "unwanted" mail will still be accepted, but at a very high price.

The relationship between products and items resembles the relationship between classes and instances in OOP. Products typically do not know about the actual volume nor do they know about individual items. For any product and any item you can answer whether or not this item falls into the product.

The operation of any party in the postal chain can be seen as follows:

— Each party knows about its own products, i.e. what it promised to accept;

— Each party knows about downstream products, i.e. what mail is accepted by downstream parties;

— Sorting and Transport is organized so incoming products are mapped to outgoing products such that all mail can be disposed and the overall price, consisting of the internal processing cost and the bill charged by the receiver, is minimized. Again in the real world, parties may operate sub-optimally, because they lack data and flexibility.

This process continues down to the individual mailboxes. My mailbox e.g. accepts all mails which are for me, my wife or my son. It shall not exceed a certain size etc. You may call this a "product" too. The mailman who delivers mail to me accepts all mail which is accepted by any of the mailboxes in his route. The delivery office accepts mail in roll-containers containing bags, where each bag is for a single route plus bags with mail whose route could not be identified, but which certainly falls into one of its routes (goes to manual sorting in the delivery office).

You may see this as "manufacturing services". My mailbox does not provide much of a service. You can drop me a letter only when you're standing right in front of my mailbox. The delivery office provides a more valuable service, because it can deliver to several addresses. And on and on it goes until you end up with the services which are actually sold by a postal operator ("from anywhere to anyone"). If you compare this with "manufacturing goods" there are a lot of similarities, but some things are backwards:

— A mail product is more valuable at the beginning of the chain, whereas goods are more valuable at the end.

— A mail item constitutes a "demand" (for a service) whereas a good constitutes an "offer". The downward trend in the postal business was caused by a lack of "demand".

— You can store material goods. This creates a stock of "offer" waiting for "demand" to arise. You cannot do this with mail. Storing mail means storing "demand" waiting for an appropriate "offer". As for mail, you cannot store "offer" at all, just like you cannot store demand in the world of material goods. Everything is backwards.

Because we're only collecting data (and not manufacturing services), it may suffice to identify a product by its "name", where the name is typically printed on a label (together with other things).

4) Aggregate assignment (packing) - assignment of an item or (lower-level) aggregate to a (higher-level) aggregate of mail which is to be handled as a unit during the next processing or transportation step(s).

Mail is bagged or trayed (bag/tray shall be filled for each selection before commencing filling another bag /tray for that selection, and you shall also ensure that each individual bag weight does not exceed a certain weight limit (typically 11kg for a bag 10k for a tray)

Every packing process accepts items (mail-items or containers) and puts them into (bigger) containers. The items always belong to some sort of product - you never pack randomly chosen items. A real product may look like this:

- inter-centre-transport from Zurich to Eclépens
    - roll-containers ”for Eclépens” containing
        - trays containing letters for sorting run 302 in Eclépens
            - letter with destination 29873423
            - letter with destination 29873424
            - letter with destination 29873425
            - letter with destination 29873426
        - trays containing letters for sorting run 303 in Eclépens
            - . . .
        - trays containing letters for sorting run 304 in Eclépens
            - . . .

The fact that destination “29873423” will be accepted by “sorting run 302 in Eclépens” has been negotiated long before the transport departed. However, these negotiations did not state that letters for destination 29873423 shall be present in the transport. In theory (though unlikely) there may be no “letters for sorting run 302 in Eclépens” in the transport at all. Still the transport and its contents would be accepted by Eclépens.

A MIS is not primarily interested in the result of the negotiations, but in what was actually contained in the Transport. It needs to be able to construct a similar structure, except with volumes and IDs added:

- 1 inter-centre-transport from Zurich to Eclépens (ID=trainNr.876, planned departure 04.10.2014)
    - 1 roll-container (id=12349) for Eclépens containing
        - 1 tray (id=12350) containing letters for sorting run 302 in Eclépens
            - 1 letter (id=292900) with destination 29873423
            - 1 letter (id=292901) with destination 29873424
            - 1 letter (id=292902) with destination 29873425
            - 1 letter (id=292903) with destination 29873426
        - 1 tray (id=12351) containing letters for sorting run 302 in Eclépens
            - 1 letter (id=292904) with destination 29873423
            - 1 letter (id=292905) with destination 29873424
            - 1 letter (id=292906) with destination 29873425

— 1 letter (id=292907) with destination 29873426

With this information a MIS can answer the following questions:

— How many letters are expected for sorting run 302 in Eclépens? You could not answer this without the notion of a product.

— Is there any tray which is not for Eclépens? For that it needs to know the structure of the inter-centre-transport from Zurich to Eclépens product, but this information can be obtained from a central place as it is much more long-lived that the transport itself.

— How many roll-containers and how many trays are expected? This works without knowing products.

You see that question concerning just "matter" is the easiest to answer. However, questions concerning its role in the process chain require knowing about products.

5) Aggregate break-up (unpacking) **-** decomposition of an aggregate into its component mail items and/or lower-level aggregates.

After this long discussion, unpacking does not pose many new challenges. Unpacking simply removes a level of nesting. The top-level container will lose its association with a product – it turns into an unspecified empty container.

MIS needs to know:

— What was unpacked (the ID of the container);

— Where it was unpacked;

— When it was unpacked.

Everything else, particularly the inner structure of the container is already known, either via a manifest or by collecting the pack-events (recursively).

6) Loading (containerisation) - placement of mail items, aggregates or lower-level containers into a (higher-level) container or into the conveyance (aircraft, ship, train, truck, …) to be used for (one of the legs of) a journey the mail concerned is to undergo.

7) Unloading (decontainerisation) - removal, from a container or conveyance, of mail items, aggregates or lower-level containers.

8) Pre-sortation - Cover events related to evaluate the postcode level and assign standard selection codes.

9) Sortation – sortation of mail under sortation criteria and apply sequencing.

Sorting takes items or containers (there really is "tray sorting") and splits them up into several groups. Sorting Processes usually create new products; in fact that's their primary purpose: you have some mail which nobody wants to accept, but if you split it up, you'll find an acceptor.

Sorting has much resemblance with packing. In fact, you may treat the stacker into which mail is sorted as some sort of container. This should make it crystal clear how unimportant stacker numbers are: they are no more interesting than any other container's ID. For all practical purposes it does not matter much if you take a container with serial number 876123 or the one with 876124.

There is a proper way to describe items and products independently in EPCIS with the distinction between "class-level" and "instance-level". Items are identified at instance level, while 'products' are identified at class-level

10) Merging - Merging is a process which is often overlooked. A real-world example of merging is when you take old class-B mail from the storage area and merge it with today's class-A mail. This is because the class-B mail has reached an urgency (due to its age), which justifies treating it like class-A mail. Another example is the merging of letters and flats to prepare mail for a postman who delivers both letters and flats, but letters and flats are produced by different sorting machines (a big problem in the real world).

For an MIS merging processes may be not that interesting. But I'm not sure. They may be difficult to observe, because there are no merging machines in a typical sorting centre.

4.4.3.2 Coding considerations

Coding associates a Mail piece with a destination code (aka "Sort code"), while all other properties of a Mail piece, particularly its location, remain unchanged. Often Mail pieces do not even carry an ID prior to coding, because ID-tagging and coding is often done in one step. However in case of offline coding, a Mail piece is given an ID first and a Sort code in a later coding step.

Coding is sometimes carried out as stepwise refinement. A first coding step may only read the Zip-code. This information can be sufficient to perform a fist sorting step. A more in-depth coding is carried out later on, usually "when there is time", typically when the mail is on a transport. This step reads detailed address information such as street and house number and the Mail piece is given a new Sort code, which is usually an extension to the original Zip-code-only Sort code (i.e. more digits are added).

A Sorting Event is emitted by a sorting machine when a mailpiece will reach its destination stacker or chute. In theory manual Sorting Racks can also emit Sorting Events, but in the real world, this is seldom the case, except for semi-automatic Sorting Racks, where the operator receives some guidance from an IT system. Such exceptions include voice-coding Sorting Frames and sort-to-light systems for parcels.

A Sorting Event is an Object Event.

Its fields are populated as follows:

eventTime	The time the event was created.
recordTime	The time the event is registered
eventTimeZoneOffset	The difference of eventTime and recordTime to UTC time
epcList.epc	A list of unique codes which identify the Mailpieces. More than one Mailpiece can be reported in the same Event.
Action	Always ADD
bizStep	
disposition	
readPoint	
bizLocation	
bizTransaction	

```
<ObjectEvent>
   <eventTime>
      2007-07-26 21:41:19
   </eventTime>
   <recordTime>
      2007-07-26 21:41:19
```

```
   </recordTime>
   <eventTimeZoneOffset>
      -05:00
   </eventTimeZoneOffset>
   <epcList>
      <!-- Section 8.2.1 EPC Identifier -->
      <epc>
         urn:epc:id:sgtin:0614141.181335.234
      </epc>
   </epcList>
   <action>
      ADD
   </action>
   <!-- Section 7.2.1 BizStep -->
   <bizStep>
      urn:epcglobal:cbv:bizstep:sorting
   </bizStep>
   <!-- Section 7.2.2 Disposition -->
   <disposition>
      urn:epcglobal:cbv:disp:active
   </disposition>
   <!-- Section 8.3.1 EPC URI for Locations -->
   <readPoint>
      <id>
         urn:epc:id:sgln:0614141.00300.1
      </id>
   </readPoint>
   <!-- Section 8.3.1 EPC URI for Locations -->
   <bizLocation>
      <id>
         urn:epc:id:sgln:0614141.00300.0
      </id>
   </bizLocation>
   <bizTransactionList>
      <!-- Section 8.4.1 EPC URI -->
      <!-- Section 7.3.2 BTT -->
      <bizTransaction type="urn:epcglobal:cbv:btt:po">
         urn:epc:id:gdti:0614141.06012.1234
      </bizTransaction>
   </bizTransactionList>
</ObjectEvent>
```

4.4.4 Storage Events

1) Holding start - commencement of a (temporary) suspension in the processing of an entity

2) Holding continuation - continuation of a (temporary) suspension in the processing of an entity

3) Holding end - resumption of processing of an entity after a period of suspension

Storing/buffering general consideration

There are two events which are of interest for a MIS:

— Placing Mail into store;

— Releasing Mail from store.

Placing Mail into storage has much resemblance with a transport process. Mail typically gets packed, probably in a nested fashion and then “sent to store”. The latter is the Event a MIS would be interested in, while the packing operation should emit their own Events as it would be the case with any other transport. Often “sending to store” does not involve a vehicle, because a MHS system directly moves containers into the storage area.

Similarly releasing Mail from store can be seen as a transport from store to some place within the mail centre. Again subsequent unpacking operations should emit their own Events.

It should be noted, that the store can often be accessed in a random-access fashion. This means that there is an element of sorting (“splitting”) involved, when Mail is released: the content of the store is split into a part which get released and another part which remains in store. Since sorting involves creating new products, the same is true when Mail get released: new products can pop into existence and the products which are put into store do not necessarily match the products which are removed from store.

In short: both placing and releasing Events should be accompanied by a product-identification.

4.4.5 Transport Events

1) Postal facility despatch - despatch of an entity from a mail processing facility

2) Transport assignment - (re-)assignment of an entity to a conveyance for (one of the legs of) the transport it is to undergo

3) Transport departure - commencement of (one of the legs of) a transport being undergone by an entity

4) Transport event - event which occurs during physical transportation of an entity (possible need for periodic reporting of geographic coordinates and for the reporting of significant events, such as shocks or excessive temperature or pressure variations, occurring during actual transportation).

5) Transport arrival - arrival of the conveyance transporting an entity at the end of (one of the legs of) the transport

4.4.6 Delivery Events

1) Business Customers staging outbound

2) Residential Customers staging outbound

3) Delivery attempt - (so far) unsuccessful attempt to deliver an item or entity

4) Delivery failure - event corresponding to conclusion, by a postal handling organisation, that it is definitely unable to deliver the entity concerned and (if the entity is still available to it) intends to dispose of it in accordance with its contractual obligations.

5) Delivery completion - successful delivery of an item, including the obtaining of proof of delivery where this is required

Transportation from a Bulk-mailer or a collection office or from one sorting-centre to another always follows the same pattern.

On the sender side, mail-items undergo a series of packing processes, where e.g. mail-items are placed inside trays, trays are placed inside roll-containers and roll-containers are placed inside a vehicle. It appears more appropriate to see a transport as “moving a vehicle” rather than “having a vehicle move roll-containers”. This allows treating a vehicle like any other container.

On the receiver side, there are a series of unpacking processes which undo the packing processes and reproduce the original mail items.

Ignoring the packing and unpacking and focusing on the transport itself, a MIS would need to know:

— What transport (e.g. “inter-centre-transport from Zurich to Eclépens”) again this is the product;

— When it departed;

— When it arrived.

