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Intelligent transport systems — Data interfaces between centres for transport information and control systems — Platform independent model specifications for data exchange protocols for transport information and control systems

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

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English Version

Intelligent transport systems - Data interfaces between centres for transport information and control systems - Platform independent model specifications for data exchange protocols for transport information and control systems (ISO/TS 19468:2019)

Systèmes de transport intelligents - Interface de données entre centres pour les systèmes de commande et d'information des transports - Spécification du modèle indépendant de plateforme pour les protocoles d'échange de données pour les systèmes de commande et d'information des transports (ISO/TS 19468:2019)

Intelligente Verkehssysteme - Datenschnittstelle zwischen Transportinformationszentren und Steuerungssystemen - Plattformunabhängige Modellspezifikation für Datenaustauschprotokolle für Transportinformationen und Steuerungssysteme (ISO/TS 19468:2019)

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European foreword

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 278, *Intelligent transport systems (ITS)*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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Introduction

This document defines a common set of data exchange specifications to support the vision of a seamless interoperable exchange of traffic and travel information across boundaries, including national, urban, interurban, road administrations, infrastructure providers and service providers. Standardisation in this context is a vital constituent to ensure interoperability, reduction of risk, reduction of the cost base, promotion of open marketplaces and many social, economic and community benefits to be gained from more informed travellers, network managers and transport operators.

Especially in Europe, delivering transport policy in line with the White Paper issued by the European Commission requires co-ordination of traffic management and development of seamless pan European services. With the aim to support sustainable mobility in Europe, the European Commission has been supporting the development of information exchange mainly between the actors of the road traffic management domain for a number of years.

This document supports a methodology that is extensible.

To be able to successfully connect systems and start exchanging data, in an interoperable and easy way, there is a need to describe and agree on how the exchange should be done. This is set out in a data exchange specification. Data exchange in different scenarios can have different needs and requirements. Therefore, several data exchange specifications can be needed.

Data exchange specifications need to address two main issues. First, they model the stakeholders and actors involved in data exchange, each potentially in different roles, as well as abstract exchange patterns for their interactions. Second, they select a suitable implementation platform and clearly specify how the abstract scenarios and patterns are effectively implemented on this platform.

The following diagram in Figure 1 shows such an abstract communication scenario from the perspective of a road operator who requires data exchange interfaces between the different components of its own operational systems, either between centre side components or between centre and field devices, but also to exchange information with other road operators or service providers.

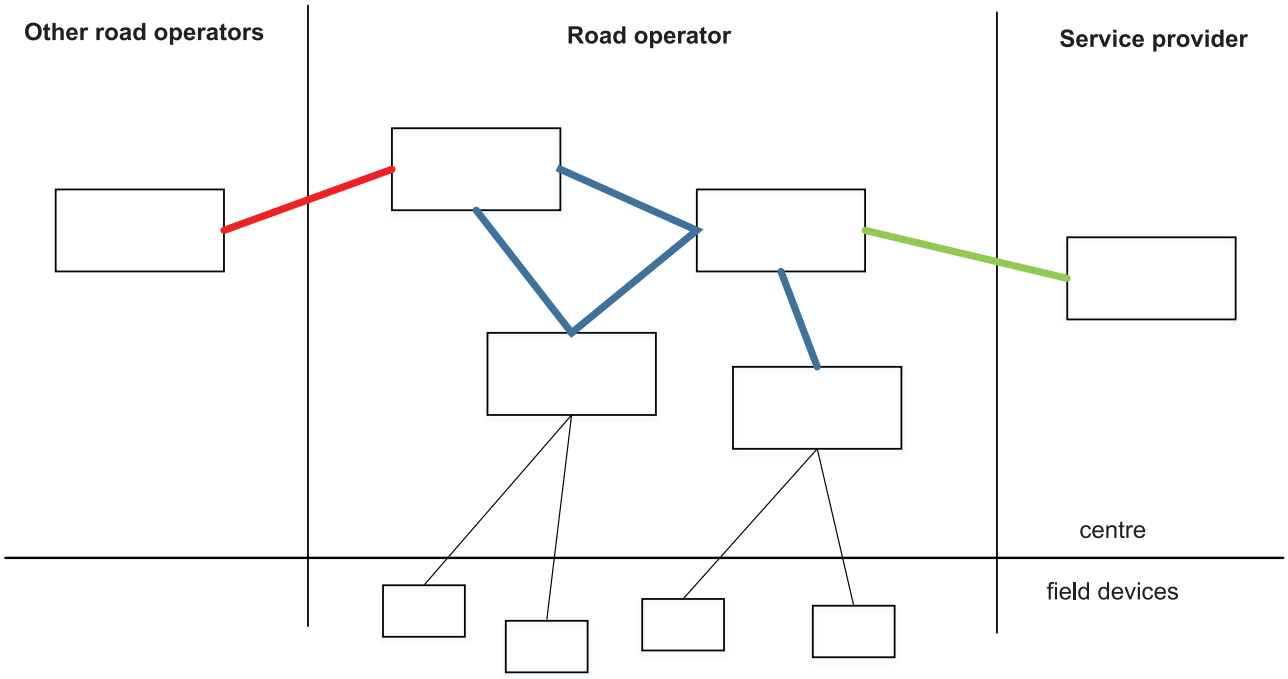

Figure 1 — Abstract communication scenario

While the black links between centre side components and field devices may use a variety of communication protocols, mostly depending on the physical link conditions, the vast majority

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of other coloured links between centre-side components, internal to one organisation or external to others, is based on an IP network and mostly use the TCP transport layer protocol (UDP is also possible in a few cases).

Nevertheless, as the different colours indicate, they can very well have significantly different requirements. Internal links (blue) can reside in one domain of trust, hence do not require protocols compatible with security gateways. This can already be different for links to other road operators (red) and will certainly not hold for links to other types of organisations, like service providers, via the Internet (green).

While different security requirements offer the most striking and obvious example, there are more criteria that can lead to different preferences on different types of links, e.g. scalability, robustness, integration complexity.

In broad terms, the colours blue – red – green form a hierarchy from more internal, closely-coupled, well-integrated systems towards external, loosely-coupled, and non-integrated systems. The world of *information and communication technology* (ICT) offers a broad range of solutions for these different scenarios, offering different advantages and disadvantages. It is obvious that the *one-size-fits-all* principle will not provide the most efficient way of working here. Even on the highest level of abstraction and inside the ICT domain itself, we already find a well-known battle of paradigms between *remote-procedure-call* (RPC) type service specifications and *RESTful* architectures. The same clusters of options are found in the domain of ITS standards, where for example the European standard for the real-time information interface relating to public transport operations (SIRI – EN 15531 series) introduces both concepts as complementary options: *Publish-Subscribe* and *Request-Response*.

As well, the ITS station architecture is not in contradiction with this document but is complementary of what is defined in this document. According to the principles and the taxonomy defined in ISO 21217, this document defines a conceptual notion of:

— How 2 *central ITS (sub) stations* could communicate to:

  — deliver (*application data units*) information,

  — negotiate functional service behaviour for collaborating traffic management functions (even if this use case could not directly be matched to ISO 21217 as it is not about information delivery).

— How a *Central ITS (sub) station* could communicate to deliver information (*application data units*) to another *ITS station* with the characteristics of a central ITS station.

This document specifies the process of defining the exchange characteristics by use case-driven feature selection of relevant parameters for the relevant OSI layers as defined in ISO 21217. Two exchange schemas are considered: *Information delivery* and *Functional service negotiation* between central ITS stations.

The drafting of this document was guided by the following principles:

— Interoperability, such that different implementations can successfully engage in a data exchange process;

— Support legacy implementations which are based on existing (exchange) specification, in order to maximize investments already made by stakeholders;

— Address other user profiles, not only road operators, and thus make this document available to a broader audience;

— Reuse of existing (communications) standards, in order to reduce implementation complexity and take benefit of proven and already existent solutions for common ICT problems;

— Clear separation between the payload content and the exchange model.

The informative Annex A details the adopted methodology for defining this exchange Platform Independent Model.

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Intelligent transport systems — Data interfaces between centres for transport information and control systems — Platform independent model specifications for data exchange protocols for transport information and control systems

1 Scope

This document defines and specifies component facets supporting the exchange and shared use of data and information in the field of traffic and travel.

The component facets include the framework and context for exchanges, the data content, structure and relationships necessary and the communications specification, in such a way that they are independent from any defined technical platform.

This document establishes specifications for data exchange between any two instances of the following actors:

— Traffic Information Centres (TIC);

— Traffic Control Centres/Traffic Management Centres (TCC/TMC);

— Service Providers (SP).

This document can be applied for use by other actors, e.g. car park operators.

This document includes the following types of information:

— the use cases and associated requirements, and features relative to different exchange situations;

— the different functional exchange profiles;

— the abstract elements for protocols;

— the data model for exchange (informational structures, relationships, roles, attributes and associated data types required).

In order to set up a new technical exchange framework, it is necessary to associate one functional exchange profile with a technical platform providing an interoperability domain where plug-and-play interoperability at technical level can be expected. The definition of such interoperability domains is not part of this document but can be found in other standards or technical specifications, e.g. ISO 14827-3. This document is restricted to data exchange. Definition of payload content models is beyond the scope of this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
business scenario
high level description of the interactions that can exist within a system being analysed or between the system and external entities (called actors) in terms of business functions

Note 1 to entry: See also *use case* (3.20).

3.2
client
entity that receives the information

Note 1 to entry: It is represented in the information delivery *business scenario* (3.1).

3.3
Functional Exchange Profile
FEP
selection of data exchange features for a particular *business scenario* (3.1)

3.4
HTTP server
software application that provides content to client applications by using the HTTP protocol

3.5
interoperability domain
pair of *Functional Exchange Profile (FEP)* (3.3) and platform selected for implementing a data exchange subsystem

Note 1 to entry: Each Platform Specific Model (PSM) document defines an interoperability domain, which ensures that two implementations of this PSM are interoperable and can successfully exchange payload.

