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FLEXCoop

Democratizing energy markets through the introduction of innovative flexibility-based demand response tools and novel business and market models for energy cooperatives

WP4 – DATA ACQUISITION, MANAGEMENT AND SECURITY



FLEXCoop

D4.7 – FLEXCoop Common Information Model - Final Version

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FLEXCOOP CONSORTIUM PARTNERS

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S5	SUITE5 DATA INTELLIGENCE SOLUTIONS Limited
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SomEnergia	SOM ENERGIA SCCL
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EXECUTIVE SUMMARY

This deliverable provides the final version of the Common Information Model (CIM) of the FLEXCoop project.

The scope of this document is the explanation of the process followed to define a common data model of the variables that are going to be communicated between the different subsystems, including the modifications that has suffered from the preliminary version of the CIM explained in the D4.3, and the changes in the methodology from the previous deliverable. The new version of the CIM itself is submitted along with this document.

The document contents begin with a description of the CIM, with a detailed explanation of all the fields selected to determine each variable. Then an explanation of the methodology followed to include the contributions of all the partners and to solve the contradictions and discussions that emerged during the course of the task. Next, some examples of the mapping of the data structure in the standard protocols selected for the deployment of communications are displayed. Finally, the conclusion of the work made in this task.

The CIM has been defined in an Excel file that could be shared if needed to a better evaluation. In this deliverable, it has been included as an Appendix. In order to share the resulting structure, the information has been divided by components of the architecture, presenting the inputs and outputs of each one in a different sheet. The characteristics of the variables were agreed by all the partners and explained in the section 2 of this document.

The preliminary version of this deliverable was used as a reference for the implementation of the communications in T6.4 during the progress of the project. A new version has been produced, as planned in the time distribution of Task 4.2, by the end of the developments, to merge the final outcomes, formats and data exchange. This has required a common effort from all implementing partners, according to the approach adopted.

In any case, the final version of this deliverable contributes to a relevant milestone, for it reflects the common agreement for the information interfaces within the project architecture. This paved the way for ensuring the interoperability of the FLEXCoop systems, including domain-related definitions.

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ABBREVIATIONS

API	APPLICATION PROGRAMMING INTERFACE
CIM	Common Information Model
D	Deliverable
DER	Distributed Energy Resource
DR	Demand-Response
DoA	Document of Action
EC	European Commission
EMS	Energy Management System
EU	European Union
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
H2020	Horizon 2020 Programme
HTTP	HyperText Transfer Protocol
MoM	Message Oriented Middleware
OSB	Open Smart Box
PM	Person Month
PU	Public
R	Report
REST	Representational State Transfer
T	Task
VEN	Virtual End Node
VPP	Virtual Power Plant
VTN	Virtual Top Node
XML	Extensible Markup Language
WP	Work Package
Y1, Y2, Y3	Year 1, Year 2, Year 3

1. INTRODUCTION

Several definitions of data standardization can be found in the literature, such as “*the process by which similar data received in various formats is transformed to a common format that enhances the comparison process*” or “*the critical process of bringing data into a common format that allows for collaborative research, large-scale analytics, and sharing of sophisticated tools and methodologies*” [1]. All of them agree in the final goal of this standardization, which is no other than enabling data exchange within a system with common rules as a tool to reach the desired functionalities. This is especially relevant in communications or data-based architectures, such as the ones required to manage DER scenarios in a combined way to upper level business and technical goals from the service-provision or grid point of view.

The definition of a common data model is a challenging effort, especially at the beginning stages of extensive, multiple-components developments, but comes with a lot of benefits. It allows different agents to understand each other, improves the follow-up of the information flow through the system and helps the integration of the system with third parties, or the addition of new modules in the existent architecture.

FLEXCoop Task 4.2 will provide a Common Information Model (CIM) to ensure the interoperable information exchange in the system and that every partner has the necessary variables to perform their functionalities defined in the “Concept and Approach” section of the Annex I, Part B, of the FLEXCoop Grant Agreement.

A methodology has been defined to have an ordered procedure for the definition process. This task has been based on the study of the current standardization performed in D2.3 “*Analysis of EU-wide Interoperability Standards and Data Models and Harmonization Requirements*”, and the explanation of the architecture in D2.6 “*FLEXCoop Framework Architecture including functional, technical and communications specifications*” and D2.9 “*FLEXCoop Framework Architecture including functional, technical and communications specifications – Final version*”. After defining a common data structure to include the variables of the system, a recurrent process was started to periodically produce new or updated versions of the data model.

This deliverable explains the structure according to which the data are stored and the process that has been followed to achieve both the structure and the information items themselves. These outcomes required a compound effort of several partners with different necessities and concerns to be addressed. It also includes the modifications that has been made in the preliminary version to adapt this data model to the real situations founded in each demo site.

The obtained result was used by each partner to develop their communications mapping of the data structure into the selected standard protocol of its corresponding links. Also, an example of mapping for the selected protocols is shown in this deliverable.

2. DESCRIPTION OF THE COMMON INFORMATION MODEL

Based on the FLEXCoop Architecture (see also D2.6 “*FLEXCoop Framework Architecture including functional, technical and communication specifications - Preliminary Version*” for the initial version) shown in Figure 1, the communication between the different modules has to be defined in order to ensure semantic interoperability among them and within the whole system. To fulfil this purpose, a data model defining all the variables and the information exchange flows, called Common Information Model (CIM), has been developed.

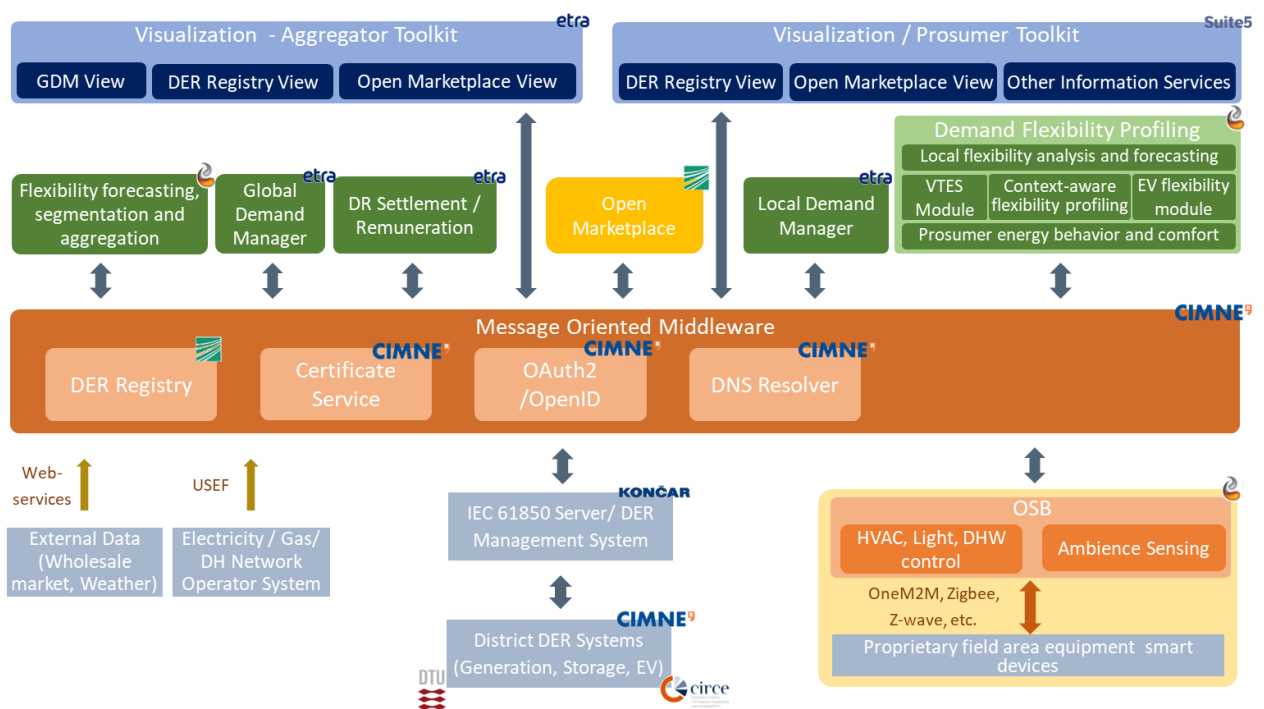


Figure 1: FLEXCoop Architecture

The definition of the data model was agreed in the meeting in Athens during month 13 (23/10/2018). The resultant document of the work in this task is included in *Appendix A: Common Information Model* at the end of this document. The format is an Excel file where each line represents a variable shared in the architecture, and the different columns show the characteristics of each variable. To make easier the reading of the document, the information has been divided in different sheets, one per component. The column structure is explained below.

The current structure is the result of the discussion between all the involved partners in the development of the different components of the architecture (CIMNE, ETRA, Fraunhofer, Hypertech, Suite5), started at the task beginning and producing the first agreed version, as an initial proposal. It has been refined and completed over the subsequent periodical teleconferences and meetings between tasks participants. This structure includes all the relevant characteristics that define a variable in the standardized FLEXCoop communication interfaces, considered by the partners as key parameters for the implementation of the FLEXCoop components. Having a common reference model helps to reduce the problems of integration of the components in the architecture that was performed in the T6.4 “*Integration of FLEXCoop Components, Preliminary Testing, Parameterization and Pre-Pilot Validation*”.

Besides the communications characteristics, another key feature included in the data model, as pointed out in the description of the task, is the use of standard models of communications, like OpenADR. As explained in chapter 3, the presented approach and the methodology of this task makes it possible to define and set the data in a technology-independent way and later assess and select the most suitable standards for mapping the information elements into communication messages. The resulting model remains available to perform this process even with new protocols, for example when designing new applications or updating the underlying components of the current architecture.

At the beginning of the project, the discussion between using OpenADR or Representational State Transfer (REST) Application Program Interface (API) was quite open, but finally was established that all the communication of the components will go through the Message Oriented Middleware (MoM) using the REST API communication, except from the information send by the Open Smart Box (OSB) that is using OpenADR. The advantage of implementing OpenADR in the FLEXCoop platform is to allow the communication not only with the OSB, but also with any other devices implementing this standard, expanding the possible devices to consider. Even given that only one component differs on the standard used, making less necessary to include this information in the data model, the correspondent column remains in the final version of the CIM. As a general consideration, this information is always interesting when facing the implementation of a data model communication.