The location of departure and arrival is almost insignificant, because it is part of the definition of inter-centre-transport from Zurich to Eclépens though it wouldn’t hurt to include it in the MIS data. In fact, the location should be the location of the observation. You can observe the inter-centre-transport from Zurich to Eclépens anywhere between Zurich and Eclépens

What products are in the transport is not terribly important for a MIS. The “inter-centre-transport from Zurich to Eclépens” always brings the same kind of mail for an extended period of time. Inside the vehicle you will find roll-containers which belong to a pre-defined product, which in turn contain trays for pre-defined products. You just don’t expect to find refrigerators in there, because a product “refrigerator” has not been negotiated between Zurich and Eclépens.

What a MIS is interested in however, is the volume of mail as this changes daily (or however often the transport occurs). You may be tempted to believe that knowing about each and every Mail piece is sufficient information. But this is not the case because it makes a huge difference in which way those mail pieces are packaged up. Imagine you take a real-world transport, where everything is packaged up correctly. Then you take the same mail pieces, the same trays and the same roll-containers and mess everything up. The result would not be accepted by the receiver (Eclépens) anymore, even though the physical mail pieces, trays etc. haven’t changed at all.

So the least thing you need to know is how everything is packaged up. You may convey this information as some sort of manifest. Alternatively you can reconstruct the manifest from events previously received, namely the events emitted by the packing processes (“the stuff inside a container is the stuff that was put into it”).

For a MIS life gets a bit easier, when a transport is accompanied by a manifest. Then again, the manifest is not directly observable when the transport departs. All you see is a vehicle which claims to do “inter-centre-transport from Zurich to Eclépens”. What’s in there can only be deduced by taking the packing events into account. So any way you look at it, you can only know what is in a transport by observing packing processes.

4.4.7 Delivery

— Delivery units with bar codes

  — Truck – Serial Shipment Container Code (SSCC) on a GS1 Logistic Label using a GS1-128 bar code

  — roll containers with barcode

- pallets with barcode

- Roll Container with bags - a barcode
  - bags with barcodes
- Pallet with Trays
  - trays with barcode

- Delivery units with an RFID tag (passive / active)
  - Truck
    - an automatic consignment system associates the mail items to the containers carrying these items and to the trucks transporting these.
    - documentation of times of arrival and departure of vehicles, which postal containers are loaded/unloaded, vehicle load space management, real-time information on types of mail, quantities, times of arrival, delays or changes in transport times etc
  - Roll Container
    - system of the monitoring and managing roll cages includes tag (active or passive, it depends of application), that is placed on a side or on the bottom of the container
    - also includes a handheld terminal solution for consignment of roll container, product and destination enabling load control on all roll containers
  - Tray
    - each letter tray has a tag that communicates and transmits information to the reader in Real-time load control
  - Bag
    - each mail bag has a passive RFID tag that contains information about letters, which are inside the bag and some other additional information useful for sorting and other postal processes

4.5 Business Steps

As a consequence of the modelling of the diagram in the chapter above, we have come into a point in which the entire postal process place is in a strong correlation with some of the events that happen in the process with a more abstract entity that we will call “business step”. A Business Step is an atomic action (a task in the overall process) that affects (i.e. introduce changes, creates or deletes) some of the objects defined in the data model. See Table 1.

Table 1 — Business Step Processes and Operations

	Processes	Operation
1	**Collections**	**Collecting** – method of mail induction in which customers deposit mail in unmanned depositories (posting boxes) which are periodically emptied by the mail service contractor or its agent
		Induction – mail aggregate consisting of one or more mailing submissions for which responsibility is handed over between a mail submitter and a postal operator in a single hand-over transaction
2	**Inward/ Outward Sorting**	**container discharge / unloading** – removal, from a container or conveyance, of mail items, aggregates or lower-level containers
		Unpacking - Unforming – process by which a mail aggregate is unpacked into its constituent parts i.e. individual postal items, sets of postal items, bundles and/or postal receptacles
		Acceptance for postal processing – completion of the process of ensuring that mail can legally be conveyed by post, fulfils postal system requirements, regarding size, addressing, etc. and that correct postage has been paid or is chargeable under normal contractual arrangements
		Mail processes / facing, cancelling and sortation of mail. **The outward sorting** centre accepts the mail from the collections, and undertakes the first phase of processing of mail for dispatch and transport to destination mail sorting centres or, in case of local mail, to delivery offices; **Inward sorting** usually takes place in the same sorting centres used for outward sorting but during a different time slot. Postal items are prepared for the final handling in the delivery offices at the mail centre that is closest to the delivery office
		Packing / forming – process by which individual postal items, bundles, and/or postal receptacles are assembled into mail aggregates
		Containerization/loading – placement of mail items, aggregates or lower-level containers into a (higher-level) container or into the conveyance (aircraft, ship, train, truck, …) to be used for (one of the legs of) a journey the mail concerned is to undergo
3	**Transport**	**Transport arrival** – arrival of the conveyance transporting an entity at the end of (one of the legs of) the transport
		Transporting are used for transportation to transport postal item between sorting centres and sometime between distribution sorting centre and delivery offices.
		Transport departure – commencement of (one of the legs of) a transport being undergone by an entity
4	**Delivery**	**Postal process** in which a postal item leaves the responsibility of the postal operator through being handed over to, or left for collection by, the addressee, the mailer or an authorised representative, or deposited in a private letter-box accessible to one or other of these
		Attempt – (so far) unsuccessful attempt to deliver an item or entity.
		Delivery completion – successful delivery of an item, including the obtaining of proof of delivery where this is required by the postal service applicable to the item concerned
		Delivery failure – definitely unable to deliver of an item.

There are different postal organization structures with postal processes organized differently. For our purposes we can use processes with the following steps:

— Receiving – from another hub

— Unpacking –open the receptacles and take the items

— Sorting – sorting items for further transportation or sorting to finely delivery

— Packing – create receptacles

— Shipping – transportation the receptacles to the next hub

— Delivery– delivery items to house addresses

5 MIS Interface

5.1 General

MIS covers the **intra-organizational**, computer-to-computer exchange, meaning that MIS and business processes are coupled.

A MIS Interface Standard needs to be able to convey the following information

— Information about processes which move Items;

— Events triggered by items in a machine;

— Events triggered by machine state changes;

— Statistical information (“counters”);

— Information about Process States.

In the following chapters we will lay-out and structure this information.

While we will talk about attributes a lot, we will neglect their data types. Furthermore we will omit all considerations about the data format (XML vs. JSON etc.) and the protocol by which data is sent and received.

5.2 Information about processes which move Items

5.2.1 General

Traditional MIS data models focus on Events which signal the fact, that an Item was “seen” at a particular Location. Those events are well suited to convey information about Transport, Buffering and Sorting processes.

However, with such Events alone it is not possible to track items fully. The missing pieces are Pack and Unpack processes. Without these, the “sighting” of a container will not reveal anything about the current Locations of its contained items. In short: we need to know what is inside a Container, i.e. what was previously packed into a container.

5.2.2 Item

An Item is either

— A Mail piece

— A Container

— A Vehicle (a special Container)

An Item carries a unique ID, a Format and Destination information.

The ID can be obtained in any way which makes it unique. Mailpieces often carry an ID in the form of an ID-barcode.

Trays and other containers sometimes do not carry any ID. This reflects the fact, that e.g. Trays produced by one Stacker of one Sorting run can be used interchangeably, i.e. you can swap the first tray with the second tray without causing any trouble downstream. For Trucks (a Vehicle) the license plate uniquely identifies the vehicle.

The format distinguishes between various mail formats such as Letters, Flats and Parcels, but also between various containers, such as Trays, Bags or Roll-containers.

The Item Destination tells you “what kind of item” it is and allows determining the future destiny of an Item.

For a Mail piece this is the Destination information encoded as a Sort code in the barcode, for a Tray it is (part of) the information you find on the Tray label. For Vehicles the Destination is a flight number, a train number or some other information indicating the itinerary of the Vehicle.

5.2.3 Object / Product

In line with the postal procedure we focus on the object types described in Table 2.

Table 2 — Basic Object Types

Object	Category	Descriptions
Postal Items	Letters Register letter Insured item Postal parcel Printed papers	generic term referring to anything dispatched by the Post's services (letter post, parcel post, money orders, etc.
Postal receptacle (Aggregations)	Bundle Mailbag Tray Containers Pallet	Receptacle which is primarily intended to hold or transport postal items. A postal receptacle may contain mail and / or other postal receptacles. Examples include mailbags, trays, wheeled containers (roller-cages), pallet and pallet-based containers and airfreight containers (ULDs) Some types of postal receptacle (e.g. roller cages and ULDs) may have a residual value; others may not (e.g. disposable trays).
Vehicle	Routing plan vehicle (i.e. trucks) Non routing plan vehicle	vehicles used for the transport of postal items

Object data model will contain references to status of product aggregation and classification during the overall process.

A MIS would need to know:

— The Mail piece ID, if the product traced is at final item level

Or, alternatively:

— The Product ID, where with product ID it is generally intended an aggregation of mail pieces (or an aggregation of intermediate products) that are intended to be transported (or packed) for a specific rerouting mechanism of a distribution step of a mail delivery product workflow

— The coding time

— The Aggregation criteria (CLASS).

  — This field carries information about the routing process, and the same routing process is specific of the postal organization delivery and workflow rules. This element is a function of :

    — the postal product type (registered letter might be carried along different sorting centres than priority letters, just because of a different logistic)

    — the specific delivery step (a letter might fall into different stacker of the same even of the same sorting machine if it is happening when sorting inbound mail or outbound)

— The physical destination of the object

  — Often this field has the same value of the "Aggregation Criteria" (because in the process workflow of a Postal Organisation the aggregation criteria are combination of items to be designated to the same business location). More in general, this field contains the actions business location to which the aggregation is designated for the next processing step to happen, considering eventual possible rerouting events.

5.2.4 Location

A Location describes where an Item was seen, but does not necessarily refer to a physical location, which could be expressed by means of geo-coordinates. Geo-location information would be of little use for a MIS. Instead, Location shall identify a position within the process chain.

A Location can denote a Stacker of a Sorting Machine, a Buffer holding a number of Containers or the Destination of a Transport. The set of interesting Locations in a postal network changes very slowly. For a MIS it is important to put Locations into context, i.e. to relate a Location to the Infrastructure. This link between Locations and Infrastructure however, is not part of the MIS interface, but part of an Infrastructure Database, which is beyond the scope of this document.

It may seem tempting to use mnemonic keys to express e.g. the association between. Sorting Machines and their Stackers ("MachineNr.StackerNr"). This would simplify the infrastructure database to the extent that it only needs to know about Sorting Machines, but not about their stackers. However this approach has some drawbacks:

A MIS could not know about the possible Locations without having received at least one Event from each. It would e.g. not know how many stackers a particular machine has.

A MIS may not be able to function without full infrastructure information. Consequently much of the infrastructure database may end up being hardcoded in the MIS.

Therefore Locations should be nothing but Ids. There is no problem, when the keys follow a naming scheme, which expresses "containment" as long as they are unique. However, the naming scheme only "hints" at the infrastructure and the only valid source of infrastructure information shall be the infrastructure database.

5.3 Classification of Postal Business Events in EPCIS data model

5.3.1 General

Starting from the following schema in Figure 6.

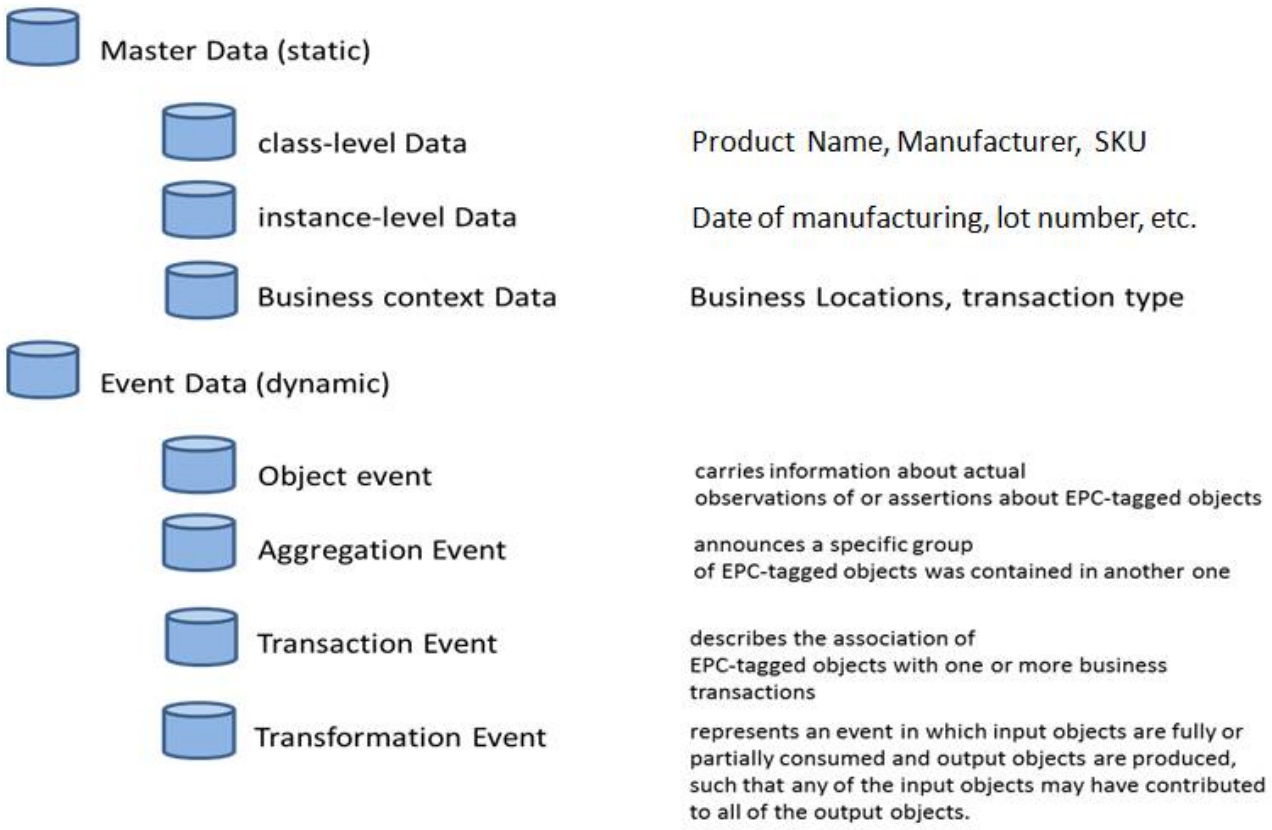

Figure 6 — EPCIS data model reference — Master data and Event Data

It is a visible correlation with the Data Model used in EPCIS[2)] standard. To be able to correlate these data schema model with the EPCIS data schema and define if we need to define extension to the EPCIS model we will have to consider a correlation matrix like this one in Table 3:

[2)] EPC Information Services (EPCIS) Version 1.1. Specification - GS1 Standard, May 2014.

