Use of the ENVRI Reference Model to Support the Design of Environmental Research Infrastructures

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INTRODUCTION

Environmental Research Infrastructure systems are designed to support communities carrying out data intensive research from the solid earth, atmospheric, aquatic, and biosphere domains.

The FP7 ENVRI project (2011-2014) and its successor Horizon2020 ENVRIplus project (2015-2019) developed of the ENVRI Reference Model (ENVRI RM), a standards-based modelling framework to support the modelling and development of Environmental Research Infrastructure systems.

Here we show a process for modelling the systems of an archetypical research infrastructure using the ENVRI RM and highlight the potential advantages.

MODELLING PROCESS

The ENVRI Reference Model can be applied following a five step process. In this process, the designer is free to select a starting viewpoint, model the characteristics of interest within that viewpoint and then model additional details by mapping the specification to other viewpoints. After mapping to another viewpoint, the system designer can add detail to the models while keeping consistency at different levels of abstraction.

Identify: Look up the exiting objects

Model: Use the objects to build a model (if suitable use existing models)

Refine: add, remove, decompose, compose. Include new objects, including objects not included in the RM

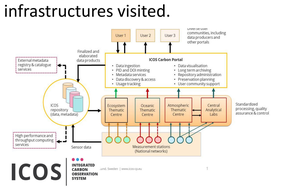
Review and Revise: Consult with the team to see if all concerns have been addressed at viewpoint level

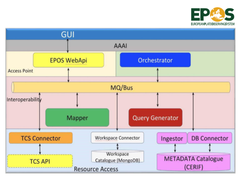
Map: Select next viewpoint to model and repeat from the top

CASE STUDIES

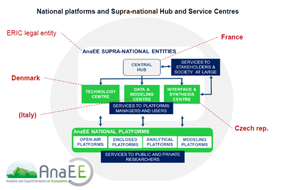
Nine environmental research infrastructures from different domains were consulted about their status and development plans during the period from April 2017 to January 2018.

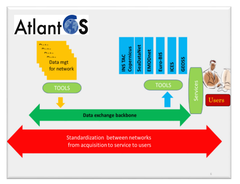
The diagrams below show the architectures of six of those research infrastructures visited.

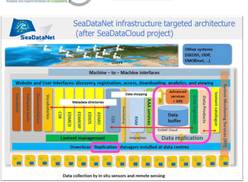


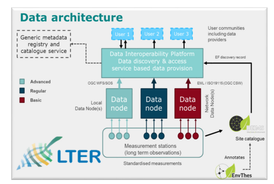


National platforms and Supra-national Hub and Service Centres









EXAMPLE OF THE MODELLING PROCESS

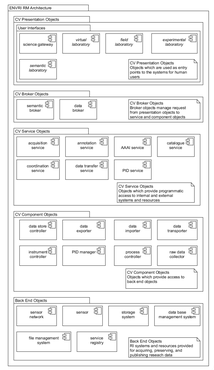
IDENTIFY: Select Starting Viewpoint

The architecture diagrams define functionalities and interactions of Research Infrastructure system components.

The ideal context to model those architectures is the Computational Viewpoint of the ENVRI RM.

The Computational Viewpoint (CV) defines a set of computational objects (CV objects) that can be used to describe the architectures.

The diagram on the right represents the CV objects defined in the ENVRI RM.



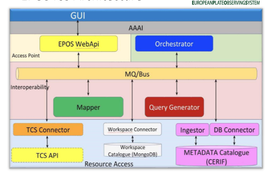
MODEL: Use CV Objects to Build Models

The diagrams on the right represent the EPOS Integrated Core Services layered architecture (top) and its corresponding ENVRI RM CV model.

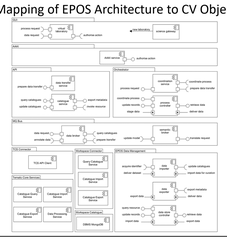
In the second diagram EPOS modules are mapped to one or more CV objects according to the functionalities exposed.

There are two special cases: Thematic Core Services and Workspace Connector which need to be mapped to complex compositions (See next panel below).

EPOS ICS Architecture

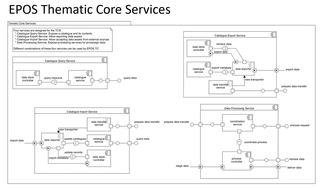


Mapping of EPOS Architecture to CV Objects

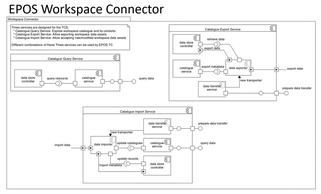


REFINE: Build Custom CV Models

EPOS Thematic Core Services



EPOS Workspace Connector



Special cases are modelled as composites because the components described in the architecture do not map one-to-one to existing CV objects.

