Horizon 2020
Coordination and Support Action (CSA)

CatRIS
Catalogue of Research Infrastructures Services

WP4
Service catalogue design, alignment, acquisition and support

Deliverable 4.2
Towards a Service Management Standard – Framework Assessment

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Due date of deliverable: 30.06.2019
Actual submission date: 18.02.2020
Dissemination level: Public

Funded by
the European Union

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Document Revision History

Date	Version	Author/Editor/Contributor	Summary of main changes/Status
07.06.2019	v0.1	H.Georgiadis	Semantics platform presented to partners
04.09.2019	v0.2	J. Sanchez, N. Vogiatzis, P.Spyrou, V.Cvijanovic, A.Kamenskaya, M. Zorgno, G. Giannopoulos, A.Helman	Agreement to incorporate the CatRIS Vocabulary on Semantics
04.09.2019	v0.3	H. Georgiadis, I.Sougioultzoglou, V.Bonis	Incorporation of 18 service and resource Classifications Vocabularies on Semantics
13.09.2019	v0.4	H. Georgiadis, I.Sougioultzoglou, V.Bonis	Incorporation of 20 service and resource Classifications Vocabularies on Semantics & OWL Ontology drafted
27.09.2019	v0.5	J. Sanchez, N. Vogiatzis, P.Spyrou, N. Liva	First version sent for input to partners
10.01.2020	v0.6	A. Sevasti, N. Vogiatzis	Adaptations for compliance to EOSC developments at European level
27.01.2020	v0.7	N. Vogiatzis, N. Liva	Pre-final draft
29.01.2020	V0.8	V. Cvijanovic, A. Sevasti	Quality review of deliverable
31.01.2020	V0.9	N. Vogiatzis	Draft version circulated to all consortium for approval
10.02.2020	V0.91	V. Bonis, A. Helman	Improvements to ontology sections and overall editorial enhancements
18.02.2020	v1.0	J. Sanchez, N. Vogiatzis	Final version for submission to EC

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Acronyms

Abbreviation	Meaning
API	Application Programming Interface
CF	Core Facility
CSA	Coordination and Support Action
COBIT	Control Objectives for Information and related Technologies
CoS	Catalogue of Services
DoA	Description of Action
DoW	Description of Work
DT	Description Template
EC	European Commission
e-IRG	e-Infrastructure Reflection Group
EOSC	European Open Science Cloud
ERA	European Research Area
ESFRI	European Strategic Framework for Research Infrastructure
HPC	High Performance Computing
IT	Information Technology
ITIL	Information Technology Infrastructure Library
ITSM	IT Service Management
NGI	National Grid Initiative
NOAD	National Open Access Desk
NREN	National Research and Education Network
RI	Research Infrastructure
SDT	Service Description Template
SLA	Service Level Agreement
SP	Service Provider
SSR	Shared Scientific Resources
TRL	Technology Readiness Level
WP	Work Package

1. Summary

WP4 aims to establish a common service and resource catalogue framework for describing and offering RI services and resources in a user-friendly searchable format. Currently, research infrastructures and facilities provide information about their services and resources mostly in free formats via their individual websites with varying degrees of completeness and detail. The MERIL[1] platform has been gathering information on services and resources and some preliminary work has already been done in terms of exploring ways to display this information in a structured way. Several initiatives at national level and within certain thematic areas have also established portals where information about services and resources is reported in some form.

Task 4.2 of the CatRIS project aims, among others, to deal with the various service and resource typologies and service and resource-related aspects in an efficient manner. The task used the various service and resource typologies and service and resource-related requirements identified in WP3 and T4.1, to deliver a common service and resource vocabulary as well as a common model definition for RIs to reach a harmonised approach to service and resource catalogues. The expected outcome of this task is the harmonization of the RI service and resource provision under a common service and resource catalogue framework (through documenting the developed service and resource vocabularies and descriptions).

This deliverable (D4.2 Towards a Service Management Standard – Framework Assessment), includes a preliminary service and resource management vocabulary for RI service and resource provision that will be the basis for a gradual convergence to a common vocabulary and will facilitate the decision making process of RIs to adopt a standard or framework. Moreover, it presents the CatRIS Vocabulary as an Owl[2][3] Ontology, and its representation on the Semantics tool.