The study of the relevant standards in this field have been included in the D2.5 “*Analysis of EU-wide Interoperability Standards and Data Models and Harmonization Requirements*” (submitted during month 12). This outcome was considered in the discussions about the CIM and was decided that the standard to be used in each communication link will be included in the final result.

Another relevant topic included in the CIM is the centralization of information. According to the initial architecture, the MoM component was handling all the information of the system, but after the initial discussions the responsible of the storage of the information was not so clear. This is an important issue to consider because of the responsibility of ensuring the security of the information according to the new EU General Data Protection Regulation (GDPR). Therefore, a new field indicating if the data is going through the middleware or not was included in the preliminary version. This was used to code if the information is stored in the MoM, because all the information going through this module has been stored on its database.

The result of the final revision was that all the information is saved in the MoM, but also other modules could store their own information in their systems. That means the column added to indicate if the information is going through the middleware in the preliminary version for this matter is no longer needed, and has been removed in the final version, as seen in Table 1: Explanation of the CIM fields.

		Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	devices	REST/JSON OpenADR	uuid		Always	1	No	Random number
			string					
			float					only set if available on device
			float	1-10				only set if available on device
			string	"1"[HEAT]/"				only set if available on device
			string	"0"[OFF]/"1"				only set if available on device
			uuid					
			uuid					
			url					
			string	"hvacDevice"				
			string	"yes"/"no"/"				
			string	"yes"/"no"				
			string	"yes"/"no"				
			point					Rounded GPS coordinate
			string	"Demand"/"				optional
			float					
float								
Outputs	devices	REST			On Request			
	devices	REST			On Request			
	devices	REST			On Request			
	devices	REST			On Request			

Figure 2: Example of variables of the final CIM. shows some examples of the final composition of the CIM. In the preliminary version there were some cases where not all the fields were completed, belonging to interfaces that were not totally defined, so their communication requirements were not concluded. At the current point of the project, the developments of the modules have been finished and all the missing fields that are relevant in each variable have been fulfilled.

		Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination
Inputs	devices	device_id	The id identifying the device	Middleware	OSB	DER Registry
		device_name	Human readable name			
		setpoint	The setpoint of the device			
		x-fanspeed	The fan speed (only hvac)			
		mode	The mode (only hvac)			
		operationState	The on/off status of the device			
		account_id	The id identifying the user			
		ven_id	The id identifying the OSB			
		aggregator_id	The id identifying the aggregator			
		device_class	The type of the device			
		availability	If the device is available			
		marketplace_availability	The availability of the device for the marketplace			
		dr_availability	The availability of the device for dr events			
		location	The location of the device			
		device_type	The quality of the device			
max_capacity	The max capacity of the device					
available_capacity	The available capacity of the device					
Outputs	devices	<i>See its details on the Input part</i>		Middleware	DER Registry	Open Market Place
	devices	<i>See its details on the Input part</i>		Middleware	DER Registry	Aggregator Toolkit
	devices	<i>See its details on the Input part</i>		Middleware	DER Registry	Prosumer Toolkit
	devices	<i>See its details on the Input part</i>		Middleware	DER Registry	Local Demand Manager

		Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	devices	REST/JSON OpenADR	uuid		Always	1	No	Random number
			string					
			float					only set if available on device
			float	1-10				only set if available on device
			string	"1"[HEAT]/"				only set if available on device
			string	"0"[OFF]/"1"				only set if available on device
			uuid					
			uuid					
			url					
			string	"hvacDevice"				
			string	"yes"/"no"/"				
			string	"yes"/"no"				
			string	"yes"/"no"				
			point					
			string	"Demand"/"				
float								
float								
Outputs	devices	REST			On Request			
	devices	REST			On Request			
	devices	REST			On Request			
	devices	REST			On Request			

Figure 2: Example of variables of the final CIM.

The following table contains the description of all the columns of the CIM.

COLUMN NAME

COLUMN MEANING

Attribute name

A representative identifier that should help to easily identify the information modelled in the attribute.

Meaning

Definition of the variable in the FLEXCoop communication context.

Container subsystem	Module from the architecture that holds the information exchange source for this attribute. Sometimes is the same as the information exchange source.
Information exchange source	Component that sends the variable to its destination element. In case of multicast communication, the variable will be duplicated or replicated in the data model with the same source.
Information exchange destination	Component that receives the variable from the source information exchange source.
Proposed suitable standards	Communications standard proposed for this specific exchange. The options vary between OpenADR and API REST.
Data type	Attribute that indicates how the variable must be interpreted in order to extract its value. Some examples are String, integer, float, etc.
Data range	Quantitative limits for the value of the magnitude or parameter coded by this attribute.
Data frequency	The periodicity which this variable is going to be sent
Granularity	This parameter shows the time distance between measurements when an historic of data is sent. For example, one measurement every 15 minutes.
Historical period	Amount of measures of the variable that are going to be sent each time a new communication occurs (depends on the frequency).
Comments	This field contains any additional information that must be considered in the development phase.

Table 1: Explanation of the CIM fields.

The variables and messages presented in the final version of the CIM gather all the modifications in the data model that had occurred during the implementation phase. These

changes are common in any project of this nature and duration because the demo sites could change during the project, and with them their necessities of communication.

The information exchanged between the components suffer several variations during the implementation process. The result is reflected on the new version of the document included in the Appendix A: Common Information Model of this document.

3. METHODOLOGY

The first step of this task was the definition of a methodology for the partners to develop the common data model in a collaborative way, in order to establish a roadmap with the appropriate milestones. The definition of a common model of data exchange is always a challenge, especially when the number of components of the architecture is high and there are several partners involved.

The beginning of the task involved the study of the results of Task 2.5 “*Smart Grids Interoperability Standards Analysis and overall system architecture design*” in D2.6 “*FLEXCoop Framework Architecture including functional, technical and communication specifications*” (submitted during month 12) and the models delivered in WP3 “*Demand Flexibility Modelling and Forecasting*”. The analysis of the role of the components of the architecture was performed in parallel with the study of the data standards coming from D2.5 “*Analysis of EU-wide Interoperability Standards and Data Models and Harmonization Requirements*”.

After this preliminary study, a workshop was performed in month 13 (during a face-to-face consortium meeting), to start an open conversation about how to structure the information of the project. The result of this discussion was a first outline of the composition of the CIM, meaning the characteristics that will define each variable were determined.

Using this outline, each partner defined a first version of the variables of each module, those that they expect to provide for the system, and those that they need to perform the functionalities established in D2.6 “*FLEXCoop Framework Architecture including functional, technical and communication*”. To speed up this process, each partner developing a component in the project worked on its own and delivered their output to CIRCE.

As leader of the task, CIRCE gathered all this information and unified it in a common version. This common version included a comparison between inputs and outputs of each module, to identify the variables that were depicted in the source and the destination component, and to check if the format of both definitions were compatible. The incompatibilities or contradictions between modules were marked so that they could be solved in the next version.

The common version was shared with the partners, pointing out the open points to discuss to the responsible for each one. The following steps were performed by a recurrent process showed in Figure 3. On that phase the work focused on solving the issues by pairs of modules. Bidirectional partner-to-partner revisions were performed, under the supervision of CIRCE and CIMNE, as leader of task and work package respectively.

Following the advances in these individual communications, CIRCE was in charge of updating the common version to share it with the rest of the partners. This process was repeated during several iterations.

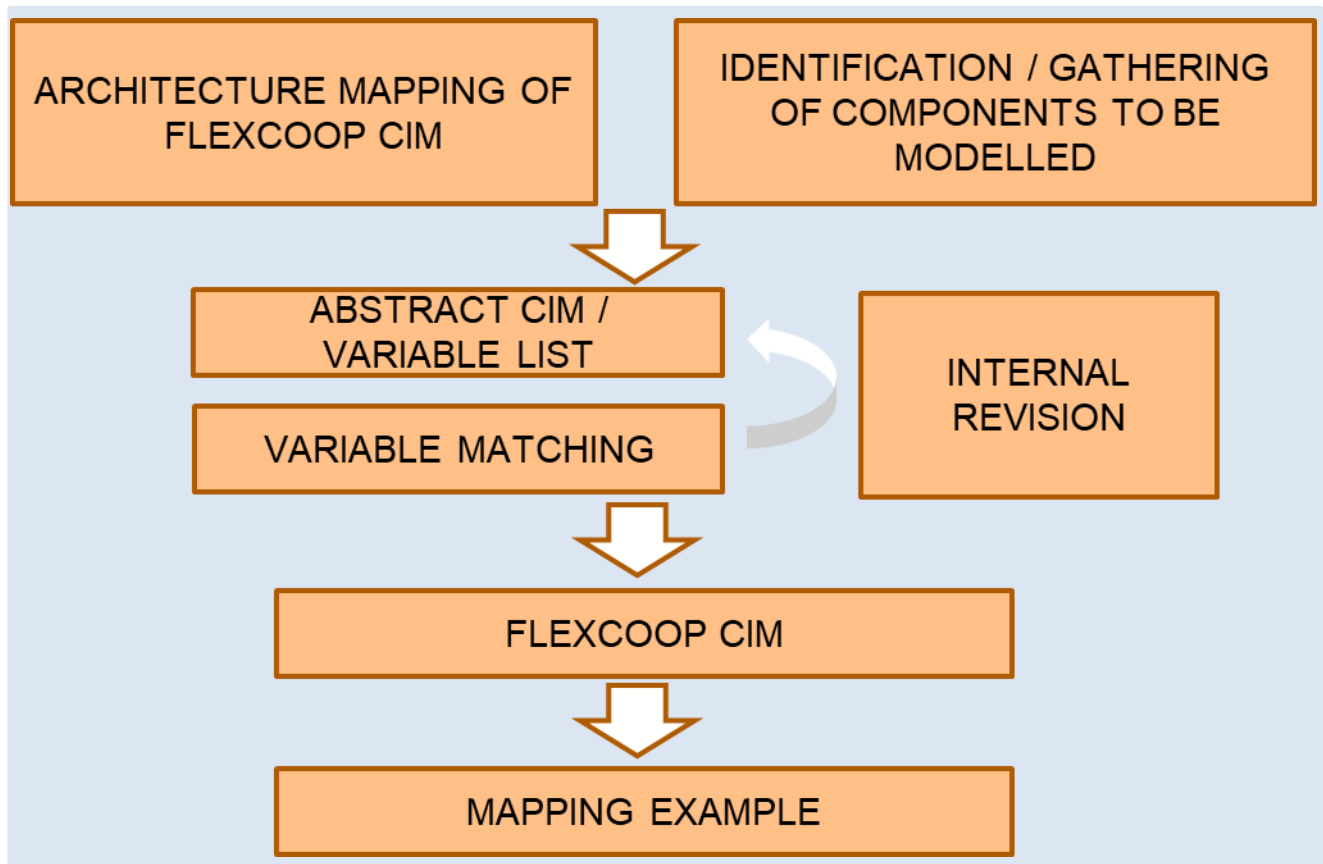


Figure 3: Methodology followed in T4.2

While parallel conversations between each two partners (the ones on the source and destination of each variable) was the fastest solution to focus on the specific aspects to be discussed, for some problems the implication of all technical partners was mandatory. The face-to-face consortium meetings that took place during the first working period of this task (from month 10 till month 20) were used to put in common the status of the document and to address the unsolved problems in technical sessions that allowed every partner to contribute in the solution.