3.6
payload content model
content model
UML definition of the data structures that can be used to describe travel and traffic information to be exchanged in an exchange system

3.7
payload publication
payload
bundle of information that is exchanged between two exchange systems containing an instance of the *content model* (3.6)

3.8
Platform Independent Model
PIM
document describing the abstract model of the standardised data exchange process in a platform-independent way

Note 1 to entry: This definition is specific to this document.

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3.9
Platform Specific Model
PSM
document providing the implementation details of a *Functional Exchange Profile (FEP)* (3.3) described in a *Platform Independent Model (PIM)* (3.8) for a concrete platform

Note 1 to entry: This definition is specific to this document.

3.10
profile-to-platform mapping
act of defining an *interoperability domain* (3.5)

3.11
pub/sub
publish-subscribe pattern

3.12
pull exchange
exchange pattern where the exchange of information is originated by the client

3.13
push exchange
exchange pattern where the exchange of information is originated by the *supplier* (3.19)

3.14
simple push
push-based exchange pattern where that does not require state to be maintained

3.15
snapshot
set of data providing all of the last known state as opposed to providing partial changes

Note 1 to entry: This definition is specific to this document.

3.16
snapshot pull
pull-based exchange pattern where only the last snapshot version is exchanged

3.17
snapshot push
push-based exchange pattern where only the last snapshot version is exchanged

3.18
stateful push
push-based exchange pattern where data describing a communication session is maintained across successive communication within that session

3.19
supplier
entity that provides the information

Note 1 to entry: It is represented in the information delivery *business scenario* (3.1).

3.20
use case
UC
set of operational interactions between entities (called actors) and a system to ease understanding the main functions behind such interactions

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4 Symbols and abbreviated terms

ASN.1	Abstract Syntax Notation One
BUC	Business use case
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technology
IP	Internet Protocol
ITS	Intelligent Transport Systems
MDA	Model Driven Architecture
REST	Representational State Transfer
RPC	Remote Procedure Call
SOAP	Simple Object Access Protocol
TCP	Transmission Control Protocol
TMP	Traffic Management Plan
UDDI	Universal Description Discovery and Integration
UDP	User Datagram Protocol
UML	Unified Modeling Language NOTE Specified in ISO/IEC 19505.
VMS	Variable Message Sign
W3C	World Wide Web Consortium
WSDL	Web Service Definition Language
WSIL	Web Services Inspection Language
WSS	Web Services Security
XML	eXtensible Markup Language

5 Exchange modelling framework

5.1 Overview

The model driven approach is chosen to describe exchange: this leads to describe exchange systems by means of abstract models which are named Platform Independent Model (PIM), in which modelling of exchange features is done by describing interaction among systems and subsystems as exchange patterns. These interactions implement system capabilities as features which fulfil exchange requirements requested by specific business scenarios which are used to specify specific uses of exchange.

Since simple data exchange process is no longer sufficient for resolving all business needs, this document encompasses more business functions as stakeholders consolidate their systems and look at new ways to address the requests they encounter with the tools they already know and have in place.

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5.2 Business scenarios and Functional Exchange Profile (FEP)

This document is based on business scenarios, i.e. a high-level description of the interactions that can exist within a system being analysed or between the system and external entities (called actors) in terms of business functions. It is derived from requirements a business scenario has on information as well as technical parameters. FEPs are identified to ensure interoperable services with the restriction of determining one FEP per business scenario for a specific technical platform. One FEP can support more than one business scenario (see Figure 2).

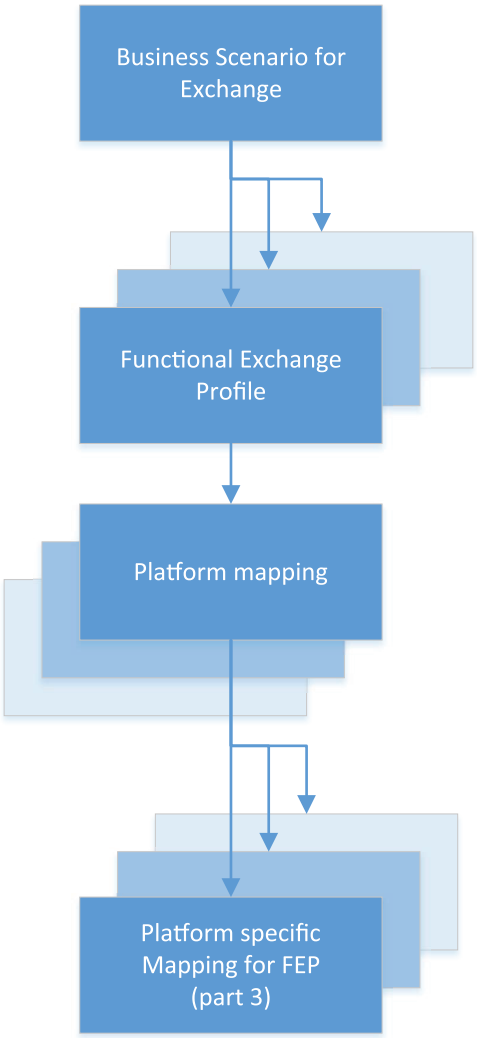

Figure 2 — Business scenario and Functional Exchange Profile (FEP)

This version of the document addresses the following business scenarios:

— Information delivery,

— Collaborative ITS services (partly).

Other business scenarios can be developed in future versions using the same methodology.

5.3 Requirements, feature and exchange patterns

Requirements can vary depending on data exchange applications, i.e. use cases to be fulfilled, so there are many reasons to consider or not any requirement based both on the gathering of data at supplier system and the usage of the delivered data in the client.

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Requirements address the following items:

— Information provision,

— Communications,

— Security,

— Financial aspects.

Exchange is defined through **features** which implement the information exchange and fulfils data exchange requirements.

Depending on many possible exchange platforms considered for implementation, a subset of features and relative requirements is possible to be implemented. To fulfil a set of requirements many platforms are possible, but to be interoperable a client and a supplier shall implement the same platform with the same pattern. Allowing a wide variety of possible **exchange patterns**, the best suitable for an application is chosen, according to requirements the fulfilment of which is granted by the selected exchange pattern.

Based on the requirements of a specific business scenario, a set of appropriate exchange features shall be combined into a Functional Exchange Profile (FEP).

The following schema in Figure 3 represent the domains of PIM and PSM introducing exchange pattern (EP) and Functional Exchange Profile (FEP).

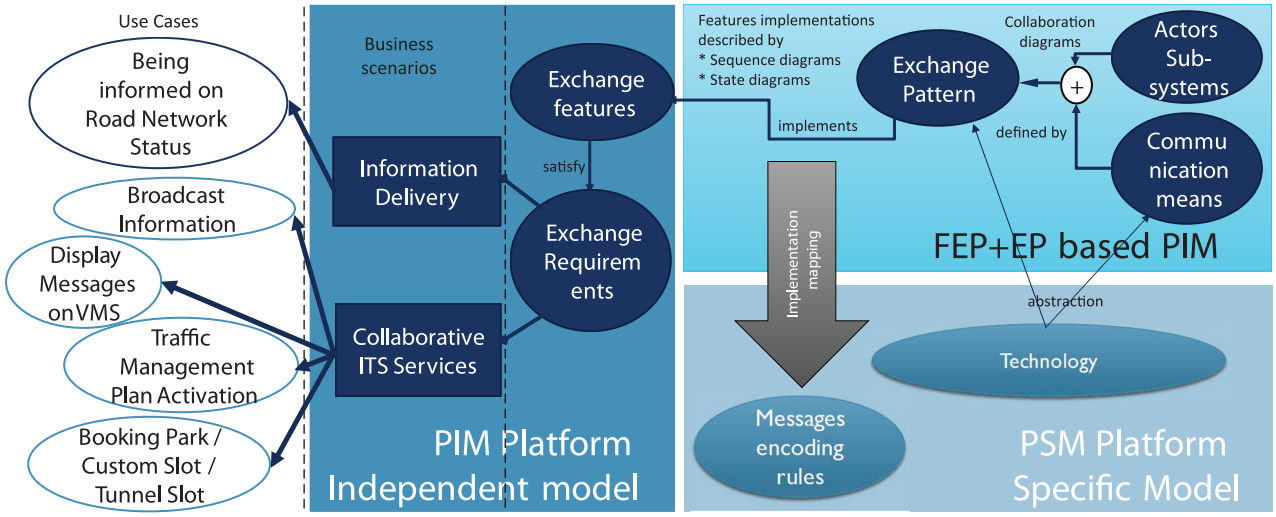

Figure 3 — Business scenario and Functional Exchange Profile (FEP)

5.4 Business scenario: Information delivery

5.4.1 Overview

One of the most common applications of a data exchange system is the exchange of traffic and travel information between two nodes. In such a scenario, one node acts as the supplier of the information while the other acts as the intended receiver of that information, i.e. the client.

EXAMPLE It is done by using the form of publications, e.g. in the European DATEX II.

The data delivery business scenario considers the actors as defined in the following Figure 4:

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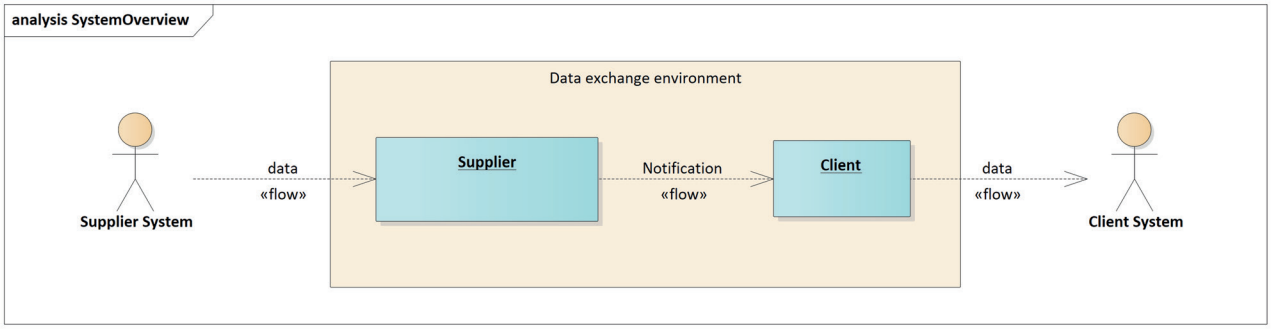

Figure 4 — General data delivery business scenario actors

The following table provides the basic definitions for exchange:

Table 1 — Main definitions in exchange

Name	Definition
Supplier system	A system which gathers information (road information) which needs to be conveyed to another system named client system. Examples of supplier systems are traffic control centres or traffic information centres or service provider systems, gathering road data from any available source they have.
Client system	A system which needs to update its internal information based on information which is available from another system named supplier. Examples of client systems are traffic control centres or traffic information centres or service provider systems.
Exchange environment	The set of components which enables information exchange among client systems and supplier systems via a data exchange protocol.
Supplier	The component of exchange environment which is devoted to providing data to client, retrieving them from supplier system.
Client	The component of exchange environment which is devoted to collecting data from supplier, delivering them to the client system.