Table 3 — Correlation Matrix

Category	#	Postal Supply Chain Process Step	'WHY' DIMENSION		'WHAT' DIMENSION		'WHEN' DIMENSION				'WHERE' DIMENSION			
			Business Context		MASTER DATA		EPCIS EVENT TYPE							ACTION
			Business Step	Disposition	Class Level	Instance Level	Object	Aggre-gation	Trans-action	Transfor-mation	Read Point	Business Location	Comment	
			Within a business process	*Business Condition*	*'Product'*	*' Postal Item'*	*Event*	*Event*	*Event*	*Event*	*event took place*	*place after the event*		
Delivery	28	Business Customers	shipping	In_transit		X			X		Read PointID	Business LocationID	At Business Customers	OBSERVE
Delivery	29	Residential Customers	shipping	In_transit		X			X		Read PointID	Business LocationID	At Residential Customers	OBSERVE
Delivery	30	Delivery Attempt	Other	In_transit		X			X		Read PointID	Business LocationID	Item is held at Delivery Office pending further delivery attempts / collection.	OBSERVE
Delivery	31	Delivery Completion	Accepting	In_progress		X			X		Read PointID	Business LocationID	Proof Of Delivery	OBSERVE
Delivery	32	Delivery Failure	Other	Returned		X			X		Read PointID	Business LocationID	Delivery Office	OBSERVE
Handover	1	Collected Mail Posting	Collecting	Active	X	X	X				**Read PointID**	**Business LocationID**	1. Location of posting, 2. Facility ID services the posting location	ADD
Handover	2	Bulk Mail Posting	Collecting	Active	X	X	X				**Read PointID**	**Business LocationID**	1. Location of posting, 2. Facility ID services the posting location	ADD
Handover	3	Collected Mail Outward facility Entry	Receiving	In_progress	X	X	X				**Read PointID**	**Business LocationID**	1. Location of posting, 2. Facility ID services the posting location	ADD
Handover	11	Carrier Reception	Loading	In_progress	X	X	X				**Read PointID**	**Business LocationID**	1. Hand-over location, 2. Location to which the entity is to be delivered by the carrier	ADD
Handover	17	Carrier Hand off	Departing	In_progress	X	X	X				**Read PointID**	**Business LocationID**	1. Hand-over location, 2. Despatch location	DELETE
Handover	18	Bulk Mail Regional DC Entry	Receiving	In_progress	X	X	X				**Read PointID**	**Business LocationID**	1. Location from which the entity has been despatched, 2. Destination facility	ADD
Handover	20	Inward processing facility entry	Receiving	In_progress	X	X	X				**Read PointID**	**Business LocationID**	1. Location to which the entity has been delivered, 2. Location from which the entity was transported	ADD
Handover	27	Delivery Office Entry	Receiving	In_progress	X	X	X				**Read PointID**	**Business LocationID**	1. Location from which the entity has been despatched, 2. Destination facility	ADD

Category	#	Postal Supply Chain Process Step	'WHY' DIMENSION		'WHAT' DIMENSION		'WHEN' DIMENSION				'WHERE' DIMENSION			
			Business Context		MASTER DATA		EPCIS EVENT TYPE							ACTION
			Business Step	Disposition	Class Level	Instance Level	Object	Aggre-gation	Trans-action	Transfor-mation	Read Point	Business Location	Comment	
			Within a business process	*Business Condition*	*'Product'*	*'Postal Item'*	*Event*	*Event*	*Event*	*Event*	*event took place*	*place after the event*		
Processing	4	Acceptance for Postal process	Accepting	In_progress	X	X	X				Read PointID	Business LocationID	1. Facility in which the event took place, 2. if transport was provided by the postal handling organisation, location from which the entity was collected	ADD
Processing	5	ID assignment	Encoding	Encoded	X	X	X				Read PointID	Business LocationID	Facility in which the event took place	OBSERVE
Processing	6	Mail processing (facing, canceling, sortation)	Inspecting	Active	X	X				X	Read PointID	Business LocationID	Facility in which the event took place	ADD
Processing	7	Aggregate Assignment (packing)	Packing	Active	X	X		X			Read PointID	Business LocationID	Facility in which the event took place	ADD
Processing	8	Aggregate Break Up (unpacking)	Unpacking	Active	X	X		X			Read PointID	Business LocationID	Facility in which the event took place	DELETE
Processing	9	Loading (containerisation)	Loading	In_transit	X	X			X		Read PointID	Business LocationID	Facility in which the event took place	ADD
Processing	16	Unloading (decontainerisation)	Unloading	In_transit	X	X			X		Read PointID	Business LocationID	Facility in which the event took place	ADD
Processing	19	Downstream access	Collecting		X	X	X				Read PointID	Business LocationID	Facility in which the event took place	ADD
Processing	24	PreSortation	Inspecting	In_progress	X	X		X		X	Read PointID	Business LocationID	Facility in which the event took place	OBSERVE
Processing	25	Sortation	Picking	Active	X	X		X		X	Read PointID	Business LocationID	Facility in which the event took place	ADD
Processing	26	Merging	Assembling		X	X				X	Read PointID	Business LocationID	Facility in which the event took place	ADD
Storage	21	Holding start (storage)	Holding	In_progress	X		X				Read PointID	Business LocationID	Facility in which the event took place	OBSERVE
Storage	22	Holding Continuation (storage)	Storing	In_progress	X		X				Read PointID	Business LocationID	Facility in which the event took place	OBSERVE
Storage	23	Holding End (storage)	Holding	In_progress	X		X				Read PointID	Business LocationID	Facility in which the event took place	OBSERVE
Transport	10	Postal Facility Dispatch	Shipping	In_transit	X				X		Read PointID	Business LocationID	Place of despatch	DELETE
Transport	12	Transport Assignment	staging_outbound	In_transit	X				X		Read PointID	Business LocationID	Place of departure	DELETE
Transport	13	Transport Departure	Transporting	In_transit	X				X		Read PointID	Business LocationID	1. Place of departure, 2. Location of the end point of the (current leg of the) transport	DELETE
Transport	14	Transport Event	Other	In_transit	X				X		Read PointID	Business LocationID	1. Location at which the event took place, 2. Location of the end point of the (current leg of the) transport	DELETE
Transport	15	Transport Arrival	Arriving	In_transit	X				X		Read PointID	Business LocationID	1. Place of arrival, 2. Place of final delivery after the last leg of a transport chain	DELETE

The EPCIS standard data model of "what," "when," "where" and "why." The "where" and "why" is what differentiate EPCIS events from raw RFID tag reads.

— The “what” dimension is specified by a list of EPCs identifying one or several physical objects and a list of so-called business transactions that these items are involved in

  — EPC – can be a list (Object or Transaction Events) or parent/child (Aggregation or Transaction Events). It is possible to include any unique identity in the EPC field.

  — Business Transaction – includes a type (e.g.: Production Order) and a number. By including the Business Transaction number in a business event, it is possible to relate EPCs to a Business Transaction – e.g.: state that EPCs 1-5 are in Production Order A-123.

— The "where" dimension includes detailed location information, which the plant and asset managers need for their applications.

  — Read Point – indicates the location where an event took place – e.g.: DC X conveyor belt #2

  — Business Location – describes where the object is immediately after the event occurs – e.g.: DC X Shipping Area

— The "why" dimension indicates what process step is being carried out, which the plant managers need, but is less important to the asset manager. The "why" dimension also contains links to Production order, critical information for the plant manager.

  — Business Step – indicates what business operation was taking place at the time of the event – e.g.: Receiving, Picking, Loading, Sorting, Holding, Shipping

  — Disposition – describes the status of the object immediately after the event occurs – e.g.: Active, Inactive

— The “when” dimension

  — Event Time – states when an event took place

  — Record Time – indicates when the event was received through the EPCIS Capture Interface

The final standard field is Action, which has three values:

a) Add – indicates the first event in a product’s lifecycle for an Object Event, or indicates joining child EPCs to a parent EPC in an Aggregation Event

b) Observe – indicates an event between beginning of life and end of life for an Object Event

5.3.2 Business steps in EPCIS[3)]

Accepting: a specific activity within a business process where an object (i.e. product, shipment or asset) arrives into a location causing a change of possession and/or responsibility.

Arriving: Shipment is arriving at a location

Assembling: one or more trade item(s) or identifiable component parts are combined with other objects creating a new finished product.

3) A reference of generic EPCIS Business steps can be found at:

http://apps.gs1.org/GDD/Pages/clDetails.aspx?semanticURN=urn:gs1:gdd:cl:EPCISBusinessStep&release=1.

Collecting: a specific activity within a business process where an object (i.e. product, asset, shipment or container) is picked up and collected for future disposal, recycling or reused.

Commissioning: one or more trade item(s) or identifiable component parts are combined with other objects creating a new finished product.

Decommissioning: disassociating an EPC with an object (i.e. product, shipment, asset or container). EPC may be re-commissioned at some point in the future and read again – however only with new information.

Departing: Shipment is leaving a location on its way to a destination

Destroying: terminating an object (i.e. product, shipment, asset or shipping container) The object and its EPC should not be the subject of subsequent events that require a physical observation; subsequent physical observations are likely indicative of error (such as a stray read of a tag inside an incinerators

Disassembling: a trade item is broken down into separate, uniquely identified component parts.

Encoding: writing an EPC code (or a barcode) to a tag. EPC is not associated with an object (i.e. product, shipment, asset or container) at this step in the process.

Entering exiting: a specific activity within a business at the Entrance/Exit door of a facility. Customers are either leaving with purchased product or entering with product to be returned to the facility

Holding: a specific activity within a business process where an object (i.e. product, shipment, asset, or containers) is being segregated for further review.

Inspecting: reviewing product to address potential product or documentation defects

Installing: part or component is put into a composite product or piece of equipment or machinery.

Killing: terminating an EPC RFID tag previously associated with an object. The object and its EPC code may continue to exist and be the subject of subsequent events (via a bar code, manual data entry, replacement tag, etc)

Loading: an object (i.e. product, shipment, asset, or container) is loaded into shipping conveyance.

Other: A business step not identified by any of the values listed in the core business vocabulary

Packing: includes putting product (individuals, inners, cases, pallets) into a larger container – usually for shipping. Aggregation of one unit to another typically occurs at this point.

Picking: selecting of product to fill an order

Receiving: an object (i.e. product, shipment or asset), is being received at a location and is added to the receiver's inventory.

Removing: a part or component is taken out of a composite product, or piece of equipment or machinery.

Repackaging: an object's packaging configuration is changed.

Repairing: a malfunctioning product is repaired (typically by a post-sales service), without replacing it by a new one.

Replacing: an object (part, product, asset, and container) is substituted or exchanged for another object.

Reserving: Process for an EPC number manager to provide a set of EPC numbers for use by another party.

Retail selling: at a point-of-sale for the purpose of transferring ownership to a customer in exchange for something of value (currency, credit, etc).

Shipping: Indicates the overall process of picking, staging, loading and departing. It may be used when more granular process step information is unknown or inaccessible. It may indicate a final event from a shipping point. The use of shipping is mutually exclusive from the use of departing, staging, or loading.

Staging outbound: a movement of an object (i.e. product, shipment, asset, container) from a facility to an area where it will await transport pick-up

Stocking: within a location to make a product available to the customer or for order fulfilment within a DC

Storing: objects are moved into and out of storage within a location

Transforming: one or more objects are an input into a process that irreversibly changes that object / those objects into a new object or objects; the output has a new identity and characteristics

5.4 The impact of events on MIS

— Flow of requirements

  — The relevance of an event is driven from the data need of the application. From this need, events are defined and the equipment manufacturers are obliged to deliver these events.