A common version was generated highlighting the main considerations to be addressed. A technical workshop for the CIM was organized taking advantage of a consortium meeting celebrated in Barcelona during month 17. With the help of all the partners, all corresponding points were dealt with one by one, and most of them were clarified.

The result was a document, the previous version of the current one, containing all the needed modifications. Each partner looked over its contributions and modified what was necessary. The iterative process established previously was carried out again until the last consortium meeting in Zagreb (15/04/2019) during month 19, where the last inconsistencies of the CIM were worked out in a specific working session.

For the final version all the methodology followed during the initial discussions was continued in the implementation tasks between the partners involved. During the main implementation

process this task was pushed into the background until the changes performed by each partner were consolidated.

This process was arranged in several sprints. Each sprint includes only some components of the architecture, carrying out the iteration methodology followed in the previous version of the CIM. Contradictions founded were solved before moving on to the next sprint, where new components were added to the validated version, and the verification process includes both the consolidated and new components. This process continued until having all the components consolidated.

By the time of submitting this deliverable, an update from each partner was requested to ensure that any change in the data was reflected in the final version, and the same process of iteration until solving all the problems was performed. The result of this last procedure is the one gathered in the Appendix A: Common Information Model.

4. EXAMPLE OF FLEXCOOP CIM MAPPING INTO STANDARDS

One of the main goals of defining a Common Information Model, is to be able to develop different protocol communications in different links without losing the interoperability and data cohesion of the system.

In the analysis performed in Task 2.5 “*Smart Grids Interoperability Standards Analysis and overall system architecture design*”, a broad study of the most relevant interoperability standards and data models was presented. Using this information, two standards were selected: OpenADR and Representational State Transfer (REST).

OpenADR is a flexible data model to facilitate common information exchange between electricity service providers, aggregators, and end users. The concept of an open specification is intended to allow anyone to implement the two-way signalling systems, providing the servers that publish information to the automated clients subscribing to the information. This standard covers the signalling data models and includes information related to specific Demand Response (DR) electric reduction or shifting strategies, which are taken at the facility. This standard can be leveraged to manage customer energy resources, including load, generation and storage, via signals provided by grid and/or market operators. These resources may be identified and managed as individual resources with specific capabilities, or as virtual resources with an aggregated set of capabilities.

There are several services that allows the communications of different messages between the Virtual Top Node (VTN) and the Virtual End Nodes (VENs). The OpenADR 2.0b profile supports the following services:

- EiEvent – to notify the VENs of upcoming DR events and sending DR signals from VTN to VEN
- EiOpt – to opt-in and opt-out capability by the VEN
- EiReport – to share all kind of information between the openADR components; typically is used to perform the monitoring capability of the device metrics
- EiRegisterParty – to establishment the communication between a VEN and a VTN.

In the FLEXCoop project, the EiReport will be used to gather the different measured data coming from the OSB. The EiEvents is used to send the actions to be performed by the devices.

OpenADR defines eight standard Reports to send information to the VTN, but it admits the possibility to define new reports with other names if necessary. In the scope of the FLEXCoop project we are going to use the “TELEMETRY_STATUS” for the changes on the devices status and the “TELEMETRY_USAGE” for the data reported by the meterings and sensors.

The messages are encapsulated in Extensible Markup Language (XML) format. In Code Listing 1 there is an example of a current EiReport message of the definitive data exchange between the OSB and the MoM.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ns8:oadrPayload xmlns="http://www.w3.org/2000/09/xmldsig#" xmlns:ns2="http://docs.oasis-
open.org/ns/energyinterop/201110" xmlns:ns3="http://docs.oasis-
open.org/ns/energyinterop/201110/payloads" xmlns:ns4="http://docs.oasis-
open.org/ns/emix/2011/06" xmlns:ns5="urn:ietf:params:xml:ns:icalendar-2.0"
xmlns:ns6="http://naesb.org/espi" xmlns:ns7="urn:ietf:params:xml:ns:icalendar-2.0:stream"
xmlns:ns8="http://openadr.org/oadr-2.0b/2012/07" xmlns:ns9="http://www.w3.org/2005/Atom"
xmlns:ns10="http://docs.oasis-open.org/ns/emix/2011/06/power"
xmlns:ns11="http://www.opengis.net/gml/3.2" xmlns:ns12="http://docs.oasis-
open.org/ns/emix/2011/06/siscale" xmlns:ns13="http://www.w3.org/2009/xmldsig11#"
xmlns:ns14="urn:un:unece:uncefact:odelist:standard:5:ISO42173A:2010-04-07">
  <ns8:oadrSignedObject>
    <ns8:oadrUpdateReport>
      <ns3:requestID>0</ns3:requestID>
      <ns8:oadrReport>
        <ns5:duration>
          <ns5:duration>P3Y6M4DT12H30M5S</ns5:duration>
        </ns5:duration>
        <ns7:intervals>
          <ns2:interval>
            <ns5:dtstart>
              <ns5:date-time>2019-09-24T12:14:03.784</ns5:date-time>
            </ns5:dtstart>
            <ns5:duration>
              <ns5:duration>P3Y6M4DT12H30M5S</ns5:duration>
            </ns5:duration>
            <ns5:uid>
              <ns5:text>0</ns5:text>
            </ns5:uid>
            <ns8:oadrReportPayload>
              <ns2:rID>multisensor_4_Test_OpenSpaceEL_sensingDevice_1_sensorLuminance</ns2:rID>
              <ns2:payloadFloat>
                <ns2:value>25.0</ns2:value>
              </ns2:payloadFloat>
            </ns8:oadrReportPayload>
          </ns2:interval>
        </ns7:intervals>
        <ns2:eiReportID>1</ns2:eiReportID>
        <ns2:reportRequestID>0</ns2:reportRequestID>
        <ns2:reportSpecifierID>RP_1</ns2:reportSpecifierID>
        <ns2:reportName>TELEMETRY_USAGE</ns2:reportName>
        <ns2:createdDateTime>2019-09-24T12:14:03.784</ns2:createdDateTime>
      </ns8:oadrReport>
      <ns2:venID>da7d5c6a-175b-11ea-acfc-ac1f6b403fbc</ns2:venID>
    </ns8:oadrUpdateReport>
  </ns8:oadrSignedObject>
</ns8:oadrPayload>
```

Code Listing 1: Example of ADR report

REST communication is a software architecture for web development sustained by HTTP standard. Basically, it establishes a set of rules that must be followed in the definition of an Application Program Interface (API). Nowadays REST API are widely used in many projects.

In the Code Listing 2 it can be seen an example of the JSON message communicated from the Local Demand Manager component to the Message Oriented Middleware by using the REST API. This is the same format that the Global Demand Manager will get from the Message Oriented Middleware when requesting this information by using, also, the API REST.

