MASTERPLAN - TECHNICAL SPECIFICATION
SERVICE REGISTRY

A Service Registry of an organization supports its discoverability at '**business service**' level, and its **data sharing** capabilities. Each organization **must** have a Service Registry, either itself or provided by a third party.

1. Functionality of the Service Registry

The data structure of a Service Registry is specified by the data sharing ontology. The Service Registry can be applied in two ways:

- **Design** – to specify business activities and their choreographies with multimodal ontology. Industry associations, communities, supply chain stakeholders can do design.
- **Configure** – to specify an organizational profile by searching and selecting those parts of a design that are relevant to an organization, to specify business services, and to select the various lower layer protocols it supports (including endpoints).

A design can be general applicable, i.e. for a large variety of stakeholders and in various use cases. A design specifies generic **access control policies**, for instance by a structure of an interaction like a transport order, which is made specific by a configuration. Thus, each organization with its organizational profiles has its own access control policy aligned with its business activities, - services, and a design.

These two ways of applying the Service Registry will be described in more detail.

2. Design

Constructing a design, i.e. data structures to be shared according to a logic defined by a choreography, can be done at various levels:

- **openAPI generator (minimal)**. Only the 'interaction' and/or 'business document' concepts of the data sharing ontology are used. After specifying an interaction or business document with the multimodal ontology, an openAPI (and potentially also an XSD and/or JSON(-LD)) and its description is published. Organizations or platforms can implement this openAPI by including an endpoint.
- **Visibility pattern (events and queries)** – specification of a visibility interaction pattern for transport by specifying events that can share links to business documents and generating at least an openAPI to access the business documents and webhook APIs for sharing events. Additionally, openAPIs are generated to access data of relevant parts of the business documents, like subtypes of Digital Twins.
  Since design is shared by SHACL between Service Registers (see further), the SHACL output can also be used for data validation (see further).
  The Service Registry implements a single phase of the data sharing ontology with its states and state transition, triggered by interactions and resulting in business documents. The states and state transitions are simply indicating a sequencing of the events, like a sequence of a load event, one or more ETA events, and finally an ATA and/or a discharge event.
- **Business activity interaction patterns (maximal functionality)** – full support of the data sharing ontology enabling the construction of interaction

patterns for business activities (transport bookings, transport orders, etc.), generation of openAPIs, XSDs for messaging, and SHACL output for sharing a design and implementing data validation.

A Service Registry must at least provide the minimal functionality. A Service Registry can be developed in such a way that it is configurable for a user. In such a way, it can be upgraded to the maximal functionality.

Independent of the way a design is established, a list of connectivity protocols must be provided for configuration purposes.

3. Configuration

Configuration is at two levels, namely discovering and applying a design and specifying and publishing business services. These levels comprise an **organizational profile**, that can have the following functionality:

- **openAPIs (minimal)** – an openAPI for an interaction and/or business document is imported, and an endpoint is included. Preferably, the complete openAPI is implemented, although an organization may not necessarily support the complete functionality of an openAPI. Selection of openAPIs may include the support of visibility events and queries, the second level of design.
- **Semantic technology** – visibility events and queries are implemented by semantic technology, i.e. SHACL validation rules are generated according to the logic specified for this phase.
- **Business Services (maximal)** – one or more business activities are selected, a subtype of that business activity is specified, and business services for these subtypes are specified and published. Semantic technology is applied for data sharing. Although subtyping is specific to a business activity, subtyping of for instance 'transport' is given as:
    - **Support of Digital Twins** – selection of the Digital Twins that are supported. These may include one or more modalities and cargo.
    - **Cargo characteristics** – any additional constraints to the cargo that can be handled, e.g. weights, volumes, reefer, and dangerous cargo.

  A business service is a business activity provided in an area (transport) or at a location (transshipment). In case of a customer – or authority role, only a business activity must be selected and (potentially) subtyped.
  In addition to subtyping of a business activity by an organization, a selection of the business transaction phases must be made, indicating the data sharing capabilities. This selection can comprise all phases that are part of the design of a given business activity.

In all levels of functionality, an organizational profile must consist of at least one connectivity protocol from the available list.

4. Discoverability and interfaces of the Service Registry

The interfaces of the Service Registry are based on semantic technology, i.e. RDF/SHACL and SPARQL.

Each design and organizational profile must be discoverable. Discoverability is implemented at two levels, based on known and trusted (SPARQL) endpoints of

Service Registries. The endpoints of Service Registries must be trusted and discoverable. They are subject to Identification and Authentication.

Queries and results are at two levels:

- **Technical level** - re-use of a design for configuration and access to a configuration. SPARQL queries are formulated on the data sharing ontology and query results are specified as constraints to the multimodal ontology by SHACL. Query results must contain a design or an organizational profile of an organization with openAPIs or semantic technology for a single transaction phase. Query results must include any choices of lower layer connectivity protocols.
- **Business level** - SPARQL queries represent goals that match business services (see further). The result of a query also provides access to an organizational profile.

Any two stakeholders can share data for those parts of their organizational profile they have in common. They can do business digitally (and be compliant) if goals and business services can be matched. The more stakeholders implement of a maximal design, the more their business can be supported digital according to plug and play.

A search on **business level** is the matching of goals with **business services** or **regulatory** data requirements for compliance.

Discoverability of a business service is based on a **matching algorithm**: the goal formulated by a customer is matched with one or more business services of (potentially) different logistics service providers. Any matching algorithm is considered a value-added service in a federated network of platforms. Customers must be able to formulate their 'goals' as a subtype of a business activity (see before).

Each **authority** must publish its regulations and data requirements in their Service Registry. These regulations must be designed at least at openAPI and/or messaging level and at most as a (subtype of) a business activity applicable in an area (like a business service). A search is by matching a business activity or goal with such a regulatory type of business service.

In case a provider supports a Service Registry on behalf of its users, the organizational profile of each user must be discoverable (federated network of platforms).

5. Data quality

The model supports **data quality** at different levels, namely:

- **Data correctness** – the data that is shared must comply with its scheme, expressed by the semantic model. Correctness is expressed by SHACL (SHape Constraint Language).
- **Data completeness** – the data that is shared must be complete as specified by its scheme. At least the minimal required data set is shared according to its SHACL document.

- **Data accuracy** – the data represents a feasible state in the real world. This refers to agreed real world states like a container that can be transported by a truck, but a container cannot be used to transport a truck.
- **Data relevancy** – the data is shared according to an agreed sequence. This refers to the state transitions. State transitions are implemented by event logic.

A data holder must assure data quality of shared data. An Index implements data quality validation on actual data.

Other aspects of data quality must be implemented in practice. For instance, **timeliness** cannot be expressed by the semantic model. Other intrinsic data quality features like **believability** and **reputation** refer to Identity and Authentication of a data holder. The **data amount** and its **conciseness** are also quality aspects; these are specified by a scheme.