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[1] The MERIL (Mapping of the European Research Infrastructure Landscape) portal provides access to a database that stores information about openly accessible research infrastructures (RIs) in Europe, across all scientific domains, including the social sciences and humanities. See more at: https://portal.meril.eu/meril/

[2] A Web Ontology Language (OWL) is a knowledge representation language for authoring ontologies, namely a formal way to define the structure of knowledge for a certain domain. An OWL language is characterized upon formal semantics and is built upon the World Wide Web Consortium's (W3C) XML standard for objects called the Resource Description Framework

2. Introduction

The European Open Science Cloud (EOSC) initiative is established to address the historical lack of a single online catalogue of Services and Resources that potential users could explore across Europe. A services and resources Catalogue aims to present in a well-organised manner the available services and resources that are on offer to a user/customer by a provider.

CatRIS continues and extends on previous and ongoing work in other projects (eInfraCentral, EOSC-hub and OpenAIRE) related to the development of the EOSC Service Description Template by harmonizing the access and presentation of services and resources offered by a wide range of Research Infrastructures (RIs), Core Facilities (CFs) and Shared Scientific Resources (SSRs) at European and national level, through an open, trusted and user-friendly portal, being interoperable with the EOSC catalogue[4].

To this end, CatRIS builds on the prior experience and work developed jointly with other EOSC initiatives to complement the Description Templates (DTs) and Service Classifications covering important aspects of **physical RIs**. In line with its multi-faceted and consensus-driven approach followed throughout the project, CatRIS (a) performed a state-of-play **Desk Research** for existing catalogues, gaps and best practice catalogues at global level (D4.1), (b) gathered input through a **Survey** (D3.2) from potential users/customers of RI services, RI service managers/providers and policy makers and funders, (c) enhanced the results of the survey via **Interviews** with key stakeholders and experts in the field, (d) consulted with key RI stakeholders during a **Validation Workshop**, (e) interacted with a wide range of RI users, managers and policy makers through a set of three **Focus Groups** and (f) consulted its high-level **Advisory Board** on all results produced so far. Overall, this set of concerted actions have led to the identification and enhancement of the DTs and Classifications, which are presented in detail in D4.3.

The adoption of a single, common catalogue specification across the RIs is a first step in presenting and delivering services and resources that are on offer to a user/customer in a well-organized manner. Additionally, a common service and resource vocabulary that underpins service and resource management and delivery processes and operations of the service catalogue is of paramount importance for RIs, in order to reach a harmonised approach. In this document, the Service Management Vocabulary that underpins the CatRIS Service Description Template and classifications is presented. The Vocabulary is based upon the following previous work and specifications:

- The EOSCpilot project[5] vocabulary
- The FitSM[6] vocabulary
- The EOSC/CatRIS Service Description Template (and associated specifications).

As far as the EOSCpilot vocabulary is concerned, the Vocabulary presented here adopts terms defined in the context of Service Management, namely non-EOSC specific terms for IT Service Management such as (EOSC) service, service catalogue, service portfolio, underpinning agreement etc. as well as EOSC-specific ones, such as EOSC Data Service Supplier, EOSC Data Registry, EOSC Service Component Supplier etc.

The Vocabulary also adopts the entirety of terms of the FitSM vocabulary together with the terms 'Thematic services' and 'Infrastructure & value-added services' as adopted from the

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[4] https://catalogue.eosc-portal.eu/home

[5] The European Open Science Cloud for Research pilot project (EOSCpilot) www.eoscpilot.eu received funding by the European Commission, DG Research & Innovation under contract no. 739563 (https://eoscpilot.eu/,)

[6] FitSM is a family of standards for lightweight IT service management (ITSM). More information at: https://www.fitsm.eu/

EOSC-hub[7] project vocabulary. Adoption of the FitSM vocabulary terminology ensures coverage of important Service Management processes such as Service Portfolio Management (SPM), Service Level Management (SLM), Service Availability and Continuity Management (SACM), Capacity Management (CAPM), Customer Relationship Management (CRM), Supplier Relationship Management (SUPPM), Incident and Service Request Management (ISRM). Where EOSCpilot glossary terms overlap with FitSM ones, the former have been preserved. Other than that, no adaptations have been implemented to the FitSM terms adopted, in order to maintain backward compatibility. Such adaptations, if deemed necessary, should be a matter of consensus across the CatRIS stakeholders. Furthermore, at this point in time, there are no concrete requirements for adoption of additional terms (not covered by FitSM) for the CatRIS Service Management vocabulary. Should such requirements emerge, those should be addressed by adopting additional terms and definitions, as necessary, from the ITIL ® Framework Glossary[8] and the ISO/IEC 20000[9] standard.