```
[
  {
    ldem_id: 'cd8dd006-4998-11ea-9280-ac1f6b403fbc'
    account_id: 'a95efc1a-482e-11ea-9280-ac1f6b403fbc'
    aggregator_id: 'flexcoop.somenergia.coop'
    start: '21 May 2020 07:00:00 GMT',
    end: '21 May 2020 07:14:59 GMT',
    baseline: 591.1346,
    upwards_flex: 794.5241,
    downwards_flex: 551.50977,
    devices: ["a95efc1a-482e-11ea-9280-ac1f6b403fbc", "b94efc1b-472e-99bb-9320-
ac1f6b4012ea"]
  },
  {
    ldem_id: 'cd8dd006-4998-11ea-9280-ac1f6b403fbc'
    account_id: 'a95efc1a-482e-11ea-9280-ac1f6b403fbc'
    aggregator_id: 'flexcoop.somenergia.coop'
    start: '21 May 2020 07:15:00 GMT',
    end: '21 May 2020 07:29:59 GMT',
    baseline: 591.1346,
    upwards_flex: 794.5241,
    downwards_flex: 551.50977,
    devices: ["a95efc1a-482e-11ea-9280-ac1f6b403fbc", "b94efc1b-472e-99bb-9320-
ac1f6b4012ea"]
  },
  {
    ldem_id: 'cd8dd006-4998-11ea-9280-ac1f6b403fbc'
    account_id: 'a95efc1a-482e-11ea-9280-ac1f6b403fbc'
    aggregator_id: 'flexcoop.somenergia.coop'
    start: '21 May 2020 07:30:00 GMT',
    end: '21 May 2020 07:45:59 GMT',
    baseline: 591.1346,
    upwards_flex: 794.5241,
    downwards_flex: 551.50977,
    devices: ["a95efc1a-482e-11ea-9280-ac1f6b403fbc", "b94efc1b-472e-99bb-9320-
ac1f6b4012ea"]
  },
  ...
]
```

Code Listing 2: JSON format for 'attribute'

5. CONCLUSIONS AND NEXT STEPS

The final version of the CIM is included in this document in the Appendix A: Common Information Model. This is the result of the effort of all the technical partners involved in the development of the components (CIMNE, ETRA, Fraunhofer, Hypertech, Suite5) of the FLEXCoop architecture. This effort has been supervised by CIRCE and CIMNE, as leaders of the Task and Work Package respectively.

The data model has been the basis for the development of communications in the corresponding tasks of WP4 “*Data Acquisition, Management and Security*”, WP5 “*Open Demand Response Optimization Framework and Tools for Aggregators*” and WP6 “*Semantically Enhanced DER Registry and Open Marketplace for Flexibility Sharing*”. It is important to follow the format agreed with the rest of the partners, because otherwise incompatibility problems could arise in the future when trying to integrate the individual developments into the general architecture. Having a common data model is also useful for the future, in case of trying to integrate the architecture with third parties, adding new components or updating the existing ones. Besides, in case a different protocol is going to be used in the implementation of a new communication, with just mapping the CIM in the structure of the protocol, the communication should work without inconsistencies.

During the core development work of the project, some relevant changes in the CIM were performed. These changes during implementation are common in data models, because usually the initial idea for the communication variables will not match entirely with the capabilities of the system to provide it. That was the reason to have a second revision of the model at the end of the project.

This final revision has no direct value for the developers in terms of helping to implement de communications, as the previous version was, but it is in terms of reviewing the work done, comparing it with the initial proposal and analysing which variables were discarded or not necessary and which have been added, to improve the initial proposals in future developments.

The final version of the CIM reflects the data exchanged in the communication between components, after all the modules have been developed, integrated and tested, and the communications are the definitive ones, providing the expected result for this task.

FLEXCoop Common Information Model supposes an effort in order to standardize the data exchange of the relevant agents in the energy market, supported by the study performed in D2.3 “*Analysis of EU-wide Interoperability Standards and Data Models and Harmonization Requirements*”. This study nowadays is out to date, as it was reflected in D8.10 “*Standardization punch-list and promotion activities*”, and new solutions should be taken into account, especially in terms of ontology solutions, to work on the sense of having a unique data exchange technology that could serve along Europe to all the agents and stakeholders involved.

REFERENCES

- [1] Q. He, «"Three lessons of data standarization",» 2016. Available:
<https://www.linkedin.com/pulse/three-lessons-data-standardization-qi-he>.

APPENDIX A: COMMON INFORMATION MODEL

Here the complete Common Information Model is included as images of the sheets of the Excel file. Each sheet includes the information relative to a component of the architecture.

	Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	dr_campaign_step	See its details on the "Global Demand Manager" tab		Middleware	Global Demand Manager	DR Settlement & Remuneration	REST	On the "Global Demand Manager"	15 minutes	N/A	N/A	Each element of this type represents one step of the timeline of the DR Campaign
	contract	See its details on the "Open Marketplace" tab		Middleware	Open Marketplace	DR Settlement & Remuneration	REST	On the "Open Marketplace"	On demand			
Outputs	dr_campaign_id	Identifier of the dr_campaign where this remuneration belongs to	Middleware	DR Settlement & Remuneration	Global Demand Manager	REST	uuid		On demand	15'	N/A	
	start	The period of time where this remuneration refers to					datetime					
	end	The period of time where this remuneration refers to					datetime					
	account_id	Identifier of the user this remuneration belongs to					uuid					
	remuneration	Economical remuneration					float					
	dr_campaign_remuneration	Detailed above		Middleware	DR Settlement & Remuneration	Aggregator GUI			On demand			
	dr_campaign_id	Identifier of the dr_campaign where this step belongs to	Middleware	DR Settlement & Remuneration	Global Demand Manager	REST	uuid		On demand	N/A	N/A	(id, flex) are the attributes contained on each item of an array attached to this dr_campaign_baseline_step variable (id_backup, flex_backup) are the attributes contained on each item of an array attached to this dr_campaign_baseline_step variable
	start	When the step begins					datetime					
	end	When the step ends					datetime					
	flexibility	Amount of flexibility needed during this step					float					
id	Identifier of the selected idem for delivering some flexibility	uuid										
flex	Amount of flexibility that this idem should deliver	float										
backup_id	Identifier of the backup idem	uuid										
backup_flex	Amount of flexibility that this backup idem should deliver if it has to participate	float										
remuneration[]	See its details on the "Prosumer portal" tab		Middleware	DR Settlement & Remuneration	Prosumer Portal	REST	On the "Prosumer portal"	On demand	N/A	N/A		

Figure 4.- Complete Data Model for DR Settlement & Remuneration

	Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	global_optimization	on the "Global Demand M	Middleware	Global Demand Manager	Aggregator GUI	REST	On the "Global Demand		On demand	N/A	N/A	
	vpp	on the "Global Demand M	Middleware	Global Demand Manager	Aggregator GUI	REST	On the "Global Demand		On demand	N/A	N/A	
	der[]	details on the "DER Regist	Middleware	DER Registry	Aggregator GUI	REST	etails on the "DER Regis		On demand	N/A	N/A	
	contract	ails on the "Open Marketp	Middleware	Open Marketplace	Aggregator GUI	REST	ails on the "Open Marke		On demand	N/A	N/A	
	contract_message	ails on the "Open Marketp	Middleware	Open Marketplace	Aggregator GUI	REST	ails on the "Open Marke		On demand	N/A	N/A	
	inter_component_msg	etails on the "Middlewar	Middleware	Middleware	Aggregator GUI	REST	etails on the "Middlewa		On demand	N/A	N/A	
	dr_campaign[]	on the "Global Demand M	Middleware	Global Demand Manager	Aggregator GUI	REST	on the "Global Demand		On demand	N/A	N/A	
	btp_message	on the "Global Demand M	Middleware	Global Demand Manager	Aggregator GUI	REST	on the "Global Demand		On demand	N/A	N/A	
	btp_bid	on the "Global Demand M	Middleware	Global Demand Manager	Aggregator GUI	REST	on the "Global Demand		On demand	N/A	N/A	
	btp_bid_line	on the "Global Demand M	Middleware	Global Demand Manager	Aggregator GUI	REST	on the "Global Demand		On demand	N/A	N/A	
dr_campaign_remuneration	the "DR Settlement & Ren	Middleware	DR Settlement & Remuneration	Aggregator GUI	REST	the "DR Settlement & Re		On demand	N/A	N/A		

Figure 5.- Complete Data Model for Aggregator GUI

	Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments	
Inputs	local_demand_manager	idem_id	Unique identifier of the LDEM	Middleware	Middleware	Local Demand Manager	uuid		On demand	N/A	N/A		
		account_id	Identifier of the account where this LDEM belongs				string						
		idem_id	Identifier of the DR Campaign where this LDEM belongs				string						
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		creation_date	When the LDEM was registered on the system				datetime						
	dr_event_idem_request	idem_id	Identifier of the LDEM receiving this request	Middleware	Global Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A		
		aggregator_id	Identifier of the aggregator where this request originates				string						
		idem_id	Identifier of the LDEM receiving this request				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
Outputs	dr_event_idem_baseline_step	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		15 minutes	N/A	N/A	consumption, modification, account_id, device_id are the attributes contained on each item of an array attached to this dr_event_idem_baseline_step	
		aggregator_id	Identifier of the aggregator where this DR Campaign belongs				string						
		idem_id	Identifier of the LDEM where this step belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	dr_campaign	idem_id	Unique identifier of the DR Campaign	Middleware	Global Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A		
		aggregator_id	Identifier of the aggregator where this DR Campaign belongs				string						
		start	When the DR Campaign begins				datetime						
		end	When the DR Campaign ends				datetime						
		duration	The duration (in minutes) of the DR Campaign				integer						
Attributes	contract	idem_id	Unique identifier of the DR Campaign	Middleware	Open Marketplace	Local Demand Manager	uuid		On demand	See its details on the "Open Marketplace" tab	N/A	See its details on the "Open Marketplace" tab	
		aggregator_id	Identifier of the aggregator where this DR Campaign belongs				string						
		idem_id	Identifier of the LDEM where this step belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	idem_flex_step	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		Daily	N/A	N/A	See its details on the "DER Registry" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
Attributes	localFlexibilityProfile	idem_id	Unique identifier of the LDEM	Demand Flexibility Profiling	Local Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A	See its details on the "Demand Flexibility Profiling" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	weather	idem_id	Unique identifier of the LDEM	Demand Flexibility Profiling	Local Demand Manager	Local Demand Manager	uuid		1 hour	N/A	N/A	See its details on the "Weather" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