Road and traffic information is gathered in a system which is named “Supplier System” in case the information it stores is needed to be transferred to another system, named “Client System”, for any purpose.

The data delivery business scenario describes the exchange pattern and messages which are needed to be exchanged among supplier and client systems besides the underneath technology and exchange pattern. The purpose for which information is exchanged is not considered in this use case description.

As explained in the information delivery background in Annex F, any update of information status at the supplier system shall be replicated to the client system via information delivery. The main objective of information delivery is that information on the client system is updated exactly in the same way as it is in the supplier system without any difference in information values and semantics.

“Exchange message” is defined as the data structure in which the information is coded to transfer information in the exchange system from the supplier to the client.

Assuming Sc = Client status, Ss = Supplier status, exchange is a mean to have Sc equivalent to Ss,

Formally:

Ss → Information → Supplier → Exchange Message → Client → Information → Sc

i.e. client system status is updated in equivalent mode as supplier system status by means of data delivery exchange messages between supplier and client.

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Information delivery business scenario scope is implemented by selected exchange features which enable this scope and other secondary requirements which are based on available features on considered platforms and patterns.

1) Supplier system characterisation

   — Shall provide data as input to the data exchange environment

   — Is mandatory for the information data delivery process

2) Data exchange environment

   — Shall be an environment supporting the exchange of information and data by mean of messages

   — The supplier of data exchange system shall produce and transmit the messages (Notification)

   — The client of data exchange system should receive and process the messages

3) Client system characterisation

   — Shall receive traffic and travel related data from the data exchange environment

   — Can be either another system for further processing or a simple client for the content visualization, the purpose of information exchange is not considered to be relevant in information delivery business scenario

   — Is mandatory for the information data delivery process.

5.4.2 Requirements

The normative Annex B provides a description of all requirements that exist for specific business scenario including information delivery whether they are actually used in a particular FEP or not. All requirements are organised into groups based on their characteristics.

NOTE A FEP is a different concept from content profile. The description of the content profiles that can exist in an information delivery scenario is not in the scope of this document. Content profiles are handled in respect to which information is exchanged.

5.4.3 Data delivery exchange pattern

For data delivery the concept of "exchange pattern" is introduced, as well as PIM and FEP. It can be defined as follows:

Exchange pattern: the basic exchange architecture model which identifies actors in the exchange framework and messaging patterns as basic tools which are available to implement information delivery by exchange features.

Messaging patterns can be defined by means of UML sequence diagrams, collaboration diagrams and state diagrams, in a way that messages triggering conditions are well defined and any update of state is well defined and identified based on the subsequent message exchange or conditions.

Examples of exchange pattern are the GET method of HTTP, Pull, Push, PubSub, etc.

Once an exchange pattern and a selection of features (FEP) which can be implemented on this exchange pattern are set, a set of specification at PIM level for exchange pattern/FEP is well defined.

A PIM for exchange pattern/FEP that enables all mandatory requirements is a valid platform for information delivery business case.

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5.4.4 Specific exchange pattern specification PIM included in this document

In the following clauses PIM for exchange pattern/FEP will be described for the following platform:

— "Snapshot Pull";

— "Snapshot Push";

— "Simple Push";

— "Stateful Push";

— "PubSub", Publish Subscribe Pattern [based on OASIS WS Notification Specification (2006)].

The informative Annex E details the features of the main FEPs considered in this document for the corresponding exchange pattern.

5.5 Business scenario: Collaborative ITS Service (CIS)

5.5.1 Overview

In CIS business scenario the exchange of information among centres is considered as a base to trigger processes and services on this data, so the data exchange layer is to be considered as an "ITS services" enabler.

Information about CIS concept and its model description is found in Annex G.

5.5.2 Data exchange enabling service request and feedback paradigm

The involved systems which in data delivery had been considered as supplier and client can be seen in this paradigm respectively as service provider and service requester.

Note that at application level for implementing a business case such as management of TMP, some workflow modelling is normally requested. This could be simple workflow (accept request or reject request) or more complex: This workflow modelling at application level is out of the scope of this document, which only provides the essential tools to a raise service request and provide feedback: exchange of payload to be processed and processing results:

— **Collaborative** means 2 to many systems interoperating

— 1 to n Data exchange connection(s)

  — Modelling any single CIS usage invoking with

    — 1 Service Requester

    — many Service Providers

  — Reducing complex combination of single usages from many requesters

    — out of scope, not needed to be described

    — question on possible lock of resources to be managed at application or human operator level not described in the document

— ITS Services definition, just to give a reference, service description is out of the scope of this document

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- Specific definition of ITS Service in the informative Annex G:
  - TIS / Traffic Information Services
    - Information delivery
      - Allowed channels
  - TMS Traffic Management Systems
    - Hard shoulder running
    - Dynamic speed
    - Dynamic lane management
    - etc.
  - F&L Freight & Logistic
    - Secure truck parking
    - etc.

5.5.3 Requirements

The normative Annex B provides a description of all requirements that exist for specific business scenarios including Collaborative Informative Services.

5.6 Exchange data model

To implement some exchange features, such as session management or link monitoring, or security features, extra information is to be added to the informational (payload) content. This extra information, named exchange information, enables messages to convey information and data which are related to client and supplier status, identity, authorisation, etc.

Exchange information could be different among exchange pattern/FEP selection, but some common general information models are considered, which can be specialised to manage specific exchange pattern and PIM.

A general UML model for managing a minimum set of information for exchange is provided in C.2.

5.7 Data exchange features

5.7.1 Context diagram

This document defines the features and rules that systems shall implement in order to be able to communicate in the traffic and travel data exchange world.

The context diagram below in Figure 5 identifies the entities and the features that are specified in this document and which need to be addressed by the technical implementations. The diagram presents the features in different layers for communication, message rules and application.

- The **Application** layer is used for defining how using and implementing different business and application needs. This document describes the features to deal with how and when the information is published and made available, how subscriptions are managed, how to handle services and transactions. This layer defines the semantics of the communication.
- The **Messages Rules** layer defines the features and the rules used for the transport of the messages. This is the layer where the rules (protocol) are defined that enable different systems (suppliers and

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clients) to communicate and understand each other, i.e. for sending and receiving messages. This layer defines the syntax of the communication.

— The **Communication** layer deals with the support for communication between systems, and defines the protocols and services that are used by the data exchange applications, e.g. TCP/IP, security, Web Services. The communication layer deals with rules at the lowest level, i.e. the physical exchange. This layer provides solutions to the defined requirements and features although it is up to upper applications to define what protocols to use and how to use them. This layer defines the physical support for the communication.

Figure 5 shows the topics broken up into boxes representing the exchange features and the relation with each layer.

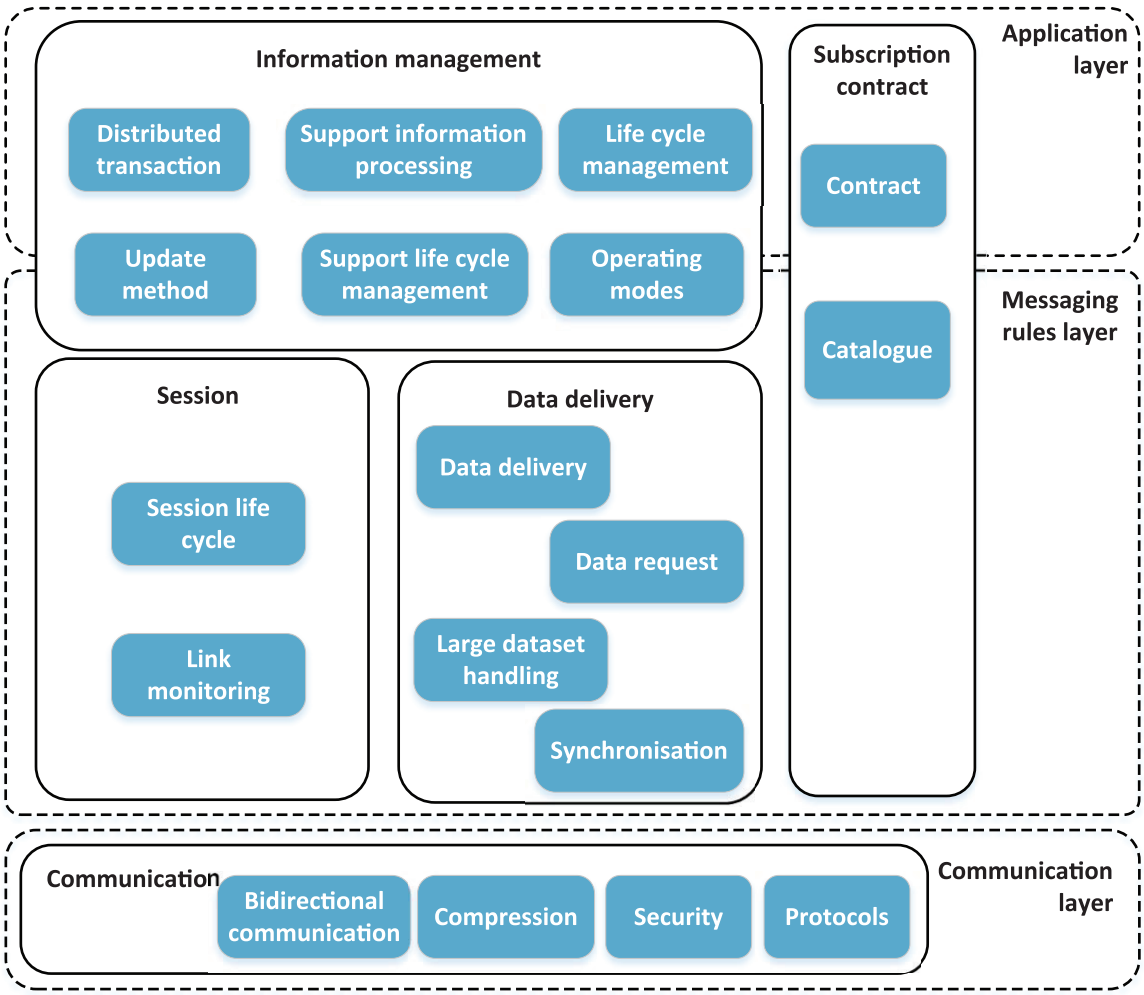

Figure 5 — Context diagram

5.7.2 Features

The features that support the requirements defined by use cases specified in this document are detailed below:

1) **Subscription contract** – Supports all features related to the contract or agreement, such as:

   i) Contract and contract life cycle: a model and features that can be used for the support of the information of a subscription contract;

   ii) Catalogue: a model for handling catalogues.