  — There is also a flow in the opposite direction: a machine can deliver certain events, and the MIS is obliged to visualize these events. This should be the exception, not the rule.

  — In real world projects it has turned out to be difficult to define a standard set of events. For example a sorting machine is typically either running or not running. However, an MHS has lots of motors each of which can be running or not running. Hence a model which is appropriate for a sorting machine can be inappropriate for an MHS as a whole.

— Layered approach

  — with raw events at the finest level and aggregated values at a higher level

  — another layer which concerns the world of “asset management”.

— Asset management

  — information which changes very slowly, like the installed software versions of various modules.

  — uptime/downtime

  — for large postal organizations it can be difficult to get a complete listing of all their sorting machines and their configurations.

— Items in machine events (feeder, format control, special reader, barcode reading, image scanning, printing, measuring, barcode verifying, sorting to stacker, reject)

— Reading events from image (address reading, Non Address Attributes(NATS), Enrichment device event (OCS, VCS)

— Events triggered by machine status changes (shut down, ready, sorting, empty, fault, service)

6 Data Collection and Transfer

6.1 General

This clause addresses how raw data is transported from the devices to the MIS. There may be more than one permissible protocol referring to different OSI layers. The standard should define where the communication requires polling and where asynchronous messages are used

Gathers and captures the input data from the data resources.

The size and structure largely depends on the nature and type of data, the transaction volumes and method of data collection.

The data captured in electronic form is handed over to the Data Storage module for storage and retrieval purposes.

6.2 Process Integration and Service Oriented Architecture

The integration of processes by appropriate IT structures in combination with an integrated information management becomes due to the increasing focus on business processes very important. A more efficient process-oriented integration of heterogeneous IT infrastructures and processes is supported by service-oriented architectures (SOA) and services.

SOA represents an architectural principle, in which services are offered abstracted of their technical implementation. The user of the services sees only the external interface of the service, but not the individual service itself. Overall, the combination of these service modules allows the implementation of more robust and flexible applications. Due to the defined interfaces, the modules can be replaced without a lot of effort. Thus, the sequences in heterogeneous system landscapes, as they can be commonly found at an IT service provider and a university research facility, are much easier to implement.

A SOA transformation includes the transition from the variety of interfaces, in which all services communicate unilaterally with other services and components in different languages, to a few protocols and to an exchange of standardized messages. An important technical component for implementing a SOA can be represented through a message-based service bus, called Enterprise Service Bus (ESB).

An enterprise service bus (ESB) is a software architecture model used for designing and implementing communication between mutually interacting software applications in a service-oriented architecture (SOA). As software architectural model for distributed computing it is a specialty variant of the more general client server model and promotes agility and flexibility with regards to communication between applications. Its primary use is in enterprise application integration (EAI) of heterogeneous and complex landscapes.

There is no global standard for enterprise service bus concepts or implementations. Most providers of message-oriented middleware have adopted the enterprise service bus concept as de facto standard for a service-oriented architecture. The implementations of ESB use event-driven and standards-based message-oriented middleware in combination with message queues as technology frameworks. However, some software manufacturers re-label their existing middleware and communication solutions as ESB without adopting the crucial aspect of a bus concept.

ESB is a modular and component based architecture. It assumes that services are generally autonomous and availability of a service at a certain moment of time cannot be guaranteed. Therefore messages need to be

routed consequently through the message bus for buffering (message queuing) to allow inspection and enhancement of content as well as filtering, correction and rerouting of message flow.

The number of point-to-point connections and the number of implemented interfaces can be reduced, if the exchange of messages is not directly done between the services, but replaced through a bus. Thus, a message-based service bus can be used in addition to its coordinating role also for the monitoring of the implemented IT processes. Essentially this service bus facilitates a standardized communication between different applications and systems.

6.3 Process Integrations Platform

6.3.1 General

An Integration Platform is defined as computer software which integrates different applications and services. It differentiates itself from the Enterprise application integration which has a focus on supply chain management. It uses the idea of System integration to create an environment for engineers.

Integration platforms can be built from components, purchased as a pre-built product ready for installation or procured from an integration Platform as a Service (iPaaS) offering.

An Integration Platform tries to create an environment in which engineers can:

— Data (information) Integration: Ensure that are using the same datasets and can share information. Data management with metadata information and versioning ensures the data is kept consistent

— Integrate all kind of applications (independent from platform, programming language or resource) so they can bound together in workflows and processes to work in conjunction. The different interfaces are hidden by the usage of uniform interface in the Integration Platform (Process Integration).

— Collaborate between distributed and scattered applications and engineers over the network.

— Interoperability between different operating systems and programming languages by the use of similar interfaces.

— Take security considerations into account so that e.g. data is shared only with the right resources.

— Visual guidance by interactive user interfaces and a common facade for all integrate applications

6.3.2 Common components of integration platform

Integration platform typically contains a set of functional components, such as

— Message bus for enabling reliable messaging between enterprise applications;

— Adapters to transform messages from and to application's proprietary protocol. Adapters often offer connectivity via common standards, like FTP, SFTP or format support, like EDI;

— Transformation engine and visualized data mapping to transform messages or files from format to another;

— Metadata repository for storing information separated from processes, like business party;

— Process Orchestration Engine for orchestration design and execution. In this context orchestration is a technical workflow that represents business process or part of it;

— Technical dashboard for tracking messages in message bus and viewing execution history of orchestrations;

— Scheduler for scheduling orchestrations;

— Batch engine for controlling large file transfers, batch jobs, execution of external scripts and other non-messaging based tasks.

An integration platform has a focus to be designed and helpful to Engineers. It has no intention to map business processes or integrate tools for supply chain management. Therefore it is not related to those systems.

6.4 Message based process integration platform

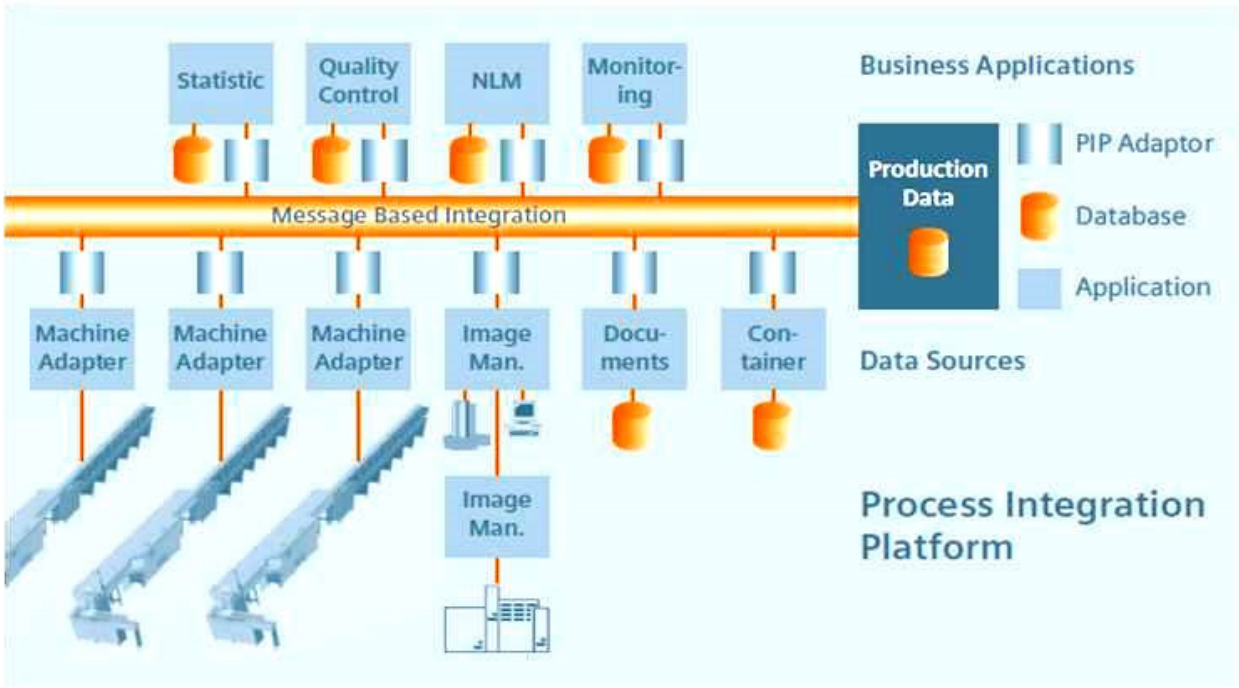

Figure 7 — Message Based Process Integration Sample Architecture

Courtesy of Siemens AG

The Process Integration Platform (from Siemens above), see Figure 7, enables a simple migration of the software from an old hard-coded architecture to a state-of the-art, message driven software architecture. In the transition phase the previous software solutions is still available and can be used parallel to the new one.

Due to the message based integration of different machines and computer systems the Siemens platform allows adoption of all data sources within the entire logistics network.

The Process Integration Platform provides a unique basis for easy deployment of already existent and new business applications.

These applications may be delivered out of the Siemens portfolio or can be provided by other suppliers.

Using the Integration Platform the postal & parcel organizations can draw some additional benefits, namely the easy access to volume & item data, as well as simple processing of these data. The software solution avoids data redundancies and offers common standardized formats/ data structures.

Process Integration Platform is implemented with state-of-the-art technologies according to Service-Oriented Architecture (SOA) principles and Enterprise patterns. An optimized blend of elements of both and their integration and configuration guarantees high level system performance in the logistics environment. The term Service-Oriented Architecture (SOA) expresses a perspective of software architecture that defines the use of services to support the requirements of software users.

Enterprise Service Bus (ESB) is defined as the use of software and computer systems architectural principles to integrate a set of enterprise computer applications. By the process of linking various applications, financial and operational competitive advantages can be realized.

Main solution features:

Data integration:

— Capture of production process data and equipment data from collection to delivery

— Standardization of interfaces to PIP

Data consolidation:

— Controlled storage of process data (centralized/decentralized)

— Synchronization of item information – even if stored at different locations

Data aggregation:

— Automatic acquisition and abstraction of information

— Reduction of data volume to the essentials

Data query:

— Standardized access for all kinds of applications to information which are provided

Data integrity:

— Network buffering of data

— Supported data encryption

— Transaction safety

Detailed features of PIP:

— Reliable Delivery of Data

— Managed Persistence of Data

— Lifecycle control for each type of Data

— Content Based Routing

— On-the-Fly Compression of Data

— Error Reporting

— Transformation of Data depending on sender and receiver

— Validation of Data

— Access and Visualization to the System via the Web

— XML based Query Language

— Methods for efficient handling of large amount of data

— Tailored to meet the performance demands of distributed postal & parcel services

State-of-the-art architecture:

— Multi Tier Architecture

— Java/J2EE supported by the Application Server

— JMS by Sonic MQ

— Relational Database and Data Warehouse by Oracle

— Web based Information Portal by Life ray technology

— Cluster Capability of Windows Server by Microsoft

Its high scalability, from small postal-like environments to full enterprise solutions, makes the Process Integration Platform a reliable system. The Siemens Platform enables the user to retrieve network wide statistics as well as item based information used in e.g. Track &Trace systems or quality systems. Furthermore, network applications like “end-to-end” monitoring and nationwide load management can be provided at costumer’s option.

7 Data Storage and Format

7.1 General

In this section, we will provide an overview of the data Storage in a Repository with the necessary Data Format.

7.2 Data storage in a Repository

7.2.1 General

EPCIS provides open, standardised interfaces that allow for seamless integration of well-defined services in inter-company environments as well as within companies. Standard interfaces are defined in the EPCIS standard to enable visibility event data to be captured and queried using a defined set of service operations and associated data standards, all combined with appropriate security mechanisms that satisfy the needs of user companies. In many or most cases, this will involve the use of one or more persistent databases of visibility event data, though elements of the Services approach could be used for direct application-to-application sharing without persistent databases.

With or without persistent databases, the EPCIS specification specifies only a standard data sharing interface between applications that capture visibility event data and those that need access to it. It does not specify how the service operations or databases themselves should be implemented. This includes not defining how the EPCIS services should acquire and/or compute the data they need, except to the extent the data is captured using the standard EPCIS capture operations. The interfaces are needed for interoperability, while the implementations allow for competition among those providing the technology and implementing the standard.

An EPC Information Service (EPCIS) is basically serving as a company’s data repository for item-level data.

An EPCIS is accessible in two ways.

Firstly, EPCglobal has standardized the EPCIS Capture Interface. This interface can be used to enter (filtered) item-level data into the repository.

Secondly, to gain benefit from the data stored in the repository this data has to be accessible by other applications. Thus, EPCglobal also standardized the EPCIS Query Interface. Through this interface the EPCIS data can be accessed either by applications within the company or by applications of other companies.

EPCIS-enabled Repository Records EPCIS-level events generated by one or more EPCIS Capturing Applications, and make them available for later query by EPCIS Accessing Applications.

The EPCIS Query Control Interface defines a means for EPCIS Accessing Applications and trading partners to obtain EPCIS data subsequent to capture from any source, typically by interacting with an EPCIS Repository. It provides a means for an EPCIS Accessing Application to retrieve data on-demand, and also enter subscriptions for standing queries.