Attributes	thermalComfortLevels	idem_id	Unique identifier of the LDEM	Demand Flexibility Profiling	Local Demand Manager	Local Demand Manager	uuid		1 hour	1 hour	N/A	See its details on the "Thermal Comfort Levels" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	pv_forecast	idem_id	Unique identifier of the LDEM	Middleware	Middleware	Local Demand Manager	uuid		1 hour	1 hour	N/A	See its details on the "PV Forecast" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
Attributes	buildingsParametersResponse	idem_id	Unique identifier of the LDEM	Demand Flexibility Profiling	Local Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A	See its details on the "Buildings Parameters Response" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	dr_campaign	idem_id	Unique identifier of the DR Campaign	Middleware	Local Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A		
		aggregator_id	Identifier of the aggregator where this DR Campaign belongs				string						
		start	When the DR Campaign begins				datetime						
		end	When the DR Campaign ends				datetime						
		duration	The duration (in minutes) of the DR Campaign				integer						
Attributes	control_signal	idem_id	Unique identifier of the LDEM	Local Demand Manager	Local Demand Manager	Demand Flexibility Profiling	uuid		On demand	N/A	N/A	See its details on the "Control Signal" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	local_optimization	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Global Demand Manager	uuid		Daily	N/A	N/A	See its details on the "Local Optimization" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
Attributes	dr_event_idem_baseline_step	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		15 minutes	N/A	N/A	consumption, modification, account_id, device_id are the attributes contained on each item of an array attached to this dr_event_idem_baseline_step	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this step belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	idem_flex_step	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Global Demand Manager	uuid		Daily	15'	N/A	Each element of this type represents one step of the next 24h flexibility of the indicated LDEM	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
idem_flex_step	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		Daily	15'	N/A	Each element of this type represents one step of the next 24h flexibility of the indicated LDEM		
	aggregator_id	Identifier of the aggregator where this LDEM belongs				string							
	idem_id	Identifier of the LDEM where this flexibility belongs to				string							
	start	When this step begins				datetime							
	end	When this step ends				datetime							
Attributes	dr_campaign_idem_step	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		On demand	15'	N/A	See its details on the "DR Campaign Idem Step" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this step belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
	Attributes	DemandFlexibilityRequest	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A	See its details on the "Demand Flexibility Request" tab
			aggregator_id	Identifier of the aggregator where this LDEM belongs				string					
			idem_id	Identifier of the LDEM where this flexibility belongs to				string					
			start	When this step begins				datetime					
			end	When this step ends				datetime					
Attributes	BuildingParametersRequest	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A	See its details on the "Building Parameters Request" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
Attributes	ThermalComfortLevelRequest	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Local Demand Manager	uuid		On demand	N/A	N/A	See its details on the "Thermal Comfort Level Request" tab	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						
Attributes	device_flex_step	idem_id	Unique identifier of the LDEM	Middleware	Local Demand Manager	Global Demand Manager	uuid		Daily	15'	N/A	Each element of this type represents one step of the next 24h flexibility of the indicated LDEM	
		aggregator_id	Identifier of the aggregator where this LDEM belongs				string						
		idem_id	Identifier of the LDEM where this flexibility belongs to				string						
		start	When this step begins				datetime						
		end	When this step ends				datetime						

Figure 6: Complete Data Model for Local Demand Manager

	Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments		
Inputs	local_demand_manager	idem_id	Unique identifier of the LDEM	Middleware	Middleware	Global Demand Manager	REST	uid		15 minutes	N/A	N/A	Each element of this type represents one LDEM	
		account_id	Identifier of the account where this LDEM belongs to					uid						
		vep_id	VPE of the DR linked to this LDEM					uid						
		aggregator_id	Identifier of the aggregator where this LDEM belongs to					uid						
		location_data	When the LDEM was registered on the system					string						
	dr_campaign_timeline_step	timestamp	Currently used it is not being used	Middleware	Middleware	Global Demand Manager	REST	datetime	See its details on the Output part	15 minutes	N/A	N/A	Each element of this type represents one step of the timeline of the DR	
		global_aggregated_flexibility	Economically new it is not being used					uid						
		time_stamp	When this data belongs to					datetime						
		day_ahead_price	Price of the energy on that timestamp					float						
		country	Country of this cost					string						
	dr_campaign_baseline_step	dr_campaign_id	Identifier of the dr_campaign where this remuneration belongs to	Middleware	DR Settlement & Remuneration	Global Demand Manager	REST	uid	See its details on the Output part	On demand	N/A	N/A	Each element of this type represents one step of the dr_campaign	
		start	The period of time where this remuneration refers to					datetime						
		end	The period of time where this remuneration refers to					datetime						
		account_id	Identifier of the user this remuneration belongs to					uid						
		remuneration	Economical remuneration					float						
Outputs	dr_campaign	dr_campaign_id	Unique identifier of the DR Campaign	Middleware	Global Demand Manager	Middleware	REST	uid		On demand	N/A	N/A		
		aggregator_id	Identifier of the aggregator where this DR Campaign has been created					uid						
		start	When the DR Campaign has been created					datetime						
		end	When the DR Campaign begins					datetime						
		duration	The duration (in minutes) of the DR Campaign					integer						
	dr_campaign_timeline_step	dr_campaign_id	Identifier of the dr_campaign where this timeline belongs to	Middleware	Global Demand Manager	Middleware	REST	uid		On demand	N/A	N/A		
		start	When this step begins					datetime						
		end	When this step ends					datetime						
		flexibility	The flexibility requested at the end of this step					float						
		dr_campaign_id	Identifier of the dr_campaign where this requested belongs to					uid						
	dr_event_idem_request	idem_id	Identifier of the LDEM receiving this request	Middleware	Global Demand Manager	Local Demand Manager	REST	uid		On demand	N/A	N/A		
		selected	If the LDEM has been selected to participate on the DR Campaign					boolean						
		start	When this step begins					datetime						
		end	When this step ends					datetime						
		flexibility	The flexibility requested at the end of this step					float						
vpp	vpp	cluster_id	Unique identifier of the cluster	Middleware	Global Demand Manager	Aggregator GUI	REST	uid		On demand	N/A	N/A	The names are contained on each item of an array attached to the	
		name	Name of the cluster					string						
		reliability	Reliability of this cluster when delivering flexibility					float						
		devices_id	Identifiers of the devices that belongs to this cluster					(uid)						
		items_id	Identifiers of the items that belong to this cluster					(uid)						
	vpp	upwards_flex	Total upwards flexibility of this cluster	Middleware	Global Demand Manager	Global Demand Manager	REST	float		Daily	N/A	N/A	The names are contained on each item of an array attached to the	
		downwards_flex	Total downwards flexibility of this cluster					float						
		aggregator_id	Identifier of the aggregator where this VPP belongs to					uid						
		location	Location of the aggregator					string						
		criteria	Criteria followed for creating this VPP					(string) ["afRR", "self-consumption", "wholesale"]						
btp_bid	btp_bid	bid_id	Unique identifier of the bid	Middleware	Global Demand Manager	Aggregator GUI	REST	uid		Daily	N/A	N/A	btp_bid are the attributes contained on each item of an array	
		timestamp	When this bid was created					datetime						
		status	Current status of the bid					string						
		btp	Identification of the supplier of balancing, and/or transport cost					uid						
		request	Identification of the request of balancing, and/or transport cost					uid						
	btp_bid_line	request	If the message is submitted at TenneT's request, the TenneT id	Middleware	Global Demand Manager	Aggregator GUI	REST	integer		Daily	N/A	N/A		
		date_of_delivery	The date for which the bids relate					datetime						
		btp_bid	Identifiers of the btp_bids attached to this bid_message					(uid)						
		bid_id	Unique identifier of the bid					uid						
		contract	Identification of the contract between the BSP/TSP and TenneT					string						
btp_bid_line	btp_bid_line	reference	BSP/TSP issued unique identification of the bid as part of the object	Middleware	Global Demand Manager	Aggregator GUI	REST	string		Daily	N/A	N/A		
		operation_period	An object enables a BSP/TSP to couple two bids, from an object SP interval relates to current for which bid is available to be delivered					string						
		minimum_number_of_consecutive_bids	Minimum number of consecutive bids for admissible activation					integer (0, 67)						
		quantity_requested	Quantity requested (downward)					float (0, 999)						
		quantity_delivered	Quantity delivered (downward)					float (0, 999)						
	btp_bid_line	location	Location of the aggregator	Middleware	Global Demand Manager	Aggregator GUI	REST	string		Daily	N/A	N/A		
		aggregator_id	Identifier of the aggregator where this VPP belongs to					uid						
		criteria	Criteria followed for creating this VPP					(string) ["Spain", "Netherlands"]						
		bid_id	Unique identifier of the bid					uid						
		bid_price	Energy price					float (0, 10000000, 100000000)						
dr_campaign_step	dr_campaign_step	dr_campaign_id	Unique identifier of the DR Campaign where this step belongs to	Middleware	Global Demand Manager	DR Settlement & Remuneration	REST	uid		15'	N/A	N/A	Each element of this type represents one finalized step of the dr_campaign (id, flexibility_requested, flexibility_delivered) are the attributes contained on each item of an array attached to this dr_campaign_step	
		start	When this step begins					datetime						
		end	When this step ends					datetime						
		flexibility_requested	Amount of flexibility that was requested during this step					float						
		flexibility_delivered	Amount of flexibility that was delivered during this step					float						
	global_optimization	global_optimization	idem_id	Unique identifier of the LDEM that was selected for delivering	Middleware	Global Demand Manager	Aggregator GUI	REST	uid		On demand	N/A	N/A	(account_id, a_down, a_up) are the attributes contained on each item of an array attached to this global_optimization variable