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The subscription contract is optional and includes the following features:

Table 2 — Subscription contract: Features and requirements

Features	Requirement type	Requirement name
Contract	Information	Subscription
		Client profiles
		Filter handling
Catalogue	Information	Catalogue exchange

2) **Session** – The session feature group supports all features related to the establishment of a logical session.

   i) Session life cycle – features for managing the life cycle of a logical session (create, manage and terminate);

   ii) Link Monitoring – features for link monitoring and control.

The session feature group is optional and includes the following features:

Table 3 — Session: Features and requirements

Features	Requirement type	Requirement name
Session life cycle	Communication	Error handling
		Time-out management
		Session
Link monitoring	Communication	Error handling
		Time-out management
		Full reliability
		Link monitoring and control

3) **Information management -** Handles the features related to management of the information, includes features such as:

   i) Operating modes: features to specify what portion of the information shall be exchanged;

   ii) Update methods: features that let a data exchange system specify when the information should be exchanged;

   iii) Life cycle management: features for handling the life cycle management of exchanged payload information for payload for which life cycle is applicable;

      I) Situation life cycle management

      II) Filter handling

   iv) Support information processing: feature for handling directives to process exchanged data and send feedback on processing outcomes;

   v) Distributed transaction: features for handling a transaction on several systems consistently, i.e. an operation is capable to keep data consistency among several systems based on undertaken operator actions.

The information management group includes the following features:

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Table 4 — Information management: Features and requirements

Features	Requirement type	Requirement name
Operating modes	Information	Reference datasets for different versions
Update methods	Information	Full audit trail data delivery (all state changes)
Life cycle management	Information	Support for life cycle management
Support information processing	Information	Support for information management
		Support for feedback on information management
Distributed transaction	Information	Distributed transaction
		Distributed atomic transaction

4) **Data delivery –** The data delivery feature group supports all features to exchange data between the supplier and client. In the publish-subscribe pattern this feature group will support all related interfaces between the producer and the consumer; it supports features such as:

   i) Data delivery: features to delivery information by the supplier to the client on a push mode (direct delivery and fetched delivery);

   ii) Data request: features to exchange information requested by the client;

   iii) Large datasets: support the exchange messages with large volumes;

   iv) Synchronisation: how to ensure data synchronisation between the systems that are communicating.

The data delivery group includes the following features:

Table 5 — Data delivery: Features and requirements

Features	Requirement type	Requirement name
Data delivery	Information	Extensibility
	Communication	Delivery/response
		Message sequence
		Snapshot data delivery (last known state)
		Exchange quality measures (ex. response times-tamp)
		On occurrence update
		Periodic update
	Security	Client identification
		Supplier identification
	Information	Incremental data delivery

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Table 5 *(continued)*

Features	Requirement type	Requirement name
Data request	Information	Extensibility
	Communication	Request/response
		Message sequence
		Snapshot data delivery (last known state)
		Exchange quality measures (ex. response timestamp)
		On occurrence update
		Periodic update
	Security	Client identification
		Supplier identification
Large datasets handling	Information	Data delivered as soon as possible
		Delayed delivery
		Multi-part data delivery
Synchronisation	Information	Synchronisation
	Communication	With state supplier
		Failed data recovery

5) **Communication –** Handles all features related to a protocol (close to the physical layer). It is used by the application for the massage transport:

   i) Communication – describe the communication protocols that can be used;

   ii) Security – describe how security features can be implemented;

   iii) Compression – how data compression can be used while transmitting data;

   iv) Bidirectional communication – enable a client to send back data to a supplier as feedback on data exchanged and processing status of data based on supplier's processing directive in Collaborative ITS Services.

The communication function is responsible for implementing the following features:

Table 6 — Communication: Features and requirements

Features	Requirement type	Requirement name
Security	Security	Security (data)
		Integrity
		Confidentiality
		State the intended recipient
		Client authentication
		Supplier authentication
		Client authorisation
		Non-repudiation
Compression	Communication	Compression
Communication	Communication	Timely responses
Bidirectional communication	Communication	Bidirectional communication

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6 Snapshot Pull

6.1 Overview

The “Snapshot Pull” exchange pattern / FEP at PIM level is based on information retrieval by a client from a supplier which delivers a snapshot of information, i.e. all currently available information content, to the client. It can be implemented in several platforms: some examples are XML retrieval of generated XML files by http/get, or supplier exposing a SOAP Web Service method (e.g. named "PULL"), from which currently available data is retrieved by the client.

This “Snapshot Pull” does not manage session life cycle and link monitoring requirements, as well as synchronisation. This feature and related requirements are not considered in this pattern, synchronisation is not needed as implicit when delivering snapshots of currently available information content.

To describe the Snapshot Pull exchange pattern/FEP at PIM level all features are described in a general abstract format, independently from the specific technology platform this model will be implemented with (e.g. http/get XML, WebService).

Table 7 — Selection of features for Snapshot Pull

Features area	Feature	Snapshot Pull implemented
Subscription contract	Contract	N
	Catalogue	N
Session	Session life cycle	N
	Link monitoring	N
Information management	Operating modes	Periodic or On Occurrence (i.e. triggered by client conditions)
	Update methods	Snapshot
	Life cycle management	Y, based on snapshot: new and updated content delivered, outdated data not delivered.
Data delivery	Data delivery	Y
	Data request	N
	Large datasets handling	N
	Synchronisation	Y
Self-Description	Handshake	N
Communication	Security	To be defined at PSM level
	Compression	To be defined at PSM level
	Communication	To be defined at PSM level

6.2 Exchange pattern messages definition

6.2.1 Overall presentation

The information delivery business scenario description and definition states that data exchange is needed to align the information kept by the supplier system into the client system. For this purpose an exchange systems is used which provides tools enabling messages generation and their transfer between supplier and client.

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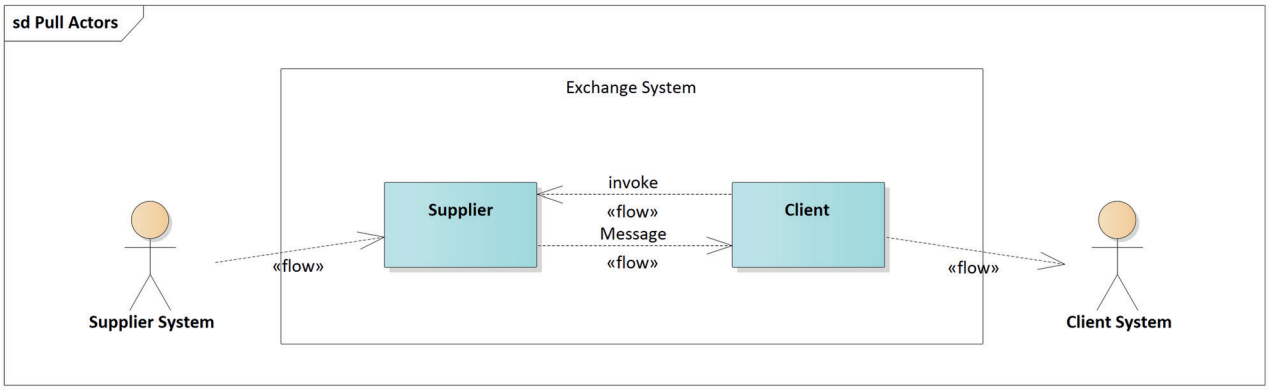

Figure 6 — Snapshot Pull exchange actors

The "Snapshot Pull" exchange pattern is described in the following subclauses.

6.2.2 Basic exchange pattern

The supplier provides a mechanism to retrieve current data, also called "snapshot" of information, normally for a specific payload, i.e. current information content of client system or last retrieved information for sampled data (see Figure 7).

