Annex: SynchroniCity Functional modules

These have been taken from SynchroniCity D2.10 and bring together content about each of the functional modules from section 2.2.4 *IOT Data Marketplace* and 2.3.4 *IOT Data Marketplace Interfaces*, that covers the APIs.

Module Name	**Catalogue Management**
Module Description	This module provides functionalities to publish and search for different data offerings. Data offerings can be organized into groups/categories - in a hierarchical fashion when possible - to allow for an easy navigation and discovery of them. Attributes define characteristics and properties of data offerings. They may also be inherited from a higher level in a category hierarchy. The module allows data providers to define the technical description of the data offerings they own as well as information related to the offering terms such as price, SLA, license, etc.
Main functionalities	Data catalogue curation: allows the marketplace provider to create and update both catalogues and categories in order to better organize and ease the discovery process of data offerings. Data source specification: allows data providers to register a new data source specification (prior validation to ensure the data provider ownership of the published resource) by detailing its description (e.g., version, data model, endpoint URL). Data offering publication: allows data providers to register a new data offering by linking a previously specified data source specification to pricing information, Service Level Agreements (SLAs) and license terms as well as defining the associated catalogue and categories. Data offering discovery: a list of available data offerings can be retrieved and refined by specifying keywords and filters that match description, characteristics and properties of the desired digital asset. As a result, data consumers can easily discover what kind of data offerings are available in the marketplace.
Interaction with other modules	The *catalogue management* interacts with the *SLA and license management* to bind an SLA and a license respectively to a new data offering. It interacts with the order management module when registering new orders. Information is also exchanged between this component and the *feedback and reputation* one to retrieve feedback, rating and reputation score for every digital asset. The *catalogue management* also interacts with the *federation management* to retrieve metadata information from external open data catalogues or other data marketplaces, so that different data offerings can be published within a single federated marketplace. Whenever a data provider specifies a data offering for a protected data source, this component interacts with the *security* components to check data provider's permission for that specific data source.

APIs	**Catalogue management APIs** are logically grouped into four sub-modules: ● Category management. A Category is used to group catalogues and data offerings in logical containers. Categories can contain other categories being possible to create a tree of categories. ● Catalogue management. These catalogues are collections of data offerings that are grouped together according to the data marketplace and data providers needs. ● Data source specification management. A data source specification is a detailed description of a data source made available in the form of a data offering to customers playing a data consumer role. ● Data offering management: data offerings represent entities that are orderable from data providers and are published in the catalogue. This resource includes pricing information and is linked to SLAs and license terms.
Module Name	**Offers/Orders Management**
Module Description	This module allows to order and acquire data offerings and managing acquired data sources. More specifically, a data consumer interested in purchasing a data offering available in the catalogue can place an order to finalize the purchase of that digital asset. To create a non-repudiable and clear proof regarding the terms of the agreement (i.e., SLAs and license terms) between a data consumer and a data provider, the latter are required to provide a digital signature of the order. This API allows to perform operations such as unsubscription, activation, deactivation, renew, by updating the data consumer role in the identity management according to the order status and the data consumer preferences.
Main functionalities	Ordering of data offerings: allows data consumers to purchase a specific data source offered through an offering available on the data marketplace, which can be a static batch of data or a real-time data streamed by one or more data sources. Management of purchased data offerings: allows data consumers to keep track of the assets purchased through the marketplace.
Interaction with other modules	The *order management* interacts with the revenue management component to enable monetization mechanisms, with the *transparency and accountability service* to track data usage information, and with the *security* components to update permissions of data consumers when purchasing data offerings.
	Order management APIs are logically grouped into order management and inventory management: ● Order management. Orders are made by data consumers, and include a set of order items, each specifying a data offering to be acquired. When creating an order, customers can select the value of the different pricing options (if available) to be applied and agree on SLA and license terms. ● Inventory management API. It allows data consumers to retrieve information of the data sources they have acquired, including the specific characteristics and pricing model selected.