			flexibility_requested	Amount of flexibility requested to this LDEM during this step					float					
			flexibility_delivered	Amount of flexibility delivered by this LDEM during this step					float					
			aggregator_id	Identifier of the aggregator where this optimization belongs to					uid					
			timestamp	When this optimization was created					datetime					
dr_campaign_step	dr_campaign_step	start	When this optimization begins	Middleware	Global Demand Manager	Aggregator GUI	REST	datetime		On demand	N/A	N/A		
		end	When this optimization ends					datetime						
		consumption	Economical cost					float						
		account_id	Identifier of the user affected by this optimization					uid						
		a_down	If this user has to activate his/her up regulation					float (0, 1)						
dr_campaign_step	dr_campaign_step	a_up	If this user has to activate his/her up regulation	Middleware	Global Demand Manager	Aggregator GUI	REST	float (0, 1)		On demand	N/A	N/A		
		dr_campaign_id	Identifier of the dr_campaign where this optimization belongs to					uid						
		start	When this optimization begins					datetime						
		end	When this optimization ends					datetime						
		consumption	Economical cost					float						

Figure 7: Complete Data Model for Global Demand Manager.

		Attribute name	Meaning	Container/Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	devices	device_id	Unique identifier of the device	Middleware	Middleware	Prosumer Portal	REST/JSON	uuid		On demand	N/A	N/A	
		setpoint	Current setpoint of the device					float					
		mode	Current mode of the device					string	1, 2, 3, 4, 5				
		operationState	Current operation state of the device					string	0, 1				
		account_id	Identifier of the account where this device belongs to					uuid					
		aggregator_id	Identifier of the aggregator where this device belongs to					uri					
		dr_availability	Current availability of the device for DR events					string	yes, no				
		marketplace_availability	Current availability of the device in marketplace					string	yes, no				
	meter[]	device_class	Type of device	Middleware	Middleware	Prosumer Portal	REST/JSON	string	dhwDevice, prosumerDeviceMetering, pvDevice	On demand	N/A	N/A	
		timestamp	timestamp of the metric					datetime					
		voltage	voltage metric					float					
		device_id	Unique identifier of the device					uuid					
		account_id	Identifier of the account where this device belongs to					uuid					
		kwh	energy metric					float					
		watts	power metric					float					
		current	current metric					float					
	aggregator_id	Identifier of the aggregator where this device belongs to	uri										
	contracts []	See its details on the "Open Marketplace" tab	Middleware	Middleware	Prosumer Portal	REST/JSON	See its details on the "Open Marketplace" tab		On demand				
	contract_message	See its details on the "Open Marketplace" tab	Middleware	Middleware	Prosumer Portal	REST/JSON	See its details on the "Open Marketplace" tab		On demand				
	interComponentMessage	See its details on the "Middleware" tab	Middleware	Middleware	Prosumer Portal	REST/JSON	See its details on the "Middleware" tab		On demand				
	remuneration[]	contract_id	Identifier of the contract	Middleware	Middleware	Prosumer Portal	REST/JSON	uuid		On demand	N/A	N/A	
		aggregator_id	Identifier of the aggregator where this device belongs to					uuid					
		account_id	Identifier of the account where this contract belongs to					uuid					
		contract_type	the type of the contract					string	for flex more_sun_energy_at_home more_en				
		timestamp	the timestamp of the remuneration					string					
		notifications_number	the number of events triggered					float					
		activation_period	the active period for a DR event					float					
		max_bid_size	the max DR request					float					
		total_bid_size	the total DR request					float					
		penalty	the penalty for non participation					float					
		prosumer_profit	the profit from DR participation					float					
		energy_saving	energy savings of the user					float					
cost_saving		cost savings of the user	float										
CO2_saving		CO2 savings of the user	float										
service_fee		the fee for the ESCO service	float										
max_number		the number of DR controls delivered	float										
prosumer_profit	the profit from market participation	float											
self_cons	the level fo self consumption for the user	float											
dr_events	See its details on the "Middleware" tab	Prosumer Portal	Prosumer Portal	Middleware	REST/JSON	See its details on the "Middleware" tab		On demand	N/A	N/A			
Outputs	comfortProfiles	WaterProfile	User Setting for DHW management	Prosumer Portal	Prosumer Portal	Middleware	REST/JSON	float		On demand	N/A	N/A	
		thermalComfortCool	User Setting for HVAC COOL management					float					
		visualComfortProfile	User Setting for LIGHTS management					string	Dim, Less Bright, Neutral, Bright, Very Bright				
		thermalComfortHeat	User Setting for HVAC HEAT management					float					
		account_id	Identifier of the account where this profile belongs					string					

Figure 8: Complete Data Model for Prosumer Portal

		Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	devices	device_id	The id identifying the device	Middleware	OSB	DER Registry	REST/JSON OpenADR	uuid		Always	1	No	Random number
		device_name	Human readable name					string					
		setpoint	The setpoint of the device					float					
		x-fanspeed	The fan speed (only hvac)					float	1-10				
		mode	The mode (only hvac)					string	"1"[HEAT]"/"				
		operationState	The on/off status of the device					string	"0"[OFF]"/"1"				
		account_id	The id identifying the user					uuid					
		ven_id	The id identifying the OSB					uuid					
		aggregator_id	The id identifying the aggregator					url					
		device_class	The type of the device					string	"hvacDevice"				
		availability	If the device is available					string	"yes"/"no"/"				
		marketplace_availability	The availability of the device for the marketplace					string	"yes"/"no"				
		dr_availability	The availability of the device for dr events					string	"yes"/"no"				
		location	The location of the device					point					
		device_type	The quality of the device					string	"Demand"/"				
		max_capacity	The max capacity of the device					float					
		available_capacity	The available capacity of the device					float					
Outputs	devices	<i>See its details on the Input part</i>			Middleware	DER Registry	Open Market Place	REST		On Request			
	devices	<i>See its details on the Input part</i>			Middleware	DER Registry	Aggregator Toolkit	REST		On Request			
	devices	<i>See its details on the Input part</i>			Middleware	DER Registry	Prosumer Toolkit	REST		On Request			
	devices	<i>See its details on the Input part</i>			Middleware	DER Registry	Local Demand Manager	REST		On Request			

Figure 9: Complete Data Model DER Registry

		Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	dr_events	device_id	The id identifying the device	middleware	middleware	OSB	OpenADR (event)	uuid		On Request		No	
		account_id	The id identifying the user					uuid					
		aggregator_id	The id identifying the aggregator					url					
		marketplace_availability	The availability of the device for marketplace					string	"yes"/"no"/"				
		dr_availability	The availability of the device for dr events					string	"yes"/"no"				
		setpoint	The setpoint of the device					float					
		x-fanspeed	The fan speed (only hvac)					float	1-10				
		mode	The mode (only hvac)					string	"1"[HEAT]"/"2"[COOL]"/"3"[FAN]"/"4"				
operationState	The on/off status of the device	string	"0"[OFF]"/"1"[ON]										
Outputs	osb_data	ven_id	The id identifying the OSB	OSB	OSB	middleware	OpenADR (report)	uuid		On Change			
		reporting_metrics	The reporting capabilities of the device					string	"ambient temperature"/"sensor"				
		rid	unique identifier including all					string					
		device_class	The type of the device					string	"hvacDevice"/"dhwDevice"/"pros"				
		value	measurement value					float					
timestamp	measurement timestamp	datetime											

Figure 10: Complete Data Model for OSB

		Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments	
Inputs	contracts	contract_id	Unique identifier of the contract	Middleware	Aggregator and Prosumer Toolkits	Open Market Place	REST	uuid			1	no	Set only by Aggregator Toolkit	
		start_date	Date the contract is valid from					date						
		end_date	Date the contract is valid to					date						
		aggregator_id	Aggregator party of the contract					string	3 to 256 chars					
		account_id	Prosumer party of the contract					uuid						
		contract_title	Human readable shortname of contract					string		On Change				
		description	Human readable description of contract					string		On Change				
		existing_pv	Contract includes a PV					boolean						
		notification	Prosumer notification settings					string	"every_DR event"/"daily"					
		date_of_signage	Timestamp both parties signed					date						
		ct_down	Dutch case					float	>0	On Change				
		ct_downND	Dutch case					float	>0	On Change				
		ct_downNAD	Dutch case					float	>0	On Change				
		ct_up	Dutch case					float	>0	On Change				
		ct_upND	Dutch case					float	>0	On Change				
		ct_upNAD	Dutch case					float	>0	On Change				
		fix_cost	Dutch case					float	>0	On Change				
		maximum_power	Spanish case: maximum flex power offered					float	>0	On Change				
		maximum_number	Spanish case: maximum number of activator					integer	>0	On Change				
		service_cost	Spanish case: Base cost					float	>0	On Change				
	status	Contract status	string	"published"	On Change									
	validated	Contract is valid	boolean		On Change									
	assets	List of devices for this contract	uuid											
	contract_type	Type of contract	string	"money for flex"/"savings"										
	timestamp	Timestamp of contract modification	date											
	devices	device_id	Unique identifier of the device	Middleware	DER Registry	Open Market Place	REST	uuid	UUID		Always	1	no	
		account_id	Account where the devices belong to					uuid	UUID					
		aggregator_id	Aggregator associated with the device					url						
marketplace_availability		If the DER is available to marketplace	string					"yes"/"no"/"						
inter Component message	notification_id	Unique identifier of the InterComponentMessage	Middleware	Middleware	Open Market Place	REST	uuid			On Request	1	no	Components shortnames OMP in case of Marketplace Characterizes payload Previous contracts fields values Updated contracts fields values	
	sender_id	Shortname of the sender of the message					string	not empty						
	recipient_id	Shortname of the recipient of the message					string	not empty						
	creation_time	Message creation timestamp					date							
	message_type	Defines type of message					string	not empty						
	payload	Payload of message depends on message type					json							
	payload.contract_id	Message payload: ID of changed contract					uuid							
	payload.initiator_sub	Message payload: Initiator of contract change					uuid							
	payload.initiator_role	Message payload: Role of initiator					string	"aggregator"						
	payload_prev_state	Message payload: Previous contracts fields					json							
payload_patch	Message payload: Patch applied	json												
Outputs	contracts	<i>See its details on the Input part</i>	Middleware	Open Marketplace	Aggregator toolkit	REST				On Request				