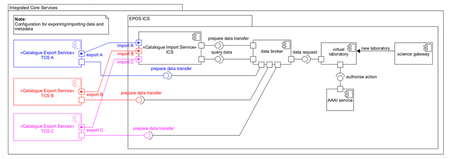
Notice that the data processing service is only needed for thematic core services, while other services are used in both definitions.

This illustrates reuse by composition and modularisation.

REVIEW: Verify CV Models

The models are verified in context, showing how they support the required functions. The diagram shows CV objects integrated to support importing data and metadata from thematic core services.

Integration of TCS to EPOs for Importing Data/Metadata



MAPPING: Further Modelling

The next step of the ENVRI RM modelling process requires selecting a new viewpoint to add details about the models.

In this example, the next viewpoint to model is the Engineering Viewpoint that allows defining the distribution of the computational units and the integration of the distributed components.

Viewpoint correspondences between allow faster identification the required objects.

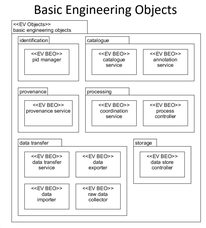
IDENTIFY: Select Engineering Viewpoint objects

Computational viewpoint objects correspond one-to-one with Engineering objects. The Engineering Viewpoint prioritises distribution and inter-connection concerns.

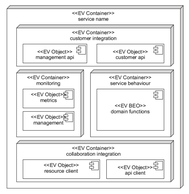
The Engineering Viewpoint of the ENVRI RM groups service objects enabling interaction between systems as basic engineering objects (EV BEO), as shown in left diagram below.

The engineering viewpoint defines an API architecture for basic engineering objects, to support interoperability, shown in the right diagram below.

Basic Engineering Objects



API Based Container Model



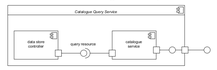
MODEL: Use EV Objects to Build Models

The Computational Viewpoint model of the catalogue query service in the top diagram is represented as an EV configuration in the middle diagram.

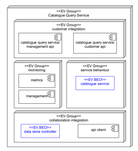
The additional components in the middle diagram are engineering objects that enable administration, monitoring, and connectivity.

The bottom diagram shows additional engineering components which need to be defined to implement a complete cataloguing system. This diagram combines basic engineering objects (EV BEO) and other additional objects such as Science Gateway, data base system and database system.

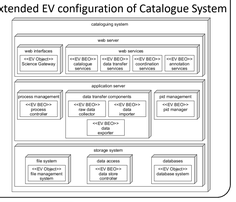
CV model: Catalogue Query Service



EV configuration of Catalogue Query Service



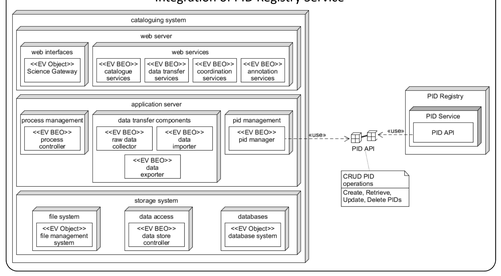
Extended EV configuration of Catalogue System



REFINE: Build Custom EV Models

Additional objects, such as PID manager, can be integrated as shown in the diagram below. The PID manager illustrates the integration with a externally provided PID service. In the diagram, the PID API used to connect the components in different clusters is represented as an Engineering Viewpoint channel.

Integration of PID Registry Service

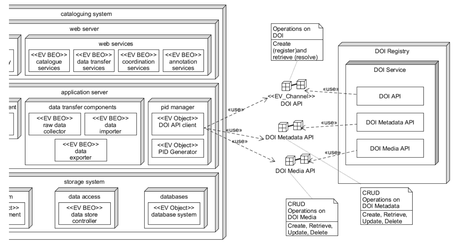


REVIEW: Verify EV Models

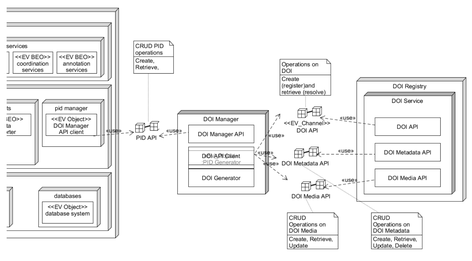
The package diagrams below show two alternatives for integrating a PID registry (DOI registry) with the cataloguing system.