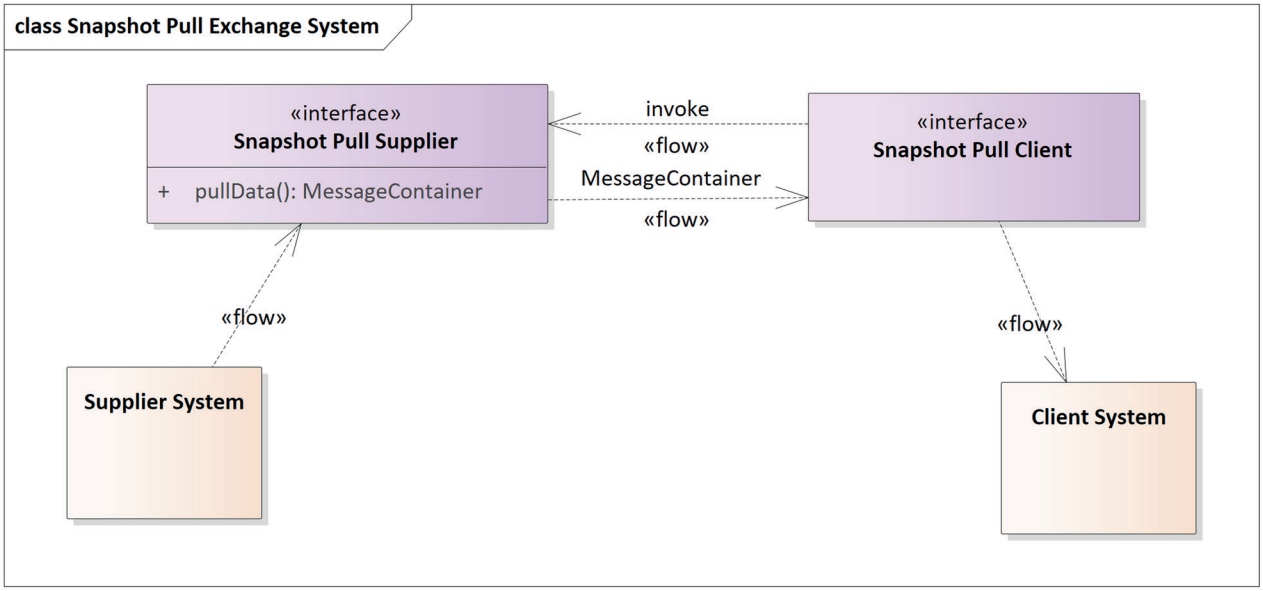

Figure 7 — Snapshot Pull exchange subsystems, interface interactions and methods

This mechanism is referred to in this document as "**pullData**".

The client takes the initiative to retrieve the data based on its needs, normally when some conditions defined at client side are triggered or in a periodic way; specifically:

— **Periodic Pull**, based on fixed or variable time cycle, depending on application logic at the client system;

— **On Occurrence** (Triggered Pull), on any condition stated by the client or by the client system.

NOTE Depending on implementation (e.g. http /get of XML static files generated at supplier side) the payload message is generated by the supplier based on condition on the supplier side (e.g. event update or data gathered at the supplier side). In these cases, extra information can be available to implement some optimisation such as bandwidth saving by not transferring the same data in case no update had been generated.

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6.2.3 Relevant exchange information in exchange data model

No extra exchange information is needed in this pattern to implement any described features.

Basic exchange data model has been provided to allow the implementation to deliver more payload content on the same message and further information to allow managing extra features not required by the Snapshot Pull exchange. The usage of the exchange data model wrapping is for harmonisation of other exchange patterns such as "Simple Push" or "Stateful Push".

A “MessageContainer” instance should be retrieved using the basic exchange data model as reported in previous figure, alternatively a payload may be retrieved without any further information.

6.2.4 Exchange messages

— Payload Message.

  — Simple payload messages can be exchanged within this FEP+EP.

  — Payload messages should be delivered wrapped into a container (see basic exchange data model in the normative Annex C with exchange data).

  — Payload messages contain payload update timestamp which can be used to understand when payload has been created/updated for error management and processing saving.

6.3 Features implementation description

6.3.1 Overview

This subclause provides a description and the corresponding specification for each feature identified in the context diagram, according to the Snapshot Pull exchange architecture. The following features are specified:

— Subscription contract;

— Subscription (also known as session);

— Information management;

— Data delivery;

— Communication/protocol.

6.3.2 Subscription contract

6.3.2.1 Contract

Managed offline, not automated. It assumes information for controls to be implemented in client to assess the identity of supplier and authenticate the supplier request in message exchange.

6.3.2.2 Catalogue

Managed offline, not automated.

6.3.3 Session

6.3.3.1 Session life cycle

No session is managed for the current EP+FEP.

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6.3.3.2 Link monitoring

Link monitoring is not managed for the current EP+FEP.

6.3.4 Information management

6.3.4.1 Operating modes

Available operating mode for client Pull is Periodic, or On Occurrence (i.e. a condition triggered based on client). Pull-exchange based on client-side conditions.

6.3.4.2 Update methods

Available update method is Snapshot, i.e. retrieval of only currently valid data.

6.3.4.3 Life cycle management

Currently available information is included in the payload at a supplier system to prepare message delivery. It can be done at time-out on a cycle basis or at specific triggering condition as "data updated" condition.

For life cycle management information, a snapshot includes all active information, outdated information is not delivered in content.

For sampled information the snapshot information contains last sampled data available at supplier site.

Whenever a condition is raised the supplier system triggers it to the supplier to manage the creation of a pull message.

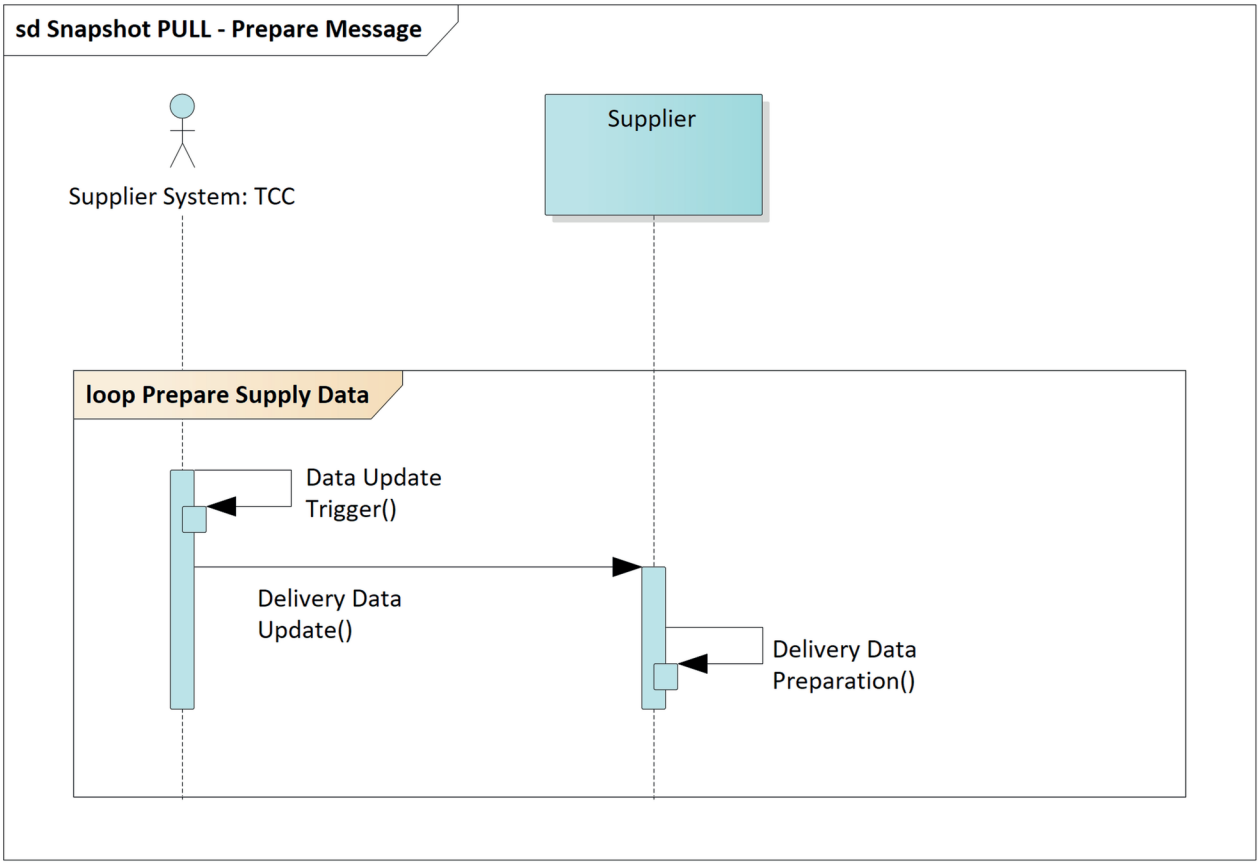

Figure 8 — Snapshot Pull sequence diagram: Information management at supplier side

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Information management for Snapshot Pull is implemented as follows: when client gets a snapshot of the last updated/created items including all active items, it has to check for information which has been removed from payload to deduce it had been invalidated (i.e. closed or cancelled).

6.3.5 Data delivery

6.3.5.1 Data delivery

The sequence diagram for data delivery is as follows in Figure 9:

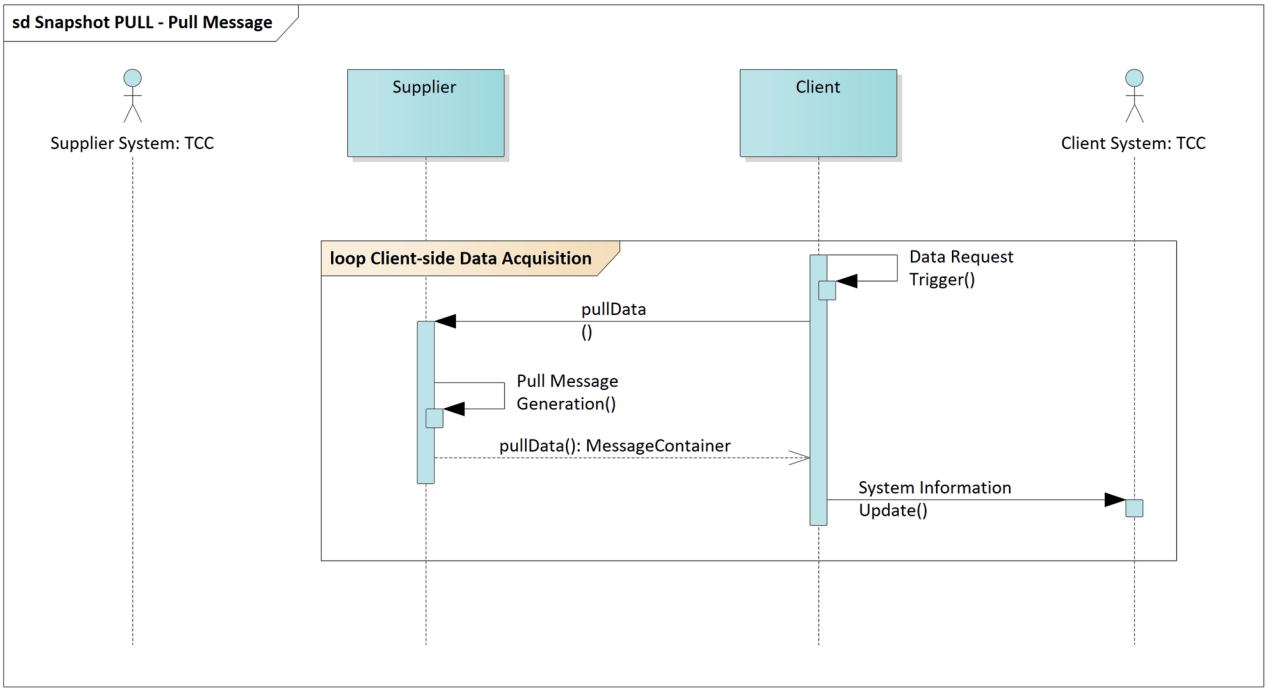

Figure 9 — Snapshot Pull sequence diagram for data retrieval: Implicit data delivery

Pull message generation processing is optional based on chosen platform technology.