Module Name	**Revenue (sharing) Management**
Module Description	This module allows data providers to generate revenue for their offerings by charging data consumers for purchasing them. It provides tools to manage data usage information in order to enable usage-based business models. It exposes an interface to interact with external charging platforms such as PayPal. It collects all the information required for the charging process (price, data usage, consumer identifier, etc.), which may differ according to the pricing model associated with the data offering and the outcome received by the external charging platform.
Main Components	Charging management: provides the charging functionality to the system by interacting with one or multiple charging platforms (e.g., PayPal) and performing the required actions to charge the data consumers for purchasing data offerings provided by different data providers. Management of data usage specification: allows the marketplace provider to support different data usage pricing model (e.g., Mbytes, seconds, number of calls, etc.). Revenue sharing management: allows to define revenue sharing models to distribute revenues between the involved stakeholders (e.g., revenue shared between data provider and data marketplace provider as the transaction fee). Billing management: is in charge of sending invoices to asset consumers for their purchases. The invoicing process starts when a purchasing order is completed. In case of static batch of data or services, a single invoice is sent to the consumer. Whereas, in case of real-time data, invoicing can be done through time-triggered transactions.
Interaction with other modules	The *revenue management* interacts with the *order management* as well as with external payment channels to enable monetization mechanisms by exchanging transactions outcome and charging information. It also interacts with the *customer management* to retrieve users' billing information as well as with the *transparency and accountability service* to record transactions information.
APIs	**Revenue management APIs** are logically grouped into six sub-modules: ● Usage specification management. Usage specifications are a detailed description of a usage event which can then be used in a usage pricing model. Usage specifications define all the attributes known for a particular type of usage. ● Usage management. Usage documents contain the actual usage made of a purchased data offering, including the information defined in its usage specification. ● Revenue sharing model management. A revenue sharing model specifies how the revenues must be distributed between the involved stakeholders. This API allows to retrieve, create, update, and delete revenue sharing models. ● Transaction management. API for the management of Charging Data Record (CDR) documents describing transactions. This API allows to register transactions. Additionally, it allows to launch the settlement process that aggregates the transactions and calculates the distribution of revenues.

	• Billing charges management. A billing charge includes the information of a payment made by a data consumer for a specific data offering purchased in the marketplace. Billing account management. A billing account is a description of a customer bill structure.
Module Name	**SLA and license Management**
Module Description	This module allows data providers to set, define and customize different SLAs and licenses for data offering published on the data marketplace, thus enabling the creation of a dynamic ecosystem in which data providers can establish various business models. It provides an interface to retrieve predefined data license templates so that data providers can link a data usage license instance selected among the available templates to the related data offerings. If the license templates do not fulfil the data provider needs, this API allows to customize them or create new ones in order for the license to better reflect the business model requirements. For instance, customizable templates allow to define: (i) business activity sectors for which the data may be used, (ii) purposes for purchasing and using the data, (iii) authorization to resell the data, (iv) geographical territories in which the data may be used and, (v) the date after which the authorization period to use the data ends.
Main Functionalities	License definition and customization: allows data providers to define different licenses templates based on standard licenses (e.g., GPL, Apache, Creative Commons) or based on custom models according to the specific business models chosen by the data providers. SLA specification: allows to define and manage extensible SLA for published
	data offerings in order to satisfy different stakeholder requirements. It allows to define SLAs for data offerings published in the data marketplace (e.g., delivery, timeliness, completeness, etc.).
Interaction with other modules	The *SLA and license management* interacts with the *catalogue management* to bind an SLA and a license respectively to a new data offering.
APIs	**SLA and license management APIs** are logically grouped into two sub-modules: • SLA specification management. A SLA specification is a detailed description of the SLA related to a particular data offering available in the marketplace. License specification management. A license specification is a detailed description of the terms and conditions by which the related data offering is made available through the marketplace.
Module Name	**Feedback and reputation**