Further to the introduction of the CatRIS Service Management vocabulary, the CatRIS Provider and Service Description Template has also been implemented and is presented here as an Owl Ontology. Furthermore, its representation is provided as a Semantic Vocabulary within Semantics.gr[10], the Information System for Semantic Vocabularies developed by partner EKT[11] that allows institutions to easily create and establish their own semantic vocabularies. The Semantic Vocabulary is freely available in the form of Open Linked Data.

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[7] The EOSC-hub project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 777536

[8] https://wiki.en.it-processmaps.com/index.php/ITIL_Glossary

[9] ISO20000-1:2018, released on 2018-07-15

[10] https://www.semantics.gr/?language=en

[11] National Documentation Center, Greece, http://www.ekt.gr/en

3. The Service and Resource Management Vocabulary in the EOSC Framework

Hereafter, the CatRIS Service Management Vocabulary, based on the FitSM standard, the EOSCpilot project vocabulary as well as prior work of the CatRIS partners and the CatRIS WP3 and T4.1 is provided.

Accessibility of information: Property of information being accessible and usable by an authorized party.

Activity: Set of actions carried out within a process.

Assessment: Set of actions to evaluate the capability level of a process or the overall maturity level of a management system.

Audit: Systematic, independent and documented process for obtaining evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled[12].

Availability: Ability of a service and resource or service and resource component to fulfil its intended function at a specific time or over a specific period of time.

Capability level: Achieved level of effectiveness of an individual process or general aspect of management.

Capacity: Maximum extent to which a certain element of the infrastructure (such as a configuration item) can be used[13].

CatRIS Portal: A Portal providing information about Research Infrastructure Services and Resources in Europe focusing on physical Research Infrastructures (RIs), Core Facilities (CFs) and Shared Scientific Resources (SSRs).

CatRIS Service or Resource: The CatRIS Portal will be offering services among which are lists and classifications of services and resources, information about the relevant service and resource providers, advanced search options, filtering and visualisation functionalities, etc.

Change: Alteration (such as addition, removal, modification, replacement) of a configuration item.

Classification: Assignment of items to defined groups based on common attributes, relations or other criteria[14].

Closure: Final activity in a workflow of a process to indicate no further action is required for a

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[12] Note 1: Audit evidence is typically based on documented information, information provided during an audit interview, and information gathered through observation.
Note 2: Audit criteria may be based on requirements from a management system (including policies, processes and procedures), agreements (including service level agreements and underpinning agreements), contracts, standards or legislation.
Note 3: An audit may be an internal audit, if it is conducted under the direct responsibility of the organisation or federation that is subject to the audit, or an external audit, if it is conducted by an external party.
Note 4: Both internal and external audits should be conducted by skilled and experienced auditors, and auditors should not audit their own work or areas of responsibilities to ensure the impartiality of the results.
[13] Note: This might mean the total disk capacity or network bandwidth. It could also be the maximum transaction throughput of a system.
[14] Note 1: Items that are subject to classification may include documents, records (such as incident records or change records), service/resources, configuration items, etc. Defined groups may include categories (such as inci-

specific case[15].

Competence: Sum of knowledge, skills and experience that an individual or group needs to effectively take for a specific role.

Confidentiality of information: Property of information not being accessible to unauthorized parties.

Conformity: Extent to which requirements are met in some context[16].

Configuration: State of a specified set of attributes, relationships and other relevant properties of one or more configuration items (CIs)[17].

Configuration item (CI): Element that contributes to the delivery of one or more services and resources or service and/or resource components, therefore requiring control of its configuration[18].

Configuration management database (CMDB): Store for data about configuration items (CIs)[19].

Continuity: Property of a service to maintain all or parts of its functionality, even in exceptional circumstances[20].

Customer: An individual or organisation or a part of an organisation that commissions a service and/or resource or a provider to deliver a service and/or resource[21].

Document: Information and its supporting medium[22].

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dent categories or change categories) or priority levels. Note 2: The act of classification often comprises the application of more than one classification scheme. For instance, an incident record might be assigned to a technical incident category such as 'software related', 'infrastructure related', etc., and also to a priority level like 'low priority', 'medium priority', etc. The assignment of various incidents, service/resource requests, changes and problems to an affected CI is also a classification. Note 3: Besides the presentation and analysis of relationships, classification is often used as input for controlling the workflow of a process, e.g. by assigning a priority level to an incident.