6.3.5.2 Data request

Not implemented in this pattern.

6.3.5.3 Large datasets handling

Not described in this pattern at PIM level (it may be implemented at PSM level as optimisation – see 6.3.8).

6.3.5.4 Synchronisation

Implicit synchronisation is available as only currently available elements are retrieved by Snapshot Pull.

6.3.6 Self-description

Handshake is not available.

6.3.7 Communication

Communication feature are implemented at PSM level, they are relevant for the specific platform chosen on which the exchange pattern will be implemented (e.g. http/XML, Web Services SOAP, REST, etc.).

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6.3.8 Optimisation issues

6.3.8.1 Bandwidth and processing savings

Payload timestamp information is available for client-side processing optimisation made at the application level.

Pull message may be generated for all clients reducing processing resources at the supplier-side.

No extra optimisation issues are considered in this EP+FEP.

6.3.8.2 Huge dataset handling

Not managed in this EP+FEP.

7 Snapshot Push

7.1 Overview

The “Snapshot Push” exchange pattern / FEP at PIM level is based on pushing information by the supplier to the client delivering a snapshot of information, i.e. all currently available information content, to the client. This exchange pattern can be implemented in several platforms: some examples are XML delivering of generated XML files by http/post, or a client exposing a SOAP web service method (e.g. named "PUSH") when currently available data can be sent by the supplier to the client.

This “Snapshot Push” does not manage session life cycle and link monitoring requirements, as well as synchronisation, these features and related requirements are not considered in this pattern. Synchronisation is not needed as implicit by snapshot delivering of currently available information content.

To describe Snapshot Push exchange pattern/FEP at PIM level all features are described in a general abstract format, independently from the specific technology platform in which this model will be implemented (e.g. http/get XML, WebService).

Table 8 — Selection of features for Snapshot Push

Features area	Feature	Snapshot Push implemented
Subscription contract	Contract	N
	Catalogue	N
Session	Session life cycle	N
	Link monitoring	N
Information management	Operating modes	Periodic or On Occurrence (i.e. Triggered by supplier condition)
	Update methods	Snapshot
	Life cycle management	Y, based on snapshot: new and updated content delivered, outdated data not delivered.
Data delivery	Data delivery	Y
	Data request	N
	Large datasets handling	N
	Synchronisation	Y
Self-Description	Handshake	N
Communication	Security	To be defined at PSM level

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Table 8 *(continued)*

Features area	Feature	Snapshot Push implemented
	Compression	To be defined at PSM level
	Communication	To be defined at PSM level

7.2 Exchange pattern messages definition

7.2.1 Overview

The information delivery business scenario description and definition imply that data exchange is needed to align the information kept by the supplier system into the client system; for this purpose, an exchange system is used which provides tools enabling message generation and their transfer between supplier and client (see Figure 10).

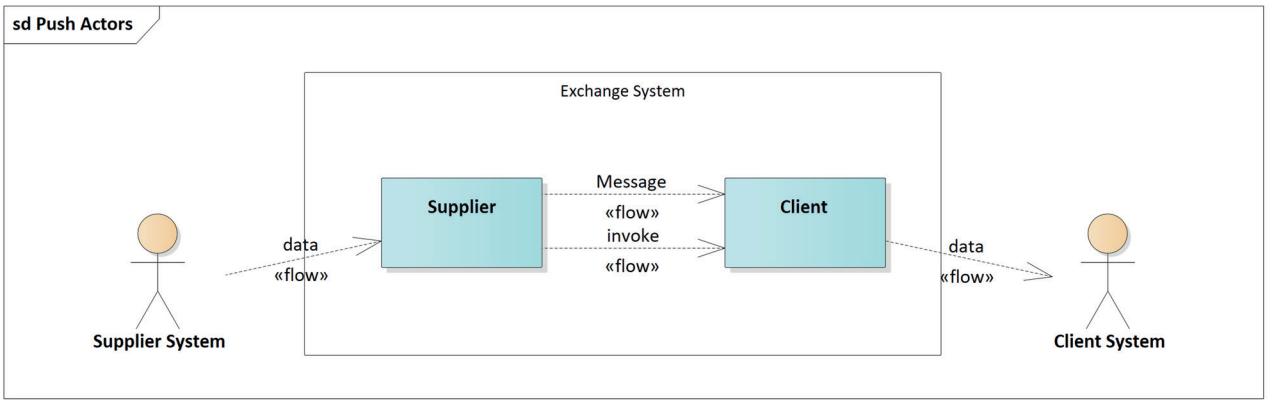

Figure 10 — Snapshot Push exchange actors

The "Snapshot Push" exchange pattern is described by the following subclauses.

7.2.2 Basic exchange pattern

The client provides a mechanism to receive data from action taken at a supplier site invoking specific resources / methods offered by the client. Then the supplier logically "pushes" messages to the client. The client shall acknowledge what is received by a return information to the supplier. This return message is available to bring some information back from the client to the supplier (Figure 11).

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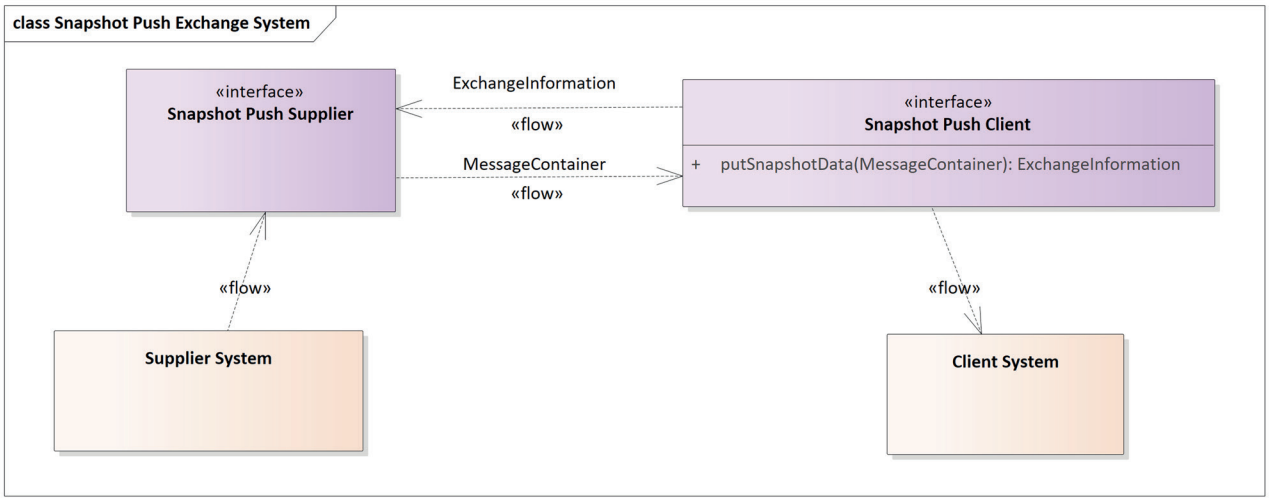

Figure 11 — Snapshot Push exchange subsystems, interfaces interactions and methods

The client provides a mechanism to the supplier to push currently available data, also called "snapshot" of information, i.e. current information content at supplier system or last retrieved information for sampled data (see Annex F).

This mechanism is referred to in this document as "**putSnapshotData**".

The supplier takes the initiative to deliver the data to the client based on some rules, normally when some conditions defined at supplier side are triggered or in a periodic way; specifically:

— **Periodic Push**, based on fixed or variable time cycle, depending on application logic at supplier system;

— **On Occurrence** (triggered push), on any condition stated by the supplier.

7.2.3 Relevant exchange information in exchange data model

No extra exchange information is needed in this pattern to implement any described features.

Basic exchange data model has been provided to allow the implementation to deliver more payload contents in the same message and further information to allow managing some extra features not required by the basic "Snapshot Push" exchange. The usage of the exchange data model wrapping is for harmonisation with other exchange patterns such as "Simple Push" or "Stateful Push".

A container should be retrieved using basic exchange data model as reported in the previous figure, alternatively a payload may be delivered.

An ExchangeInformation is returned to convey information about exchange operation and connection status.

7.2.4 Exchange Messages

— Payload message.

  — Simple payload messages can be exchanged within this FEP+EP.

  — Payload messages should be delivered wrapped into a container (see basic exchange data model in Annex C) with exchange data.

  — Payload messages contain payload update timestamp which can be used to understand when payload has been updated for error management and processing saving.

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7.3 Features implementation description

This subclause provides a description and the corresponding specification for each feature identified in the context diagram, according to the Snapshot Pull exchange architecture. The following features are specified:

— Subscription contract;

— Subscription (also known as session);

— Information management;

— Data delivery;

— Communication/protocol.

7.3.1 Subscription contract

7.3.1.1 Contract

Managed offline, not automated. It assumes information for controls to be implemented in client to assess the identity of supplier and authenticate the supplier request in messages exchange.

7.3.1.2 Catalogue

Managed offline, not automated.

7.3.2 Session

7.3.2.1 Session life cycle

No session is managed for the current EP+FEP.

7.3.2.2 Link monitoring

Link monitoring is not managed for the current EP+FEP.