Module Description	This module provides user feedback management for the different data offerings published on the marketplace. It also provides rating and reputation mechanisms to support data consumers in selecting the data offerings and to promote an honest behaviour among users.
Main Functionalities	User feedback: allows users to provide feedbacks on data offerings they have purchased. Feedbacks will be based on the quality and reliability of data sources as well as on their compliance to the related SLAs. In case of data streaming or services running for extensive periods, data consumers will be allowed to adjust their feedbacks periodically according to up-to-date levels of service. Data offerings rating: is in charge of building and maintaining a ranking of data offerings with respect to feedbacks received by the data consumers. Data provider reputation: is in charge of building overall reputations of data providers according to the rating scores of their data offerings.
Interaction with other modules	The *feedback and reputation* module interacts with the *catalogue management* and the *customer management* to exchange information regarding feedback, rate and reputation of data offerings and customers. It also interacts with the *transparency and accountability service* to track information on feedback, rate and reputation.
APIs	**Feedback and reputation APIs** provide the following main functionalities: ● User feedback: allows users to provide feedbacks on data offerings they have purchased. Feedbacks will be based on the quality and reliability of data sources as well as on their compliance to the related SLAs. ● Data offerings rating: is in charge of building and maintaining a ranking of data offerings with respect to feedbacks received by the data consumers. Data provider reputation: is in charge of building overall reputations of data providers according to the rating scores of their data offerings.
Module Name	**Customer Management**
Module Description	This module is in charge of identifying and gathering information about the users of the marketplace. It provides tools to manage customer information and related parties, which are the legal entities associated with the customer accounts. Depending on the access restrictions for the marketplace defined by the marketplace provider (e.g., city council, consortium, 3rd party), customers can be created and linked to specific roles (e.g., data provider, data consumer, administrator, etc.).
Main functionalities	Management of customer information and accounts: provides methods for the creation, retrieval, update and deletion of customer information and accounts. Management of parties: provides methods for the creation, retrieval, update and deletion of parties.
Interaction with other modules	The *customer management* interacts with the *identity management* component to retrieve users' information. It also interacts with the revenue management to retrieve users' billing information.

APIs	**Customer management APIs** are logically grouped into three sub-modules: ● Customer management API. It is used for saving customer private information that cannot be included within the party resources. ● Customer account API. Customer accounts are used as the link the billing account included in the orders to the customer objects that contain the customer contacts. Party management API. It allows to create, retrieve and update the parties.
Module Name	**Transparency and accountability**
Module Description	This module provides tools for auditing orders (including pricing model, license terms, SLAs) and tracking the parameters defined by SLAs.
Functional Components	The main functionalities provided by this module are: • Auditing orders • Tracking SLAs
Interaction with other modules	This module interacts with the revenue management to record transactions information, as well as with the *order management* Feedback and Reputation service, Offer/Order management and Customer management modules to exchange information on transactions and transparency within the marketplace.
	Transparency and accountability service provides tool for auditing orders (including pricing model, license terms, SLAs) and tracking the parameters defined by SLAs.
Module Name	**Federation Management**
Module Description	This module is in charge of managing a set of federation capabilities in accordance with the marketplace governance. Federation capabilities allow different marketplaces to interact with each other and access their resources indistinctly to provide access to data offerings across them and enable the development of aggregated services.

Main functionalities	Federation configuration: this function allows to define all the parameters related to the data offerings federation among marketplaces. For each data offering, a dissemination level parameter can be specified to enable the federation/inclusion of the data offering into other marketplaces (e.g. private, public, restricted to a specific group/network of marketplaces) and the set of information that can be shared for the related data source. Other technical parameters can be also configured to enable federation (e.g., security). Federation discovery: allows to specify all the information needed to be federated. Such information includes number/list of data offerings that can be federated, level of dissemination of the data source (e.g., specific groups or networks), last update date, security and technical access information. Every marketplace can discover the other ones by calling the federation discovery API. Data offering federation: this function provides the metadata of the data offerings exposed by a marketplace in order to be federated by other ones. The metadata exposed can be a subset of the complete metadata information of the data offering included in the original marketplace. The metadata retrieved using this function will be stored by the recipient marketplace that asked for it. Import external data catalogues: this function provides the support for retrieving metadata information related to external data catalogues. It can be used as a tool to automatically gather and expose all the datasets already published and available on different data portals directly through the marketplace.
Interaction with other modules	The *federation management* interacts with the *catalogue management* to retrieve metadata information from external open data catalogues or other data marketplaces, so that different data offerings can be published within a single federated marketplace.
APIs	**Federation management APIs** allow to create a network of federated marketplaces that exposes a common catalogue of data offerings. It is important to highlight that the federation should be considered at catalogue level: all the other functionalities, in particular the ones related to the finalization of data offering purchases, are managed by the original marketplace that “owns” the original data offering: this approach implies that security and user profile information has to be shared among the different marketplaces that are part of the federation.