EPCIS Capture Application that wishes to deliver an EPCIS event through the EPCIS Capture Interface, and a "capture server" is an EPCIS Repository or EPCIS Accessing Application that receives an event from a capture client.

Figure 8 below illustrates that an EPCIS in fact may provide two different types of data, event data and master data. Event data arises in the course of carrying out business processes, and is captured through the EPCIS Capture Interface and made available for query through the EPCIS Query Interfaces.

Master data is additional data that provides the necessary context for interpreting the event data. It is available for query through the EPCIS Query Control Interface, but the means by which master data enters the system is not specified in the EPCIS 1.0 specification

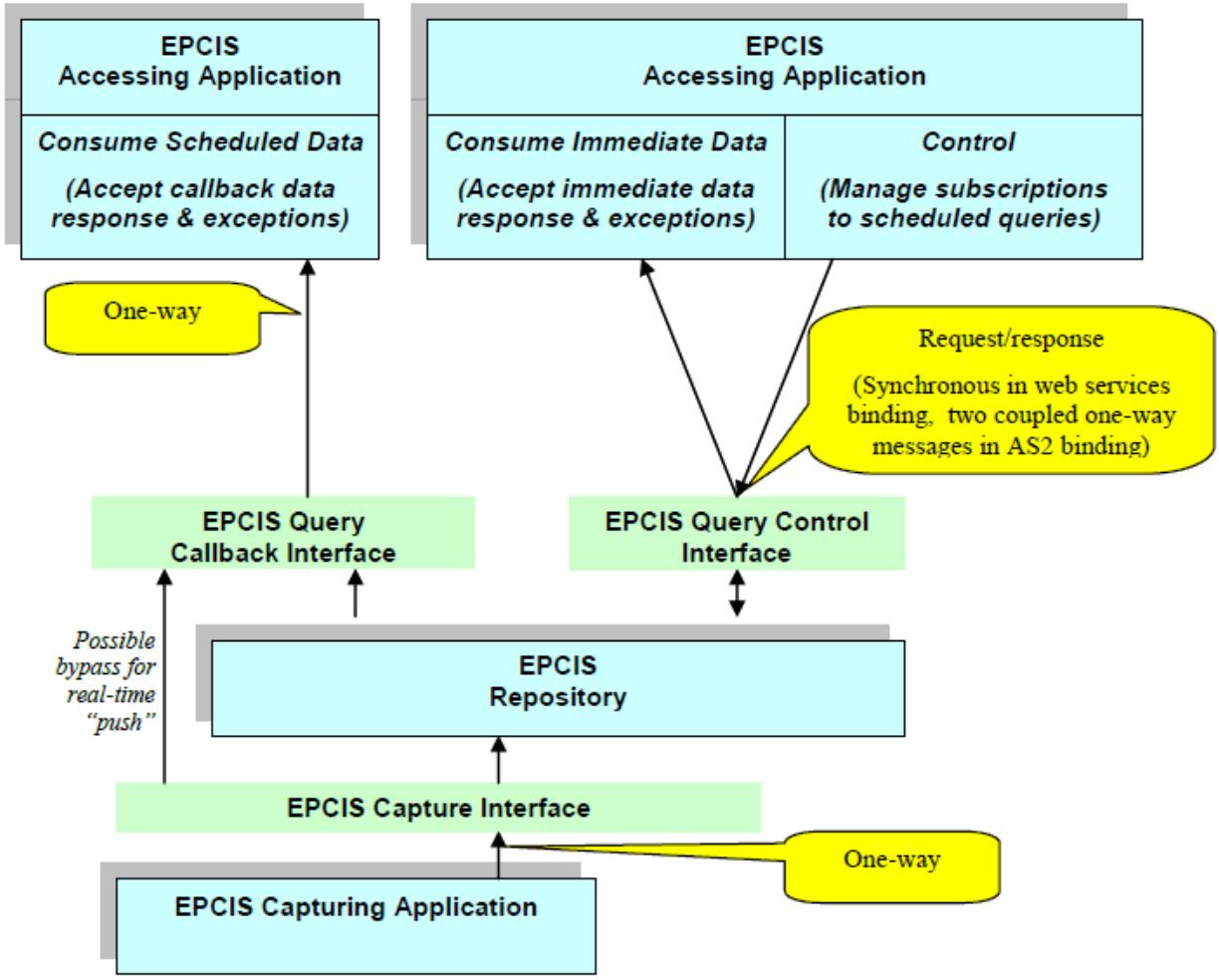

Figure 8 — EPCIS Interfaces

7.2.2 EPCIS Repository

The repository can store all of the EPCIS-level events for the products generated by one or more EPCIS external event capturing systems. These events include:

— Accepting

— Arriving

— Assembling

— Collecting

— Commissioning

— Decommissioning

— Departing

— Destroying

— Disassembling

— Encoding

— Entering_exiting

— Holding

— Inspecting

— Installing

— Killing

— Loading

— Other

— Packing

— Picking

— Receiving

— Removing

— Repackaging

— Repairing

— Replacing

— Reserving

— Retail_selling

— Shipping

— Staging_outbound

— Stocking

— Storing

— Transforming

Using the EPCIS Capture web service, events from external systems or trading partners can be populated into the EPCIS repository. This can be achieved using HTTP Post and JMS Capture. For HTTP Post or JMS Capture, any errors will be visible to you in the Web Service Exceptions page using a the

Web Service Name of capture EpcisDoc or HTTPPost. The EPCIS Capture web service uses the EPCIS setup information (preferences) that you define in OPSM to determine the data that can be captured.

Using the EPCIS Query web service, you can query on EPCIS data (business events) initiated internally, from external trading partners, or regulatory agencies. The result of this query is provided to the accessing application in XML format with a list of EPCIS Event instances. The EPCIS Query web service uses the EPCIS setup information (preferences, policies, and users) that you define in OPSM to determine the EPCIS events that can be accessed.

Before you can capture EPCIS events and post to the EPCIS repository or query the EPCIS repository you shall first set up the EPCIS repository preferences, policies, and users. The EPCIS Capture web service and the EPCIS Query web service use this setup information during their processing of data.

7.3 Data formats

7.3.1 Data levels

In this document “item-level data” is used as a general term for EPC data identifying a unique instance of an object, no matter if the object is a basket or a single product instance. The focus is on the integration of item-level data into business applications. Of course, there is a difference between processing data about millions of individual items or data about a few thousands of containers. But from an integration view this difference is one of scale rather than principle.

Class-level identifiers for physical or digital objects populate the “what” dimension of EPCIS events.

7.3.2 Identification

The Electronic Product Code was initially intended as a worldwide unique identifier for individual items. However, as different identifiers were already in very wide use in many industries and countries around the world, the user community required that the Electronic Product Code was designed in such a way that the existing identifiers, and potentially other identification schemas, could be included. Use of GS1 identifiers ensures that EPCs are unique worldwide.

The general EPC Tag Encoding is always the same, but different coding schemas can be mapped into an EPC, see Figure 9:

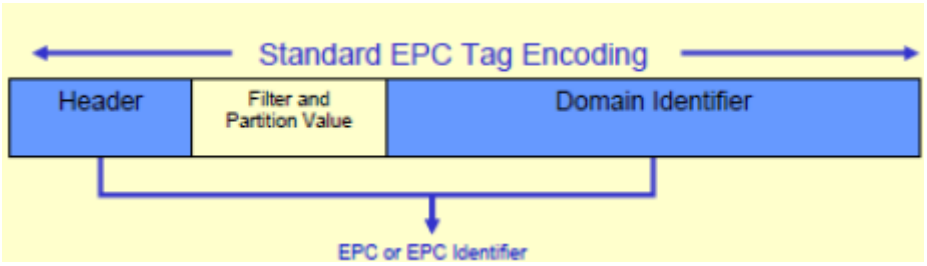

Figure 9 — Standard EPC Tag Encoding

It is also possible to include individual coding schemas into the EPC. This was an important industry requirement for the specification of the EPC, because many companies are using individual coding schemas today.

Where the EPCIS data model calls for an identifier, EPCIS allows any Uniform resource identifier (URI) to be used. URI is a string of characters used to identify a name of a resource. Such identification enables interaction with representations of the resource over a network, typically the World Wide Web, using specific protocols. Schemes specifying a concrete syntax and associated protocols define each URI. The most common form of URI is the uniform resource locator (URL), frequently referred to informally as a web address. More rarely seen in usage is the uniform resource name (URN), which was designed to complement URLs by providing a mechanism for the identification of resources in particular namespaces.

The URI syntax consists of a URI scheme name (such as "http", "ftp", "mailto", "crid" or "file") followed by a colon character, and then by a scheme-specific part. The specifications that govern the schemes determine the syntax and semantics of the scheme-specific part. However, URI syntax does require all schemes to adhere to a general syntax that (among other things) reserves certain characters for special purposes (without always identifying those purposes). The URI syntax also enforces restrictions on the scheme-specific part in order to (for example) provide for a degree of consistency when the part has a hierarchical structure.

Most commonly, the identifiers used are as defined in the EPC Core Business Vocabulary (CBV). The CBV standard provides definitions of data values that may be used to populate the data structures defined in the EPCIS standard. The use of the standardized vocabulary provided by the CBV standard is critical to interoperability and critical to provide for querying of data by reducing the variation in how different businesses express common intent.

7.3.3 Capture

Barcodes and RFID tags have in common, that both can be used to automate product identification. Comparing barcodes and RFID tags is difficult, because there are in fact many different types of RFID tags with different designs and characteristics.

For example, active tags (tags with an own power supply) enable the storage of much more data than barcodes can contain. On the other hand, they require a battery and are thus, much more expensive than barcodes. In contrast, passive tags do not require their own power supply, but as a consequence they cannot store significantly more data than barcodes. Passive tags are today more expensive than barcodes, but there is hope that the prices of passive RFID tags and barcodes will converge in future. Major differences also arise from the use of different frequencies. While high frequency (HF) tags usually can only be read from a short distance, and thus do not differ largely from barcodes in respect to the read range, ultra high frequency (UHF) tags enable significantly larger read ranges.

Table 4 below provides a comparison of barcode labels and RFID tags:

Table 4 — Comparison or barcodes and RFID tags

	Barcode Labels	RFID Tags
Pro Barcode (contra RFID):	Inexpensive (but not reusable)	Costly (though potentially reusable)
	Reliable to read	Not always reliable to read
	Work with virtually all products	Work with most products but have trouble with some (such as those containing metals and liquids)
	Can be printed before production or printed directly on items	Must be programmed, applied, and verified individually, and data synchronization is usually required
Pro RFID (contra Barcode):	Must be read one at a time and line of sight is required	Many tags can be read simultaneously and no line of sight is required
	Written once with limited data	Can potentially be written multiple times, have higher capacity, and can be combined with sensors
	Have a limited read range	Can have a longer read range

Today, the barcode technology is very widespread and a barcode can be found on nearly every product. In contrast, RFID is an emerging technology that might replace barcodes in some areas in the future.

Annex A
(informative)

Typical Postal Industry MIS interfaces

Java interface:

— JMX (Java Management eXtensions) is a java-based standard for managing and monitoring applications, system objects, devices (e. g. printers) and service oriented networks.

Microsoft interface:

— OPC / Unified Architecture UA (OLE for process control) is an interface designed by Microsoft to control PLCs. It appears to be too low-level for a MIS interface

— ODBC (Open DataBase Connectivity) is an open standard interface to access databases developed by Microsoft.

Pitney Bowes interfaces:

— SortEngine™ Full Service PostalOne! TMS interface helps you achieve the ultimate postal network connectivity and streamlined operations by tying your sorter pallet and tray separations directly to your Tray Management System (TMS) for the latest air and surface availability information. With a TMS interface your mail will navigate through the USPS delivery network at optimum speeds.

— Exponare® is an integrated suite of out-of-the-box applications that provide the gateway to an organisation's corporate data, both spatial and non-spatial. With a strong emphasis on ease of use, integration, customisability, standards compliance and multi-platform support, the Exponare product suite has been built from the ground up using Pitney Bowes Software's .NET products, based on the Microsoft® .NET platform.

SAP interface:

— FAST (Facility Access and Shipment Tracking) is designed to interface with other postal applications and systems to enable ongoing transformation to an environment where the Postal Service and customers have end-to-end visibility of the mail product from entry to delivery. SAP Business Objects Postalsoft products use the USPS Facility and Mail Direction files to support the FAST system when choosing entry points.

Siemens interfaces:

— VSI (Versatile Sorter Interface) is an interface designed by Siemens. In its first version it was based on CORBA/rmi/iiop the current version is based on XML/jms. Its purpose is to provide an interface between sorting machines and a MIS as described above.

— IIA, TIM, PCS7 are other interfaces by Siemens which are also used to control equipment

Solystic interfaces:

— Open standardized man / machine and web interfaces are used to connect TOP 2000, STAR och MOSAIC to other systems such as OCR´s, VCS or Information System.

Vanderlande Industries interfaces:

— user interface technologies, such as RF terminals, Pick-by-Voice and Pick-to-Light.