	contract_message	notification_id	Unique identifier of the InterComponentMessage	Middleware	Open Marketplace	Aggregator Toolkit	REST	uuid			On Request	1	no	OMP in case of Marketplace AGR for Aggregator Toolkit Contract flow change
		sender_id	Shortname of the sender of the message					string	not empty					
		recipient_id	Shortname of the recipient of the message					string	not empty					
		creation_time	Message creation timestamp					date						
		message_type	Defines type of message					string	not empty					
		payload	Payload of message depends on message type					json						
	payload.account_id	Message payload: ID of the aggregator	uuid											
	payload.contract_id	Message payload: ID of changed contract	uuid											
	payload.message	Message payload: Human readable message	string											
	contracts	<i>See its details on the Input part</i>	Middleware	Open Marketplace	Prosumer Toolkit	REST								
	contract_message	notification_id	Unique identifier of the InterComponentMessage	Middleware	Open Marketplace	Prosumer Toolkit	REST	uuid			On Request	1	no	OMP in case of Marketplace PRO for Prosumer Toolkit Contract flow change
		sender_id	Shortname of the sender of the message					string	not empty					
		recipient_id	Shortname of the recipient of the message					string	not empty					
		creation_time	Message creation timestamp					date						
		message_type	Defines type of message					string	not empty					
		payload	Payload of message depends on message type					json						
	payload.account_id	Message payload: ID of the aggregator	uuid											
payload.contract_id	Message payload: ID of changed contract	uuid												
payload.message	Message payload: Human readable message	string												
contracts	<i>See its details on the Input part</i>	Middleware	Open Marketplace	Local Demand Manager	REST					On Request				
contracts	<i>See its details on the Input part</i>	Middleware	Open Marketplace	DR Settlement Remuneration	REST					On Request				
contracts	<i>See its details on the Input part</i>	Middleware	Open Marketplace	FSAA Module	REST					On Request				

Figure 11: Complete Data Model of Open Marketplace

		Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments	
Inputs	DrAttributeRequest	venid	Ven ID	Middleware	Local Demand Manager	Demand Flexibility profiling	REST	String	minLength = 1, maxLength = 100, UNIQUE	On Demand	N/A	N/A		
		deviceid	Device ID					String	minLength = 36, maxLength = 36					
		derDevice	Der device type					String Enum	Light,HVAC,Dhw,Other					
	FlexibilityForecastingPeriod	venid	Ven ID	Middleware	Local Demand Manager	Demand Flexibility profiling	REST	String	minLength = 1, maxLength = 100, UNIQUE	On Demand	N/A	N/A		
		derDevice	Der device type					String Enum	Light,HVAC,Dhw,Other					
		deviceid	Device ID					String	minLength = 36, maxLength = 36					
		sratDate	datetime					datetime						
		horizon	Time horizon required					Integer						
		horizonType	Horizon type					String	minLength = 36, maxLength = 36					
		isp	ISPs forecast required					Integer						
	ispType	Type of the ISP	String Enum	minutes, hours										
	ControlSignal	timestamp	When this control signal has been generated	Middleware	Local Demand Manager	Demand Flexibility profiling	REST	datetime		On Demand	N/A	N/A		
		dr_campaign_id	Identifier of the DR Campaign where this control_signal belongs to					String	minLength = 36, maxLength = 36					
		account_id	Identifier of the account of device receiving this signal					string	minLength = 36, maxLength = 36					
		device_id	Identifier of the device receiving this signal					string	minLength = 36, maxLength = 36					
		device_class	Type of the device receiving this signal					string	Light, HVAC, Dhw, EV					
	flex	Amount of flexibility requested to the device	float											
	BuildingParametersRequest	venid	Ven ID	Middleware	Local Demand Manager	Demand Flexibility profiling	REST	String	minLength = 1, maxLength = 100, UNIQUE	On Demand	N/A	N/A		
	ThermalComfortLevelRequest	venid	Ven ID	Middleware	Local Demand Manager	Demand Flexibility profiling	REST	String	minLength = 1, maxLength = 100, UNIQUE	On Demand	N/A	N/A		
		startDate	start date that the comfort level are required					datetime						
horizon		number of intervals (15min) that the thermal comfort levels are required	Integer											
weather	See its details on the "Middleware" tab			Middleware	Middleware	Demand Flexibility profiling	REST	See its details on the "Middleware" tab			On demand	N/A	N/A	
devices	See its details on the "DER Registry" tab			Middleware	Middleware	Demand Flexibility profiling	REST	See its details on the "DER Registry" tab			On Demand	N/A	N/A	
middlewareData	rid	unique identifier including all the information of reported value	Middleware	Middleware	Demand Flexibility profiling	REST	String		On Change	N/A	N/A			
	value	measurement value					float							
	timestamp	measurement timestamp					datetime							
Outputs	DrAttributes	venid	Ven ID	Middleware	Demand Flexibility profiling	Local Demand Manager	REST	String	minLength = 1, maxLength = 100, UNIQUE	On Demand	N/A	N/A		
		deviceid	Device ID					String	minLength = 36, maxLength = 36					
		derDevice	Der Device type					String Enum	Light,HVAC,Dhw,Other					
		rampingUp	Ramping up period					float						
		deliveryPeriod	Delivery period					float						
		deactivationPeriod	Deactivation Period					float						
	LocalFlexibilityProfiles	deviceid	Device ID	Middleware	Demand Flexibility profiling	Local Demand Manager	REST	String	minLength = 36, maxLength = 36	On Demand	N/A	N/A		
		derDevice	Der Device type					String Enum	Light,HVAC,Dhw,Other					
		flexibility	Available flexibility (baseline, downwards, upwards)					list of flexibility object						
		baseline	Baseline forecast					float						
		upwards	Upwards flexibility					float						
		downwards	Downwards flexibility					float						
	interval	Interval for the forecast	integer											
	BuildingParametersResponse	venid	venid	Middleware	Demand Flexibility profiling	Local Demand Manager	REST	String		On Demand	N/A	N/A		
		c2	Walls thermal capacitances					float						
		c1	Air thermal capacitances					float						
		r1	conduction resistance					float						
		r2	convection resistance					float						
		r3	infiltration resistance					float						
		p1	Solar gains distribution to air nodes coefficient					float						
p2		Solar gains distribution to wall nodes coefficient	float											
p3	HVAC power distribution to air nodes coefficient	float												
p4	HVAC power distribution to wall nodes coefficient	float												
thermal ComfortLevels	thermalComfort	thermal comfort object	Middleware	Demand Flexibility profiling	Local Demand Manager	REST	thermalComfort object		On Demand	N/A	N/A			
	interval	interval (increasing 15' intervals ie. 96 intervals for one day)					integer							
	tMin	minimum temperature level					float							
	tMax	maximum temperature level					float							

Figure 12: Complete Data Model for Demand Flexibility Profiling

		Attribute name	Meaning	Container Subsystem - Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	DerClusterRequest	location	Location of the aggregator's portfolio	Middleware	Global Demand Manager	Flexibility Forecasting Segmentation and Aggregation module	REST	String Enum	Spain,Netherlands	On demand	N/A	N/A	
		drServiceType	type of DR service					String Enum	aFRR,self-consumption,wholesale				
		contract	contract status					String Enum	active,canceled,on hold				
		aggregatorid	ID of the aggregator					String	minLength = 36, maxLength = 36				
	DerClusterForecastingRequest	clusterID	clusterID	Middleware	Global Demand Manager	Flexibility Forecasting Segmentation and Aggregation module	REST	List of uuid		On demand	N/A	N/A	
		startDate	start date considered					Datetime					
		devices	List of device ID					List of deviceid objects					
		deviceid	device ID					String	minLength = 36, maxLength = 36, unique				
		horizon	forecasting horizon					Integer	minLength = 36, maxLength = 36, unique				
		horizonType	minutes or hours					String Enum	minutes,hours				
	ReliabilityClusterRequest	isp	ISP	Middleware	Global Demand Manager	Flexibility Forecasting Segmentation and Aggregation module	REST	Integer	minutes,hours	On demand	N/A	N/A	
		ispType	minutes or hours					String Enum	minutes,hours				
		reliability	reliability of the devices					Integer	min=0, max=100				
		startDate	start date considered					Datetime					
	OutliersRequest	endDate	end date considered	Middleware	Global Demand Manager	Flexibility Forecasting Segmentation and Aggregation module	REST	Datetime		On demand	N/A	N/A	
		devices	List of device ID					List of deviceid objects					
		deviceid	device ID					String	minLength = 36, maxLength = 36, unique				
		outliers	List of device ID					List of deviceid objects					
		deviceid	device ID					String	minLength=36, maxLength = 36, unique				
		startDate	start date considered					Datetime					
	endDate	last date considered					Datetime						
	dr_campaign_idem_step	See its details on the "Local Demand Manager Tab"		Middleware	Local Demand Manager	Flexibility Forecasting Segmentation and Aggregation module	REST	See its details on the "Local Demand Manager Tab"		OnDemand	See its details on the "Local Demand Manager Tab"		
	local_demand_manager	See its details on the "Local Demand Manager Tab"		Middleware	Local Demand Manager	Flexibility Forecasting Segmentation and Aggregation module	REST	See its details on the "Local Demand Manager Tab"		On demand	See its details on the "Local Demand Manager Tab"		
	contracts	See its details on the "Open Marketplace" tab		Middleware	Open Marketplace	Flexibility Forecasting Segmentation and Aggregation module	REST	See its details on the "Open Marketplace" tab		On demand	See its details on the "Open Marketplace" tab		
	devices	See its details on the "DER Registry" tab		Middleware	DER Registry	Flexibility Forecasting Segmentation and Aggregation module	REST	See its details on the "DER Registry" tab		On demand	See its details on the "DER Registry" tab		
Outputs	DerClusterResponse	requestCriteria	criteria for clustering	Middleware	Flexibility Forecasting Segmentation and Aggregation module	Global Demand Manager	REST	List of strings		Daily	N/A	N/A	
		clusterid	cluster ID					String	minLength=1, maxLength = 64				
		derCluster	derCluster object including the devices belonging to this cluster based on the requested criteria					derCluster object					
		devices	List of deviceid objects					List of deviceid objects					
	DerClusterForecastingResponse	deviceid	device ID	Middleware	Flexibility Forecasting Segmentation and Aggregation module	Global Demand Manager	REST	String	minLength = 36, maxLength = 36, unique	Daily	N/A	N/A	
		clusterID	cluster ID					String	minLength=1, maxLength = 64				
		flexibility	flexibility of the cluster as timeseries					List of flexibility object					
		upwardsFlexibility	upwards flexibility					Float					
		downwardsFlexibility	downward flexibility					Float					
		interval	interval					integer					
	ReliabilityClusterResponse	baseline	baseline	Middleware	Flexibility Forecasting Segmentation and Aggregation module	Global Demand Manager	REST	Float		Daily	N/A	N/A	
		reliabilityClusterID	reliabilityClusterID					String	minLength=1, maxLength = 64				
reliability		reliability	Integer					min=0, max=100					
devices		devices	List of deviceid objects										