7.3.3 Information management

7.3.3.1 Operating modes

Available operating mode for Snapshot Push is “Periodic”, or “On Occurrence” (i.e. a condition triggered based on supplier) Push-based on supplier-side conditions.

7.3.3.2 Update methods

Available updated method is Snapshot, i.e. retrieval of only currently valid data.

7.3.3.3 Life cycle management

Currently available information is included in the payload at supplier system to prepare message delivery; this can be done at time-out on a cycle basis or at specific triggering condition as “data updated” condition.

For life cycle management information, snapshots include all active information, outdated information is not delivered in content.

For sampled information the snapshot information contains last sampled data available at supplier site.

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Whenever a condition is raised the supplier system manages the creation of a push message and delivers it (Figure 12).

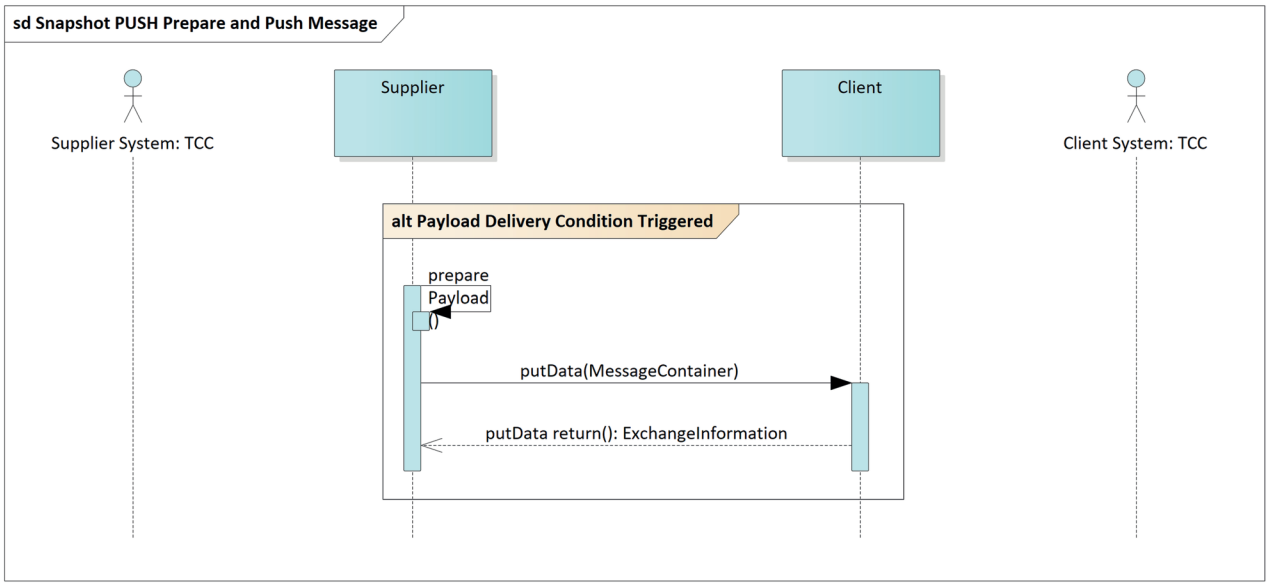

Figure 12 — Snapshot Push sequence diagram: Information management at supplier side

Information management for Snapshot Push is implemented as follows: when client gets snapshot of last updated/created items including all active items, it has to check for information which has been removed from payload to deduce it had been invalidated (i.e. closed or cancelled).

7.3.4 Data delivery

7.3.4.1 Data delivery

The sequence diagram for data delivery is the same as in the previous figure.

7.3.4.2 Data request

Not implemented in this pattern.

7.3.4.3 Large datasets handling

Not described in this pattern at PIM level. May be implemented at PSM level (see optimisation subclause).

7.3.4.4 Synchronisation

Implicit synchronisation is available as only currently available elements are retrieved by Snapshot Push.

7.3.5 Self-Description

Handshake is not available.

7.3.6 Communication

Communication features are implemented at PSM level, they are relevant for the specific platform chosen on which the exchange pattern will be implemented (e.g. http/XML, Web Services SOAP, REST, etc.).

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7.3.7 Optimisation issues

7.3.7.1 Bandwidth and processing savings

Payload timestamp information is available for client-side processing optimisation made at application level.

Push message may be generated for all clients reducing processing resources at the supplier side.

No extra optimisation issues are considered in this EP+FEP.

7.3.7.2 Huge dataset handling

Not managed in this EP+FEP.

8 Simple Push

8.1 Overview

Simple Push exchange pattern / FEP at PIM level is based on information messages sent or pushed by the supplier to a client. It can be implemented in several platforms: some examples are push of generated XML content by http/post, or client providing a SOAP WebService method "push" by which data can be provided by the supplier to the client.

This "Simple Push" adds extra features to the basic Snapshot Push exchange pattern to manage link monitoring, as well as synchronisation/realignment in case of communication lacks or system maintenance. This mechanism will be detailed at PIM level in the following subclauses.

To describe the exchange pattern/FEP at PIM level all features are described in a general abstract format, independently from the specific technology platform in which this model will be implemented. (e.g. http/get XML, WebService).

Table 9 — Selection of features for Simple Push

Features Area	Feature	Simple Push available
Subscription contract	Contract	N
	Catalogue	N
Session	Session life cycle	N
	Link monitoring	Y
Information management	Operating modes	Periodic / On Occurrence based on triggering of supplier condition
	Update methods	Snapshot, Single Element Update, All Element Update
	Life cycle management	Y
Data delivery	Data delivery	Y
	Data request	N
	Large datasets handling	N
	Synchronisation	Y, optional
Self-Description	Handshake	N
Communication	Security	At PSM level
	Compression	At PSM level
	Communication	At PSM level

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8.2 Exchange pattern messages definition

Information delivery business scenario description and definition state that data exchange is needed to align the information kept by the supplier system into the client system; for this purpose, an exchange system is used which provides tools enabling messages generation and their transfer between a supplier and a client (Figure 13).

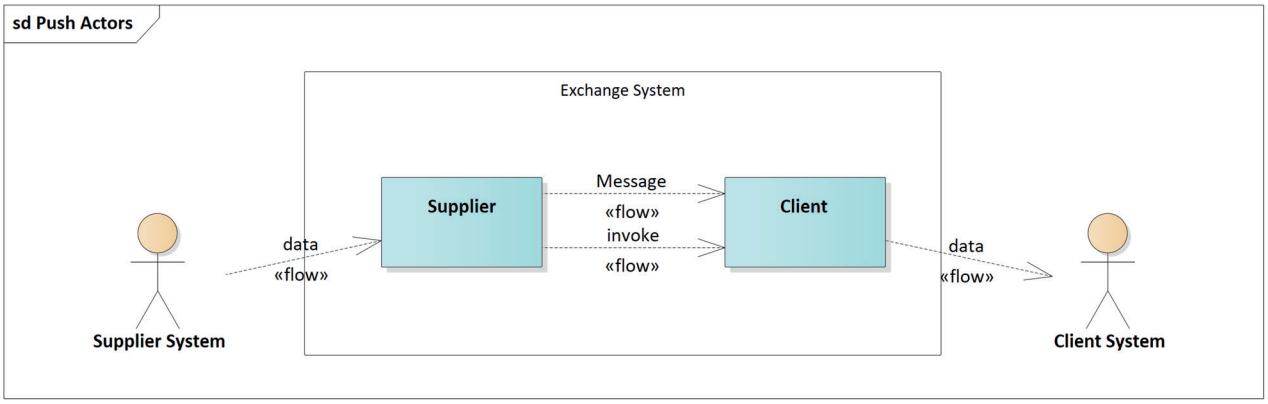

Figure 13 — Simple Push exchange actors

The “Simple Push” exchange pattern is described in the following subclauses.

8.2.1 Basic exchange pattern

The client provides a mechanism to receive data from action taken at the supplier site invoking specific resources / methods offered by the client.

Then the supplier logically “pushes” messages to the client. The client shall acknowledge what it received by a return information to the supplier. This return message is available to bring information back from the client to the supplier, such as failure, success, snapshot synchronisation request. Return message information is logically described in this PIM, while implementation will be defined at PSM, level (Figure 14).

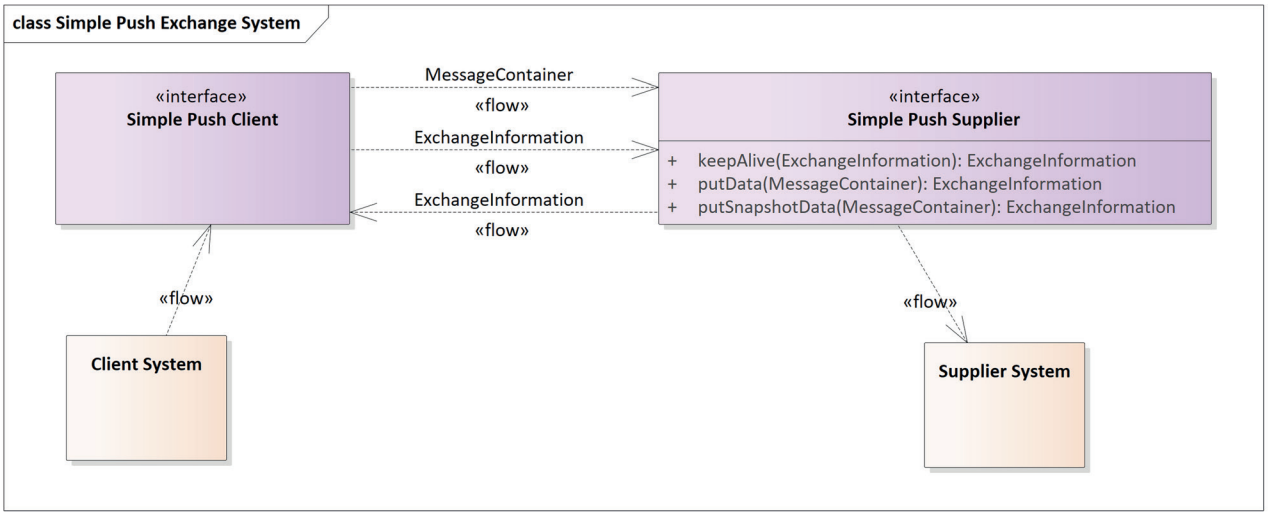

Figure 14 — Simple Push exchange subsystems, interface interactions and methods

The mechanisms available are referred to in this document as "**putData", "keepAlive"** and optional **"putSnapshotData".**

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Simple Push actually pushes available information or available updated information to the clients, but does not keep track of what has been delivered to specific clients. For specific use cases such as delivery of stateful information (e.g. situation payload information), a first snapshot can be useful and is delivered to the client based on information to be exchanged or on explicit client request in return code. This feature is optional in this FEP+EP PIM.