— VITAL VISION, VIBES systems with Business Process Intelligence (BPI)

— SCADA (Supervisory Control And Data Acquisition): real-time system monitoring tool

— ODB (Operations Dashboard): displays near-real-time process data and capacities

— TEM (Traffic light Environment Monitor)

Annex B
(normative)

EPCIS standard summary reference

B.1 Overview

EPCIS provides

— a standard data model, capture and query interfaces to not only MIS interface but also to enable track and trace, product authentication, diversion detection, and other use cases across supply chain partners across multiple industries with security (authentication and authorization) but without any vendor lock. It is industry and application neutral.

— a way to share high volume, very fine grain information about material movement and status among cooperating partners.

— what is necessary to share data, but does not provide application level functionality.

— EPCIS standard is a set of interfaces that support sharing of visibility data. This is similar to email protocols supporting the distribution of Internet mail. EPCIS defines a capture interface and a query interface to obtain and share business event information. The standard may be implemented by applications, but the applications themselves are developed by end users and solution providers

— EPCIS can work with any data carrier – captured Product ID may come from

  — Passive RFID Tag – UHF Gen 2, HF

  — Barcodes –Linear, Data Matrix

  — Active RFID Tag

  — Human Readable Number

  — And more in the future

— EPC Events answer 4 questions –What, Where, When, and Why

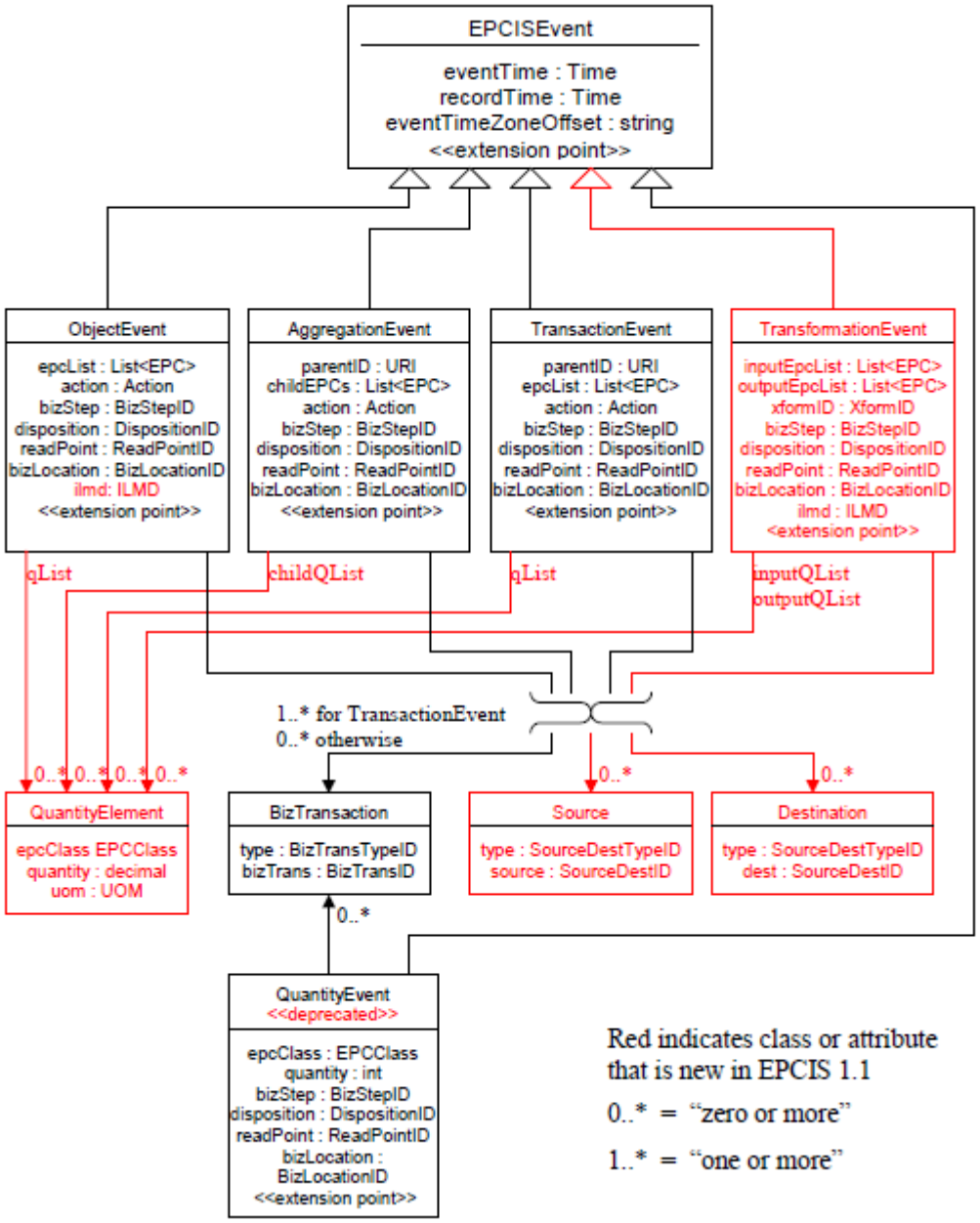

Figure B.1— EPCIS Model

B.2 EPCIS Event and Master Data example

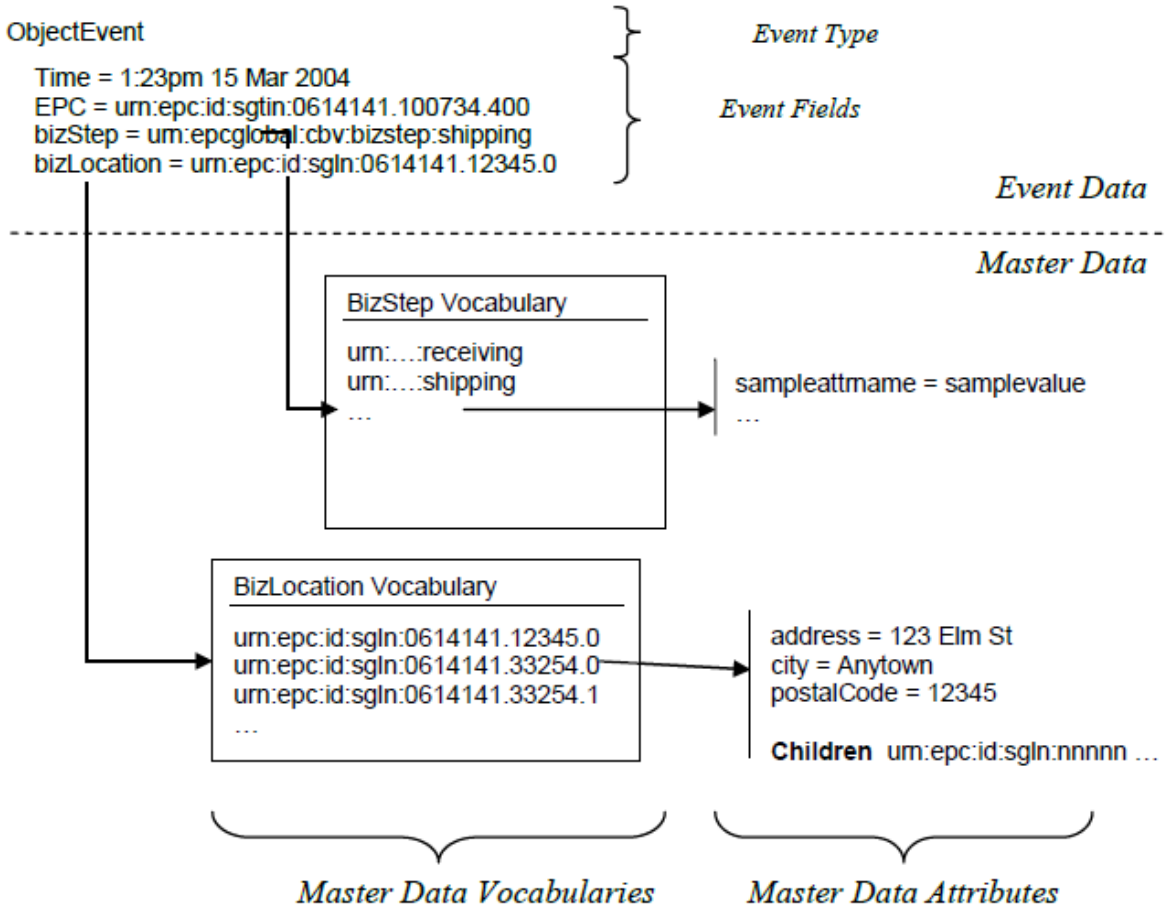

Figure B.2 — EPCIS Event and Master Data Example

B.3 EPCIS Data Exchange Components

EPC Event Data consists of the following which is the basis for standardized Data Exchange

— EPC

— Time

— Read Points

— Business Locations

— Business Steps

— Disposition

— Business Transaction Type

B.4 Services Approach

The goal of EPCIS is to enable disparate applications to leverage Electronic Product Code (EPC) data via EPC-related data sharing, both within and across enterprises. Ultimately, this sharing is aimed at

enabling participants in the EPCglobal Network to gain a shared view of the disposition of EPC-bearing objects within a relevant business context.

In particular, this specification of the EPCIS is designed to meet the requirements of a basic set of use cases that the user community has identified as a minimal useful set. Other use cases and capabilities are expected to be addressed through follow-on versions of this specification, and companion specifications.

The EPC Information Service approach will define a standard interface to enable EPC-related data to be captured and queried using a defined set of service operations and associated EPC-related data standards, all combined with appropriate security mechanisms that satisfy the needs of user companies. In many or most cases, this will involve the use of one or more persistent databases of EPC-related data, though elements of the Services approach could be used for direct application-to application sharing without persistent databases.

The interfaces are needed for interoperability, while the implementations allow for competition among those providing the technology and EPC Information Service.

— To define a standard interface – to enable EPC related data

— Data capture and queried – using a different set of service operations

— Associated EPC-related data standards,

— Combined with appropriate security mechanisms,

— Using one or more persistent databases

B.5 Relationship to the EPC global Architecture Framework

EPCIS sits at the highest level of the EPCglobal Architecture Framework, both above the level of raw EPC observations (e.g., the Tag Protocol and the Reader "Wireline" Protocol), as well as above the level of filtered, consolidated observations (e.g., the Filtering & Collection Interface).

Two components of the EPCglobal Architecture Framework: interface of EPCglobal standards and hardware and/or software components of the system.

(A single physical software or hardware component may play more than one role. For example, a "smart reader" may perform middleware functions and expose the ALE interface as its external interface. In that case, the "reader" (the metal box with the antenna) is playing both the Reader and Middleware role in the diagram, and the Reader Protocol Interface is internal to the smart reader (if it exists at all). Likewise, it is common to have enterprise applications such as Warehouse Management Systems that simultaneously play the role of EPCIS Capturing Application (e.g. detecting EPCs during product movement during truck loading), an EPCIS-enabled Repository (e.g. recording case-to-pallet associations), and an EPCIS Accessing Application (e.g. carrying out business decisions based on EPCIS-level data).)

EPCIS is an integral part of the EPCglobal Network, it differs from elements at the lower layers of the Architecture in three key respects:

a) EPCIS deals explicitly with historical data/current data.

b) EPCIS often deals not just with raw EPC observations, but also in contexts that imbue those observations with meaning relative to the physical world and to specific steps in operational or analytical business processes.

c) EPCIS operates within enterprise IT environments at a level that is much more diverse and multifaceted than the lower levels of the EPCglobal Network Architecture.

B.6 Elements of the EPCglobal Architecture Framework

Filtering & Collection: This role filters and collects raw tag reads, over time intervals delimited by events defined by the EPCIS Capturing Application.

Filtering & Collection (ALE) Interface: Defines the control and delivery of filtered and collected tag read data from the Filtering & Collection role to the EPCIS Capturing Application role.

EPCIS Capturing Application: Supervises the operation of the lower-level architectural elements, and provides business context by coordinating with other sources of information involved in executing a particular step of a business process.

EPCIS Interfaces: The interfaces through which EPCIS data is delivered to enterprise-level roles, including EPCIS Repositories, EPCIS Accessing Applications, and data exchange with partners.

There are actually three EPCIS Interfaces:

— The EPCIS Capture Interface defines the delivery of EPCIS events from EPCIS Capturing Applications to other roles that consume the data in real time, including EPCIS Repositories, and real-time "push" to EPCIS Accessing Applications and trading partners.

— The EPCIS Query Control Interface defines a means for EPCIS Accessing Applications and trading partners to obtain EPCIS data subsequent to capture, typically by interacting with an EPCIS Repository. The EPCIS Query Control Interface provides two modes of interaction. In "on-demand" or "synchronous" mode, a client makes a request through the EPCIS Query Control Interface and receives a response immediately.

— The EPCIS Query Callback Interface may be used to deliver information immediately upon capture; this corresponds to the "optional bypass for real-time push" arrow in the diagram.

EPCIS Accessing Application: Responsible for carrying out overall enterprise business processes, such as warehouse management, shipping and receiving, historical throughput analysis, and so forth, aided by EPC-related data.