OutliersResponse	deviceid	device ID	Middleware	Flexibility Forecasting Segmentation and Aggregation module	Global Demand Manager	REST	String	minLength = 36, maxLength = 36, unique	Daily	N/A	N/A		
	devices	devices					List of deviceid objects						
	deviceid	device ID					String	minLength = 36, maxLength = 36, unique					

Figure 13: Complete Data Model for Flexibility Forecasting, Segmentation and Aggregation module

		Attribute name	Meaning	Container Subsystem-Physical element	Information exchange source	Information exchange destination	Proposed suitable standards (if applicable)	Data type	Data range	Data frequency	Granularity	Historical period	Comments
Inputs	dr_events	device_id	The id identifying the device	Prosumer Portal	Prosumer Portal	All	REST/JSON	uuid		On Request		No	
		account_id	The id identifying the user					uuid					
		aggregator_id	The id identifying the aggregator					url					
		marketplace_availability	The availability of the device for the marketplace					string	"yes"/"no"/""				
		dr_availability	The availability of the device for dr events					string	"yes"/"no"				
		setpoint	The setpoint of the device					float	1-10				
		x-fanspeed	The fan speed (only hvac)					float	1-10				
		mode	The mode (only hvac)					string	"1"[HEAT]/"2"[COOL]/"3"[FAN]/"4"[DRY]/"5"[AUTO]				
		operationState	The on/off status of the device					string	"0"[OFF]/"1"[ON]				
		dr_campaign	See its details on the "Global Demand Manager" tab					Middleware	Demand M				
dr_campaign_timeline_step	See its details on the "Global Demand Manager" tab	Middleware	Demand M	Middleware	REST/JSON	See its details on the "Global Demand Manager" tab	On demand						
dr_campaign_ldem_step	See its details on the "Local Demand Manager" tab	Middleware	Demand M	Middleware	REST/JSON	See its details on the "Local Demand Manager" tab	On demand						
dr_campaign	See its details on the "Local Demand Manager" tab	Middleware	Demand M	Middleware	REST/JSON	See its details on the "Global Demand Manager" tab	On demand						
osb_data	See its details on the "OSB" tab	OSB	OSB	Middleware	OpenADR	See its details on the "OSB" tab	On Change						
Outputs	contracts	contract_id	Unique identifier of the contract	Middleware	Aggregator Toolkit	ALL	REST	uuid		On Change	1	No	
		start_date	Date the contract is valid from					date					
		end_date	Date the contract is valid to					date					
		aggregator_id	Aggregator party of the contract					string	3 to 256 chars				
		account_id	Prosumer party of the contract					uuid					
		contract_title	Human readable shortname of contract					string					
		description	Human readable description of contract					string					
		existing_pv	Contract includes a PV					boolean					
		notification	Prosumer notification settings					string	"every_DR event"/"daily report"/"weekly report"/"monthly re				
		date_of_signage	Timestamp both parties signed					date					
		ct_down	Dutch case					float	>0				
		ct_downND	Dutch case					float	>0				
		ct_downNAD	Dutch case					float	>0				
		ct_up	Dutch case					float	>0				
		ct_upND	Dutch case					float	>0				
		ct_upNAD	Dutch case					float	>0				
		fix_cost	Dutch case					float	>0				
		maximum_power	Spanish case: maximum flex power offered					float	>0				
		maximum_number	Spanish case: maximum number of activations					integer	>0				
		service_cost	Spanish case: Base cost					float	>0				
	status	Contract status	string	"published"/"edited by prosumer"/"edited by ag									
	validated	Contract is valid	boolean										
	assets	List of devices for this contract	uuid										
	contract_type	Type of contract	string	"money for flex"/"savings for flex"/"more sun_energ									
	timestamp	Timestamp of contract modification	date										
	devices	device_id	The id identifying the device	OSB	OSB	All	REST/JSON OpenADR	uuid		Always	1	No	
		device_name	Human readable name					string					
		setpoint	The setpoint of the device					float					
		x-fanspeed	The fan speed (only hvac)					float	1-10				
		mode	The mode (only hvac)					string	"1"[HEAT]/"2"[COOL]/"3"[FAN]/"4"[DRY]/"5"[AUTO]				
operationState		The on/off status of the device	string					"0"[OFF]/"1"[ON]					
account_id		The id identifying the user	uuid										
ven_id		The id identifying the OSB	uuid										
aggregator_id		The id identifying the aggregator	url										
device_class		The type of the device	string					"hvacDevice"/"lightningLoad"/"dhwDevice"/"other					
availability		If the device is available	string					"yes"/"no"/""					
marketplace_availability		The availability of the device for the marketplace	string					"yes"/"no"/""					
dr_availability		The availability of the device for dr events	string					"yes"/"no"					
location		The location of the device	point										
device_type		The quality of the device	string					"Demand"/"Generation"/"Storage"					
max_capacity	The max capacity of the device	float											
available_capacity	The available capacity of the device	float											
data_points	device_id	The id identifying the device	OSB	OSB	All	REST/JSON OpenADR	uuid		Always	1	No		
	account_id	The id identifying the user					uuid						
	ven_id	The id identifying the OSB					uuid						
	aggregator_id	The id identifying the aggregator					url						
	device_class	The type of the device					string	"sensingDevice"/"hvacDevice"/"dhwDevice"/"prosumerDeviceMetering"/"pvDevice"/"otherLoad"					
reporting_metrics	The reporting capabilities of the data point	string	"ambient_temperature"/"sensor_temperature"/"t emperature"/"lux"/"sensor_luminance"/"sensor_r elhumidity"/"humidity"/"airquality"/"tvoc"/"alarm _motion"/"motion"/"meter_current"/"meter_kwh"/"meter_voltage"/"meter_watts"										
device_status	device_id	The id identifying the device	OSB	OSB	All	REST/JSON OpenADR	uuid		On Change	On Change	3 years		
	account_id	The id identifying the user					uuid						
	ven_id	The id identifying the OSB					uuid						
	aggregator_id	The id identifying the aggregator					url						
	device_class	The type of the device					string	"hvacDevice"/"lightningLoad"/"dhwDevice"/"other					
	timestamp	The time of the measure					datetime						
	operationState	The on/off status of the device					string	"0"[OFF]/"1"[ON]					
	fanspeed	The fan speed (only hvac)					float	1-10					
mode	The mode (only hvac)	string	"1"[HEAT]/"2"[COOL]/"3"[FAN]/"4"[DRY]/"5"[AUTO]										
set_point	The setpoint of the device	float											

Outputs	indoor_sensing	device_id	The id identifying the device	OSB	OSB	All	REST/JSON OpenADR	uuid		15 Min	15 Min	3 years	
		account_id	The id identifying the user					url					
		aggregator_id	The id identifying the aggregator					string	"sensingDevice"/"hvacDevice"				
		device_class	The type of the device					datetime					
		timestamp	The time of the measure					float					
		temperature	The temperature measured					float					
		lux	The lux measured					float					
		relhumidity	The relative humidity measured					float					
		airquality	The airquality measured					string	"1 [Good '2 [Bad '3 [Moderate]				
		tvoc	The tvoc measured					float					
	inter Component Message	notification_id	Unique identifier of the InterComponentMessage	Middleware	All	All	REST	uuid		On Request	1	No	
		sender_id	Shortname of the sender of the message					string	not empty				
		recipient_id	Shortname of the recipient of the message					string	not empty				
		creation_time	Message creation timestamp					date					
		message_type	Defines type of message					string	not empty				
	payload	Payload of message depends on message_type	json										
	meter	device_id	The id identifying the device	OSB	OSB	All	REST/JSON OpenADR	uuid		15 Min	15 Min	3 years	
		account_id	The id identifying the user					url					
		aggregator_id	The id identifying the aggregator					string	"hvacDevice"/"dhwDevice"/"prosumerDeviceMetering"/"pvDevice"/"otherLoad"				
		device_class	The type of the device					datetime					
		timestamp	The time of the measure					float					
		current	The current measured					float					
		kwh	The kwh measured					float					
		voltage	The voltage measured					float					
	watts	The watts measured	float										
	occupancy	device_id	The id identifying the device	OSB	OSB	All	REST/JSON OpenADR	uuid		15 Min	15 Min	3 years	
		account_id	The id identifying the user					url					
		aggregator_id	The id identifying the aggregator					string	"sensingDevice"				
		device_class	The type of the device					datetime					
		timestamp	The time of the measure					float					
	occupancy	The occupancy measured	float										
	weather	stationid	The id identifying the weather station	Middleware	Dark Sky	All	REST/JSON	string		1 Hour	1 Hour	3 years	
		lat	The longitude of the weather station					float					
lon		The latitude of the weather station	float										
time		The time of the measure	datetime										
apparentTemperature_i		The measured apparentTemperature at the horizon i	float										
cloudCover_i		The measured cloudCover at the horizon i	float										
dewPoint_i		The measured dewPoint at the horizon i	float										
humidity_i		The measured humidity at the horizon i	float										
icon_i		The decided icon at the horizon i	string										
ozone_i		The measured ozone at the horizon i	float										
precipAccumulation_i		The measured precipitation at the horizon i	float										
precipIntensity_i		The measured precipitation intensity at the horizon i	float										
precipIntensityError_i		The calculated error for the precipity intensity at the horizon i	float										
precipProbability_i		The calculated precipitation probability at the horizon i	float										
precipType_i		The measured precipitation type at the horizon i	String										
pressure_i		The measured pressure at the horizon i	float										
summary_i		The summary at the horizon i	string										
temperature_i		The measured temperature at the horizon i	float										
uvindex_i		The measured uvindex at the horizon i	float										
visibility_i		The measured visibility at the horizon i	float										
windBearing_i		The measured windBearing at the horizon i	float										
windGust_i		The measured wind Gust at the horizon i	float										
windSpeed_i		The measured wind speed at the horizon i	float										
GHI_i		The measured Global horizontal irradiation at the horizon i	float										
dr_campaign	See its details on the "Local Demand Manager" tab			Middleware	-	Demand Ma	REST/JSON	See its details on the "Local Demand Manager" tab			On Request		
pv_forecast	See its details on the "Local Demand Manager" tab			Middleware	-	Demand Ma	REST/JSON	See its details on the "Local Demand Manager" tab			On Request		
day_ahead_price	See its details on the "Global Demand Manager" tab			Middleware	-	Demand Ma	REST/JSON	See its details on the "Global Demand Manager" tab			On Request		
local_demand_manager	See its details on the "Global Demand Manager" tab			Middleware	-	Demand Ma	REST/JSON	See its details on the "Global Demand Manager" tab			On Request		
middlewareData	rid	unique identifier including all the information of reported value	Middleware	Middleware	Flexibility profiling	REST	String		On Change	N/A	N/A		
	value	measurement value					float						
	timestamp	measurement timestamp					datetime						
dr_events	See its details on the "Input" part			Middleware	Middleware	OSB	OpenADR	See its details on the "Input" part			On Request		No

Figure 14: Complete Data Model for Middleware