The top diagram shows the integration by using a client library template. The bottom diagram shows integration using a service template.

Client Library Template Integration



Service Template Integration

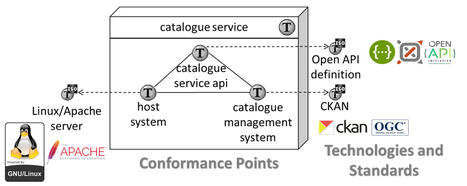


MAPPING: Further Modelling

The next step of the modelling process requires selecting a new viewpoint to add details about the models. In this case the designer can either go back to the computational viewpoint or map from the engineering viewpoint.

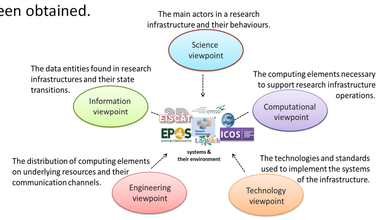
For instance, mapping from the Engineering Viewpoint to the Technology Viewpoint would require defining conformance points that would be used to evaluate the suitability of different technologies and standards. A technology viewpoint specification of a cataloguing service would look as shown in the diagram below.

Technology Viewpoint Specification of a Cataloguing Service



NEXT STEPS

The basic modelling process (identify, model, refine, review, map) can be repeated several times to obtain more accurate models. The point at which the process should stop varies according to the intended use of the model (documentation, reporting, validation, etc.). The modeller should validate with its team and stop the modelling process once a sufficiently fit for purpose set of model has been obtained.



RESULTS

Reviewing and analysing architecture proposals of Research Infrastructures has allowed extending the ENVRI RM to include the Engineering and Technology Viewpoints.

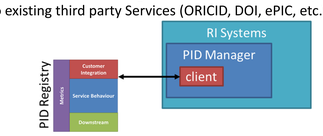
The proposed implementation of the Engineering Viewpoint follows a microservice architecture model which allows the definition API interfaces that support flexible integration of services and systems.

The proposed implementation of the Technology Viewpoint provides a template for defining conformance points to verify the suitability of technologies and standards

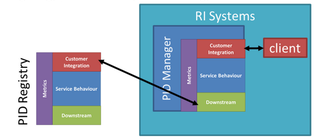
EXPECTED APPLICATION

Following the ENVRI RM recommendations for the engineering and technology viewpoint, should serve as an example for the development of

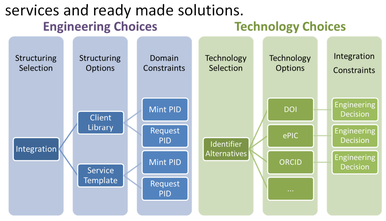
- Client libraries for commonly used services.
  Identifier services are a good use case, they are likely to connect to existing third party Services (ORICID, DOI, ePIC, etc.)



- Service Templates for commonly implemented services
  Cross cutting services are a good example, this can include cataloguing, provenance, processing, and AAAI services.



- Creating tools to facilitate/support selection and use of services and ready made solutions.



- Facilitating the profiling of complex solutions which may be used, for instance VRE implementations

RESOURCES

http://envriplus.eu
The current project supporting all ENVRI activities.

http://envri.eu/rm/
The home of the ENVRI Reference Model v2.1, includes documentation, articles, examples and guidelines on how to use the ENVRI RM.

http://oil-e.net/ontology/
The ENVRI RM is also represented in the Open Information Linking for Environmental science research infrastructures (OIL-E), a set of ontologies formalising the semantics for representing RI architecture and behaviours.

http://envri.eu/
ENVRI Community: A network of environmental research infrastructures, projects and networks as well as others interested in environmental research development, maintenance and improvement.

We would like to thank our colleagues and the institutions that participated and hosted the ENVRIplus visits: Environmental Agency Austria (EUFAR and LTER Vienna, March 2017); IFREMER (SeaDataNet, AtlantOS, and EuroArgo, Brest, April 2017); CNR Rome (EPOS, Rome, August 2017), CNRS (AnaEE, Paris, October 2017); Lund University (ICOS, Lund, December 2017); and CNR Pisa (D4Science, and EISCAT3D, Pisa, January 2018).

Supporting environmental research with integrated solutions - the Earth is our lab

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