EPCIS-enabled Repository: Records EPCIS-level events generated by one or more EPCIS Capturing Applications, and make them available for later query by EPCIS Accessing Applications.

ONS: is a network service that is used to look up pointers to EPCIS Repositories, starting from an EPC Manager Number or full Electronic Product Code. Specifically, ONS provides a means to look up a pointer to the EPCIS service provided by the organization who commissioned the EPC of the object in question.

Discovery Capability: Refers to a mechanism, (not yet defined at the time of this writing), for locating all EPCIS-3enabled Repositories that might have data about a particular EPC.

This is useful when the relevant EPCIS services might not otherwise be known to the party who wishes to query them, such as when the handling history of an object is desired but not known (e.g. in support of track-and-trace across a multi-party supply chain).

The interfaces within this stack are designed to insulate the higher levels of the stack from unnecessary details of how the lower levels are implemented. One way to understand this is to consider what happens if certain changes are made:

The Filtering & Collection Interface insulates the higher layers from the physical design choices made regarding how tags are sensed and accumulated, and how the time boundaries of events are triggered.

EPCIS insulates enterprise applications from understanding the details of how individual steps in a business process are carried out at a detailed level.

In summary, EPCIS-level data differs from lower layers in the EPC global Network Architecture by incorporating semantic information about the business process in which EPC data is collected, and providing historical observations. In doing so, EPCIS insulates applications that consume this

information from knowing the low-level details of exactly how a given business process step is carried out.

B.7 EPCIS Specification Principles

The framework of EPCIS Specification principles are designed to be:

— Layered: In particular, the structure and meaning of data in an abstract sense is specified separately from the concrete details of data access services and bindings to particular interface protocols.

— Extensible: The core specifications provide a core set of data types and operations, but also provide several means whereby the core set may be extended for purposes specific to a given industry or application area. Extensions not only provide for proprietary requirements to be addressed in a way that leverages as much of the standard framework as possible, but also provides a natural path for the standards to evolve and grow over time.

— Modular: The layering and extensibility mechanisms allow different parts of the complete EPCIS framework to be specified by different documents, while promoting coherence across the entire framework.

B.8 EPCIS Specification Framework

The EPCIS specification is designed to be layered, extensible, and modular.

B.9 Layers

The EPCIS specification framework is organized into several layers. These layers are described below in Figure B.3.

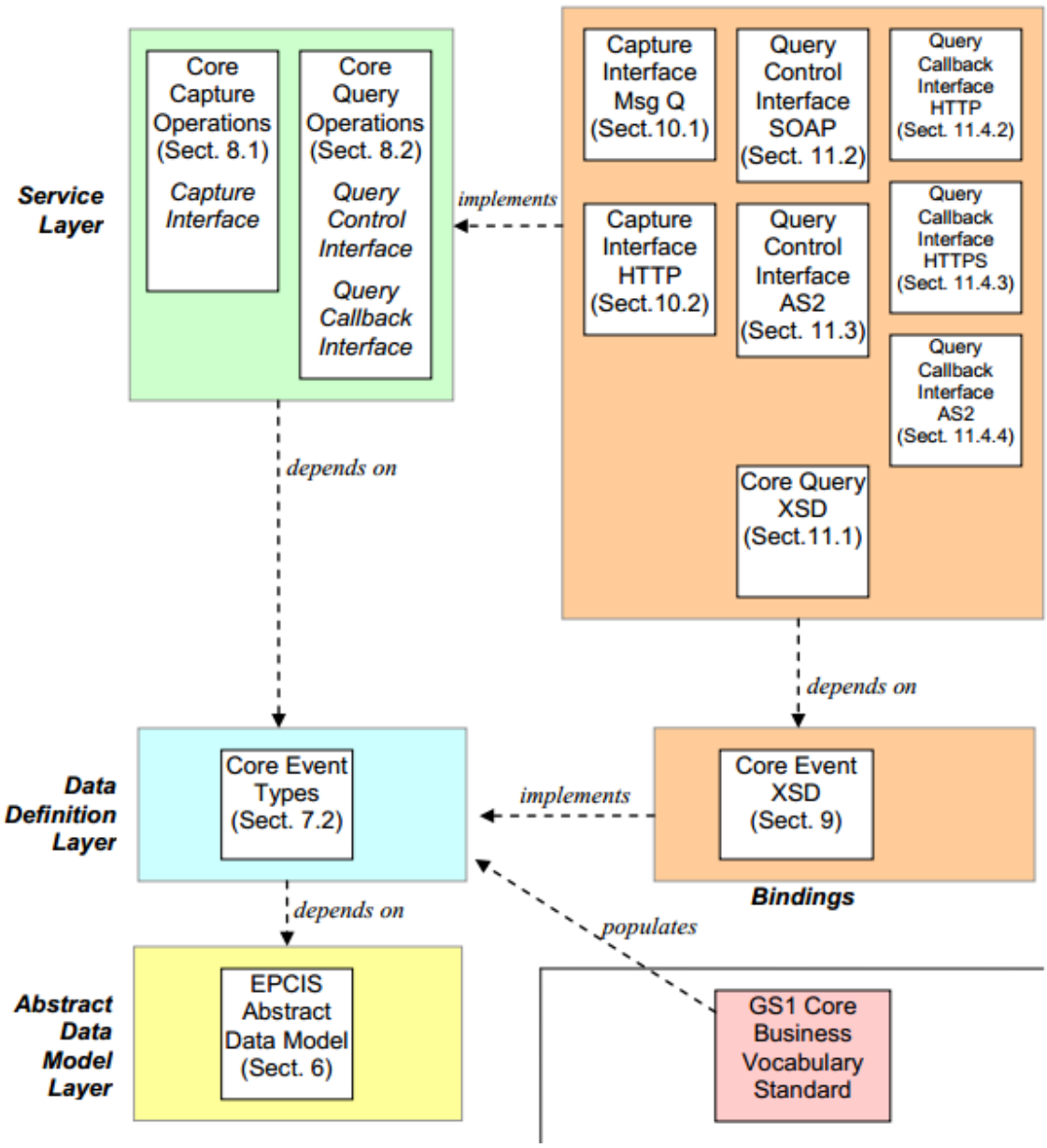

Figure B.3 — EPCIS Layers

— Abstract Data Model Layer - specifies the generic structure of EPCIS data. This is the only layer that is not extensible by mechanisms other than a revision to the EPCIS specification itself. The Abstract Data Model Layer specifies the general requirements for creating data definitions within the Data Definition Layer.

— Data Definition Layer - specifies what data is exchanged through EPCIS, what its abstract structure is, and what it means. One data definition module is defined within the present specification, called the Core Event Types Module. Data definitions in the Data Definition Layer are specified abstractly, following rules defined by the Abstract Data Model Layer.

— Bindings - Bindings specify concrete realizations of the Data Definition Layer and the Service Layer. There may be many bindings defined for any given Data Definition or Service module.

— Service Layer - defines service interfaces through which EPCIS clients interact. In the present specification, two service layer modules are defined.

- The Core Capture Operations Module defines a service interface (the EPCIS Capture Interface) through which EPCIS Capturing Applications use to deliver Core Event Types to interested parties.
- The Core Capture Operations Module provides operations by which core events may be delivered from an EPCIS Capture Application.
- The capture interface contains only a single method, capture, which takes a single argument and returns no results.
- Because the argument is a list, you can capture one or more EPCIS Events at a time.
- The capture interface is exposed as JMS, HTTP, and SOAP.

— The Core Query Operations Module defines two service interfaces (the EPCIS Query Control Interface and the EPCIS Query Callback Interface) that EPCIS Accessing Applications use to obtain data previously captured. Interface definitions in the Service Layer are specified abstractly using UML.

- The query interface supports querying the EPCIS event repository by constructing a query and a set of associated query parameters. Query parameters include:
  - time constraints,
  - event types,
  - event fields,
  - action,
  - disposition,
  - master data name/value attributes.
- Both synchronous and asynchronous queries are supported through polling and subscription mechanisms. The query interface is exposed as a SOAP Service defined by a WSDL and set of XSD files.
- EPCIS Query Control Interface,
  - defines a means for EPCIS Accessing Applications and trading partners to obtain EPCIS data subsequent to capture from any source, typically by interacting with an EPCIS Repository. It provides a means for an EPCIS Accessing Application to retrieve data on-demand, and also enter subscriptions for standing queries.
  - the interface provides both on-demand queries, in which an explicit request from a client causes a query to be executed and results returned in response, and standing queries, in which a client registers ongoing interest in a query and thereafter receives periodic delivery of results via the EPCIS Query Callback Interface without making further requests. These two modes are informally referred to as “pull” and “push,” respectively.
- EPCIS Query Callback Interface,
  - results of standing queries are delivered to EPCIS Accessing Applications via the EPCIS Query Callback Interface.

— it is the path by which an EPCIS service delivers standing query results to a client.

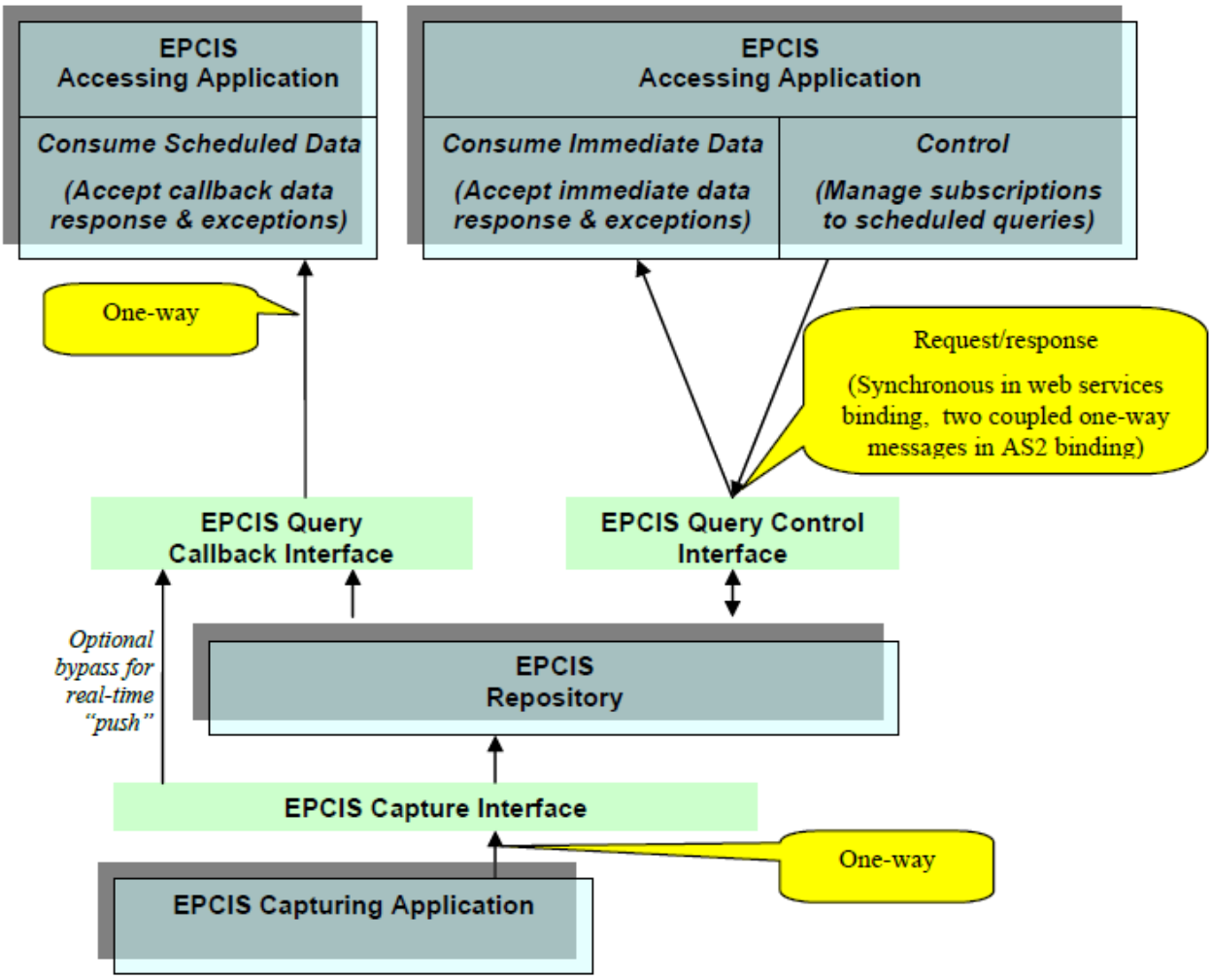

Figure B.4 — EPCIS Interfaces

B.10 Extensibility

The layered technique for specification promotes extensibility, as one layer may be reused by more than one implementation in another layer. Besides the extensibility inherent in layering, the EPCIS specification includes several specific mechanisms for extensibility:

— Sub classing data definitions in the Data Definition Layer are defined using UML, which allows a new data definition to be created by creating a subclass of an existing one.

— Extension Points data definitions and service specifications also include extension points, which vendors may use to provide extended functionality without creating subclasses.