Based on previous optional requirements, exchanged data can either be currently available data, also called "snapshot" of information, or, when a synchronisation is not needed such as for stateless information (e.g. road data), a set of information which had changed since the last push is exchanged to align the information status on the client system. These messages may include single updated element or all updated elements depending on update method chosen.

The supplier takes the initiative to push the data under the following conditions:

— **On Occurrence push**: as soon as information is updated at the supplier systems, this condition triggers the supplier to send push data to the client for updating the client system as soon as possible after this update.

— **Periodic push**: at a predefined time interval the supplier starts an exchange based on client and supplier agreement (subscription contract).

— A **snapshot synchronisation** with the whole currently available content snapshot in case a snapshot alignment is requested by client.

— **Response to a snapshot synchronisation request**: one snapshot alignment may also be transmitted to the client for internal system needs/maintenance/debug, it can be requested by the client via any return messages, i.e. wrapped in returned exchange information.

8.2.2 Relevant exchange information from exchange data model

8.2.2.1 Overview

Basic exchange data model has been provided to allow the implementation to deliver more payload contents on the same message and further information to allow managing extra features not required by the Simple Push exchange.

For interoperability convenience the exchange data model wrapping shall be managed in this exchange.

A payload shall be pushed to a client using basic exchange data model as reported in the previous figure.

An ExchangeInformation shall be returned from **putData** to convey information about exchange operation and connection status.

8.2.2.2 Exchange information

Some non-mandatory information which should be managed in the exchange information for easy application development are fully described in basic exchange data model:

— Supplier Identification (String)

  — Requirement: Supplier identification.

— Client Identification (String)

  — Requirement: Client identification.

— Exchange Information (provided both by the client and the supplier) wraps exchange and exchange status information "Success", "Fail", "Close Session Request", "Snapshot Synchronisation Request", "SessionId"

  — Requirement: Session management, Link monitoring.

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8.2.2.3 Payload information

— Generation timestamp information

  — Requirement: timely, reliable Information, session management.

8.2.3 List of exchanged messages

Different messages or supplier / client interactions (invoked method) are exchanged in Simple Push which are needed to manage synchronisation, payload exchange, link monitoring. These are formally contained in pushed messages to a client from a supplier or in return messages from client to supplier.

Table 10 — List of messages types and detailed content

Interaction message	Direction supplier client	Designation	Description	Exchanged information	Optional
Payload Push	Direct	putData	Push delivery of payload, which has to be delivered from supplier to client. Exchange information such as client and supplier identification and exchange status may be provided to easy controls.	Payload + Exchange Information (MessageContainer)	N
Snapshot Payload Push	Direct	putSnapshotData	Push delivery of current available payload, i.e. snapshot after a first initialised session in case of first connection or after an explicit snapshot realignment request from the client. Exchange information such as client and supplier identification and exchange status may be provided to easy controls.	Snapshot Payload + Exchange Information (MessageContainer)	Y
Keep Alive	Direct	keepAlive	Test exchange link and confirm session validity when no payload push update is needed, exchange information such as client and supplier identification and exchange status may be provided to easy controls and supplier identification.	Exchange Information	N
Exchange Information Return	Return	Exchange Information	Exchange information is returned from client to supplier to provide return status i.e. Success, Fail, Snapshot Synchronisation Request and to easy controls such as supplier and client identification.	Exchange Information	N

8.3 Link monitoring and error management

The supplier initiates the communication and is made aware of the client status based on the client return response to the supplier.

The following diagram (Figure 15) describes the client status as monitored and managed by the supplier.

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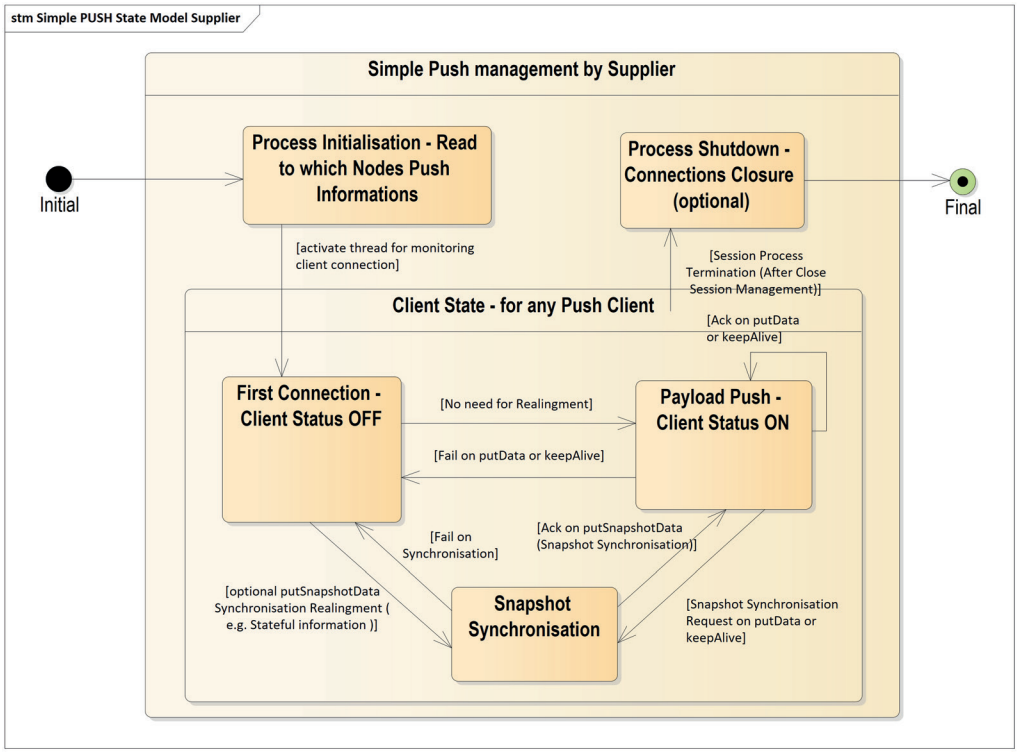

Figure 15 — Supplier-side Simple Push state diagram

The following diagram (Figure 16) describes the supplier status as monitored and managed by the client.

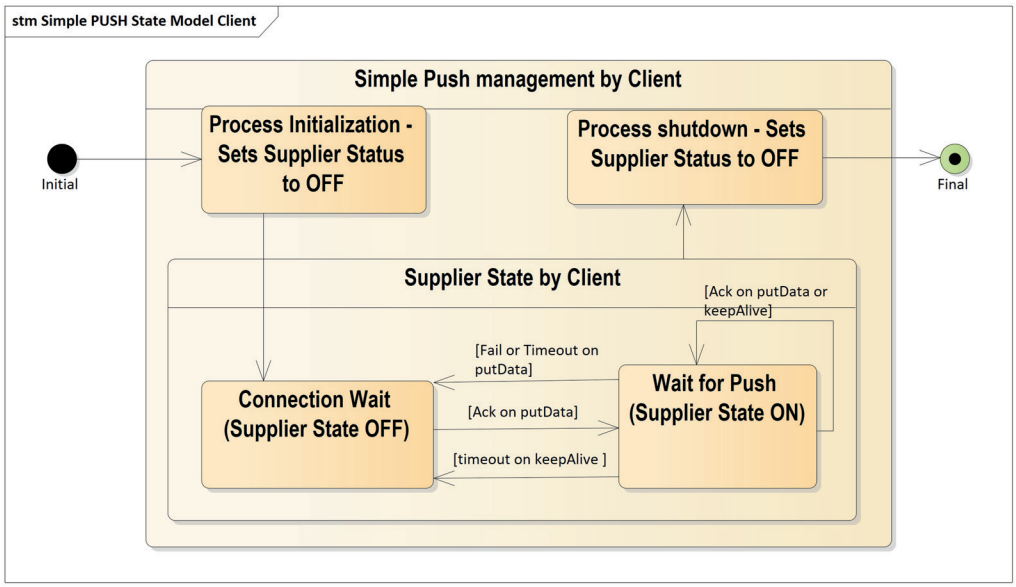

Figure 16 — Client-side Simple Push state diagram

Special management in initialisation and termination of Push process is to consider at the application level in supplier and client systems.

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8.4 Features implementation description

8.4.1 Overview

This subclause provides a description and the corresponding specification for each feature identified in the context diagram, according to the Simple Push data exchange architecture. The following features are specified:

— Subscription contract;

— Subscription (also known as session);

— Information management;

— Data delivery;

— Communication/protocol.

8.4.2 Subscription contract

8.4.2.1 Contract

Managed offline, not automated. It assumes information for controls to be implemented in client to assess the identity of supplier and authenticate the supplier request in messages exchange.

8.4.2.2 Catalogue

Managed offline, not automated.

8.4.3 Session

8.4.3.1 Session life cycle

No session is managed for the current EP+FEP.

8.4.3.2 Link monitoring

Link monitoring is done by Payload Push and KeepAlive. When data is available a payload Push is exchanged which also informs client and supplier about the session and systems status: Push received from supplier on client side and return of push on payload push on supplier side guarantee the network is available and the systems are up and running.

When no data is available at supplier and a time-out has expired a KeepAlive message is exchanged to check network and system availability.

In case payload push or KeepAlive fails or times out, the supplier assumes the client is offline and keeps trace of its status for any management purposes at the supplier system side (for delivery retry mechanism is to be described at PSM level defining a logical push mapping iterated for a maximum number of times) (Figure 17).

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