B.11 Modularity

The EPCIS specification framework is designed to be modular. That is a collection of individual specifications that are interrelated. The layered structure and the extension mechanisms provide the essential ingredients to achieving modularity, as does the grouping into modules. While EPCIS specifications are modular, there is no requirement that the module boundaries of the specifications be visible or explicit within implementations of EPCIS.

Annex C
(normative)

EPCIS Data Model assessment with respect to a standardised MIS interface

C.1 General

EPCIS deals in two kinds of data: event data and master data. Event data arises in the course of carrying out business processes, and is captured through the EPCIS Capture Interface and made available for query through the EPCIS Query Interfaces. Master data is additional data that provides the necessary context for interpreting the event data. It is available for query through the EPCIS Query Control Interface, but the means by which master data enters the system is not specified in the EPCIS 1.1 specification.

The Abstract Data Model Layer does not attempt to define the meaning of the terms “event data” or “master data,” other than to provide precise definitions of the structure of the data as used by the EPCIS specification. The modelling of real-world business information as event data and master data is the responsibility of the Data Definition Layer, and of industry and end-user agreements that build on top of this specification.

C.2 Vocabularies

- For a standard which ensures interoperability the ‘Vocabularies (CBV)’ seems to be too generic.
    - Standard vocabulary
    - User vocabulary
- ‘Events’ are the fixed points
- ‘Master data’ associated with standard vocabulary elements are defined by organisations

C.3 Locations

- A key concept, required to interpret MIS data is the location from where an Event originated
- Location needs to uniquely identify the origin of an Event
    - ‘loc_id’ needs to be linked with a meaning of the code as a ‘master data’
- If a piece of equipment is moved to another location needs to be reflected as a ‘master data’
- ‘Nesting of locations’ – a hierarchical relationship is required that may cause difficulties
    - EPCIS standard defines four types that all relate to the notion of location information:
        - Primitive Reader Types – not location types for EPCIS
            - PhysicalReaderID
            - LogicalReaderID
        - True Location Types

    - ReadPointID
    - BusinessLocationID
  - Example: Read Points may correspond to the doorways (with RFID instrumentation) and Business Locations may correspond to the rooms.

C.4 Extension points

We need to distinguish between mandatory and optional fields

C.5 Prospective assertions

Each event (an instance of an Event Type) encodes several assertions which collectively define the semantics of the event.

- Retrospective semantics of these assertions say what was true at the time the event was captured.
  - Red Point related
- Prospective semantics say what is expected to be true following the event, until invalidated by a subsequent event.
  - Business Location related

Assertions are a matter of interpreting event data and not a matter of the event data as such. Hence this is related to the MIS itself and not to the MIS-Interface.

C.6 Event Types

Each Event has fields which answer the questions “what, when, where and why”.

EPICS defines four Event types:

- Object Event
- Quantity Event
- Transaction Event
- Aggregation Event
  - it allows expressing the addition of items to or their removal from an aggregation. We may want to use it for trays in a roll container or roll containers in a truck.
  - both the item and the container should be scanned
    - a “packing” process would then see an Event describing the arrival of the container followed by a set of AggregationEvents describing the addition of items to the container.

C.7 Capture application

Key question: where raw events are interpreted and converted into something meaningful.

- for example an Event which says that mail item M_i was sorted to Stacker S_i. This information alone is of little use, because we would not know where this Stacker S_i is located. Even if S_i is really as

verbose as FSM01.S_i, i.e. we know the name of the Sorting machine, we still wouldn't know (from the Event alone) where this Sorting Machine FSM01 is located.

We want the MIS interface to be easy to implement.

— This suggests, that the sending side should be dumb fields like Business Step, BusinessTransaction and the like may be unattractive, interpreting events onto the shoulders of the MIS application and requires maintaining metadata elsewhere.

There are some supplementary documents that address the status and statistics issues.

Annex D
(informative)

Object Data Model definition in the postal process (Items and Aggregations)

Table D.1 — Object Data Model definition in the postal process

Event #	Postal Supply Chain Proces Step	Business Step	Comment	BusLocation	Object Type	Observed Object ID		Object Model Data
1	Collected Mail Posting	Arriving		BORGARELLO_01	Priority Letter	BORG123		<EPCObject> <ObjectId>**BORG123**</ObjectId> <PostalProduct>Posta Prioritaria</PostalProduct> <PostalService>Poste Italiane</PostalService> <StampValue>0,60</StampValue> <Currency>Euro</Currency> <Weight>17,0</Weight> <Address> <Recipient>Elena Rossi</Recipient> <StreetAddress>Via Darsena 33</StreetAddress> <ZIP>44122</ZIP> <Town>Ferrara</Town> <Province>FE</Province> </Address> <PostDate>2015/01/12 11:07 UTC</PostDate> <BusLocation>BORGARELLO_01</BusLocation> </EPCObject>

7	Aggregate Assignment	Packing	Assembling letters for province post office to be delivered to inbound posting centre	BORGARELLO_01	Carton	PV.PROV.IN.234		<EPCObject> <ObjectId>PV.PROV.IN.234</ObjectId> <ObjectType>Carton</ObjectType> <ObjectContained> ... <ObjectId>BORG122</ObjectId> <ObjectId>BORG123</ObjectId> <ObjectId>BORG124</ObjectId> ... </ObjectContained> <TimeStamp>2015/01/12 12:15 UTC</TimeStamp> <BusLocation>BORGARELLO_01</BusLocation> <Destineo> <BusLocation>PV_01</BusLocation> <Product>Incoming Priority Letter (To Sort)</Product> </Destineo> <DeliveryAddressLocation> <BusLocation>PV_01</BusLocation> <Address>Via Brambilla Alessandro - 27100 Pavia (PV) </Address> </DeliveryAddressLocation> </EPCObject>
			...aggregation into a truck...					
			...transport to PV_01...					
7	Aggregate Assignment	Packing	Assembling inbound email, cartons, into aggregated items to	PV_01	Pallet	PV.IN.16732		<EPCObject> <ObjectId>PV.IN.16732</ObjectId> <ObjectType>Pallet</ObjectType>

			be sent to local CMP for inbound sorting					<ObjectContained> ... <ObjectId>PV.PROV.IN.232</ObjectId> <ObjectId>PV.PROV.IN.234</ObjectId> ... <ObjectId>PV.CITTA.IN.321</ObjectId> <ObjectId>PV.CITTA.IN.321</ObjectId> ... </ObjectContained> <TimeStamp>2015/01/12 16:21 UTC</TimeStamp> <BusLocation>PV_01</BusLocation> <Destineo> <BusLocation>MI_CMP</BusLocation> <Product>Incoming Priority Letter (To Sort)</Product> </Destineo> <DeliveryAddressLocation> <BusLocation>MI_CMP</BusLocation> <Address>Via Cristina Belgioioso, 165, 20157 Milano</Address> </DeliveryAddressLocation> </EPCObject>
			...aggregation into a truck...					

			…transport to MI_CMP…					
16	Unloading (decontainerisation)	Other / unloading	Unpack pallets to submit letter to inbound sorting	MI_CMP				
25	Sortation	Sorting	Sorting inbound mail.	MI_CMP				
26	Merging	Assembling	Per effect of mail sorting, packets are going to be accumulated to output sorter trays according to destination CMP, in function of the sorting algorithms and the final destination address of items. A number of different aggregation objects are generated here, accoording to aggregated destination. Our item of interest is collected in an aggregation labeled "FERRARA CITTA", with destination Bologna CMP for the outbound sorting	MI_CMP	Carton	… TO.FICMP.c121 TO.FICMP.c122 TO.FICMP.c123 … TO.BOCMP.c333 **TO.BOCMP.c334** TO.BOCMP.c335 … TO.GECMP.c333 TO.GECMP.c334 TO.GECMP.c335		<EPCObject> <ObjectId>TO.BOCMP.c334</ObjectId> <ObjectType>Carton</ObjectType> <ObjectContained> … <ObjectId>XXX456</ObjectId> <ObjectId>BORG123</ObjectId> <ObjectId>YYY678</ObjectId> … </ObjectContained> <TimeStamp>2015/01/13 06:03 UTC</TimeStamp> <BusLocation>MI_CMP</BusLocation> <Destineo> <BusLocation>BO_CMP</BusLocation> <Product>FERRARA CITTA</Product> </Destineo> <DeliveryAddressLocation> <BusLocation>BO_CMP</BusLocation> <Address>Via Francesco Zanardi, 3040131 BOLOGNA (BO)</Address>

								</DeliveryAddressLocation> </EPCObject>
7	Aggregate Assignment	Packing	Packet/Cartons with same destination (CMP_BO, in our case) in bigger object, according volumes reached with items processed. IN a second level aggregation Product name will change not related to final postal delivery but to intermediate delivery	MI_CMP	Pallet	TO_BOCMP_p123		<EPCObject> <ObjectId>TO.BOCMP.p123</ObjectId> <ObjectType>Pallet</ObjectType> <ObjectContained> ... <ObjectId>TO.BOCMP.c333</ObjectId> <ObjectId>TO.BOCMP.c334</ObjectId> <ObjectId>TO.BOCMP.c335</ObjectId> ... </ObjectContained> <TimeStamp>2015/01/13 06:03 UTC</TimeStamp>

								<BusLocation>MI_CMP</BusLocation> <Destineo> <BusLocation>BO_CMP</BusLocation> <Product>EMILIA ROMAGNA REGION</Product> </Destineo> <DeliveryAddressLocation> <BusLocation>BO_CMP</BusLocation> <Address>Via Brambilla Alessandro - 27100 Pavia (PV) </Address> </DeliveryAddressLocation> </EPCObject>
			Re-routing event: for some reasing Bologna CMP is not operational this working day. "Emilia Romagna Region" mail is diverted to Sorting Centre of Verona					

12	Transport Assignement	Shipping	DeliveryAddressLocation for some of the objects is assigned to verona CMP	MI_CMP				<EPCObject> <ObjectId>TO.BOCMP.p123</ObjectId> <ObjectType>Pallet</ObjectType> <ObjectContained> … <ObjectId>TO.BOCMP.c333</ObjectId> <ObjectId>TO.BOCMP.c334</ObjectId> <ObjectId>TO.BOCMP.c335</ObjectId> … </ObjectContained> <TimeStamp>2015/01/13 06:03 UTC</TimeStamp> <BusLocation>MI_CMP</BusLocation> <Destineo> <BusLocation>BO_CMP</BusLocation> <Product>EMILIA ROMAGNA REGION</Product> </Destineo> <DeliveryAddressLocation> <BusLocation>VR_CMP</BusLocation> <Address>Piazzale XXV Aprile, Verona</Address> </DeliveryAddressLocation> </EPCObject>

			…aggregation into a truck…					
			…transport to VR_CMP…					
15	Transport Arrival	Shipping	Arrival event of email. Alternative diverted address is detectable by the difference between "Destineo" and "DeliveryAddressLocation"	VR_CMP				
16	Unloading (decontainerisation)	Other / unloading	Mail is unpacked for either an outbound sort or a transport assignment, according to level of aggregation of mail at this stage. Step to be processed is in function of "Product" attribute of the processed object, at any aggregation level it is…. IN the case of object "TO.BOCMP.c334" destination is already deterrmined ("FERRARA CITTA") so sorting is not required: a shipping event follows	VR_CMP				

17	Aggregate Assignment	Packing	Packet/Cartons destinated to the same intermediate destination, "FERRARA CITTA" in this case are aggregated into a proper aggregation object (carton / pallet, according to item volumes)	VR_CMP	Carton (for example)	FE.CITTA.c432		<EPCObject> <ObjectId>FE.CITTA.c432</ObjectId> <ObjectType>Carton</ObjectType> <ObjectContained> ... <ObjectId>XXX982</ObjectId> <ObjectId>BORG123</ObjectId> <ObjectId>YYY654</ObjectId> ... </ObjectContained> <TimeStamp>2015/01/13 13:12 UTC</TimeStamp> <BusLocation>VR_CMP</BusLocation> <Destineo> <BusLocation>FE_01</BusLocation> <Product>FERRARA CITTA</Product> </Destineo> <DeliveryAddressLocation> <BusLocation>FE_01</BusLocation> <Address>Viale Cavour, 27 - 44121 FERRARA (FE)</Address> </DeliveryAddressLocation> </EPCObject>
			...aggregation into a truck...					
			...transport to FE_01...					
15	Transport Arrival	Shipping	Object FE.CITTA.c432 arrives in Ferrara					

			Centra Post Office					
25	Sortation	Sorting	Letters are sorted per single postal office o per single postman bag. No intermediate destination is required. Objects have to be delivered tithe final postal address.	FE_01	packet (postman bag)	FE.bg354		<EPCObject> <ObjectId>FE.bg354</ObjectId> <ObjectType>Packet</ObjectType> <ObjectContained> ... <ObjectId>XXX982</ObjectId> <ObjectId>BORG123</ObjectId> <ObjectId>YYY654</ObjectId> ... </ObjectContained> <TimeStamp>2015/01/13 13:12 UTC</TimeStamp> <BusLocation>FE_01</BusLocation> </EPCObject>
			from the postman, mail is actually delivered		letter			final destination address

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