[15] Note: Cases that are subject to closure may include incidents, problems, service/resource requests or changes. The activity of closure puts the connected record (such as the incident record, problem record, service/resource request record or change record) in its final status, usually called 'closed'.

[16] Note: In the context of FitSM, the term compliance is generally used as a synonym for conformity. However, sometimes conformity is used in the context of adherence to internal regulations and requirements as defined by policies, processes and procedures, while compliance is used in the context of adherence to external requirements, such as laws, standards and contracts.

[17] Note: The documented configuration of a number of CIs at a given point in time is called a configuration baseline, which is usually taken prior to the deployment of one or more changes to these CIs in the live environment.

[18] Note 1: CIs can vary widely, from technical components (e.g. computer hardware, network components, software) to non-technical items such as documents (e.g. service/resource level agreements, manuals, license documentation). Note 2: The data necessary for effective control of a CI is stored in a CI record. In addition to attributes of the CI, the CI record likely includes information on relationships it has with other CIs, service/resource components and service/resources. CI records are stored in a configuration management database (CMDB).

[19] Note: A CMDB is not necessarily a single database covering all configuration items (CIs). It may rather be composed of multiple physical data stores.

[20] Continuity Property of a service/resource to maintain all or parts of its functionality, even in exceptional circumstances. Note: Exceptional circumstances include emergencies, crises or disasters which affect the ability to provide service/resources over extended periods of time. Note: Exceptional circumstances include emergencies, crises or disasters which affect the ability to provide services over extended periods of time.

[21] Note: A customer usually represents a number of users.

[22] Note: Examples of documents include policies, plans, process descriptions, procedures, service/resource level agreements, contracts or records of activities performed.

Effectiveness: Extent to which goals and expectations are met[23].

Efficiency: Degree of ability to meet goals and expectations with minimum consumption of resources[24].

EOSC Data Service Supplier: An EOSC Supplier focusing on the provision of one or more Data Services, i.e. building blocks enacting the implementation and provisioning of an EOSC Service[25].

EOSC Service: An EOSC Resource implemented by the EOSC System to provide EOSC System Users with ready-to-use facilities. EOSC Services are supplied by an EOSC Service Provider in accordance with the EOSC Rules of Participation for EOSC Service Providers. EOSC Services are approved by the EOSC Service Portfolio Management Committee[26] and populate the EOSC Service Portfolio and the EOSC Service Catalogue[27].

EOSC Service Catalogue: The list of all live EOSC Services that can be requested by EOSC System Users. It is a subset of the EOSC Service Portfolio and it populates the EOSC Service Registry[28].

EOSC Service Component Supplier: An EOSC Supplier focusing on the provision of one or more EOSC Service Component(s)[29].

EOSC Service Developer: An EOSC Supplier called to implement the software component needed to deliver and operate an EOSC Service.

EOSC Service Portfolio: The internal list of EOSC Services including those in preparation, live and discontinued. The development of this list is controlled by the EOSC Service Portfolio Management Committee[30].

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[23] Note: In a management system, effectiveness is mostly measured against the defined goals of the processes that are subject to this system.

[24] Note 1: In a management system, efficiency is mostly considered in the context of the processes that are subject to this system.
Note 2: Resources may be human, technical, informational or financial.

[25] Note: The services that such a supplier is expected to contribute represent a specific typology of service whose value resides more on the data it gives access to than on the functionality it offers. One of the primary service built by relying on Data Services is the EOSC Data Registry service typology.

[26] For EOSC governance definitions please see the EOSC Glossary as delivered by the EOSCpilot project, available from: https://eoscpilot.eu/eosc-glossary#overlay-context=eosc-glossary

[27] Note: According to FitSM a Service is "Way to provide value to customers through bringing about results that they want to achieve". Moreover, the text of the definition aims at stressing the fact that there is a service-orientation in EOSC. EOSC Services are usually IT services. EOSC Services provide value when taken on their own – unlike the specific EOSC Service Components of which they are composed of.

[28] Note: It is a duty of the EOSC Service Provider to provide access to relevant service information to its EOSC System Users and other interested parties.

[29] Note: According to FitSM, a Supplier is an "External organisation that provides a (supporting) service or service component(s) to the service provider, which they need to provide services to their customers / users". This term should not be confused with the EOSC Service Provider for several reasons including the "what" (namely an EOSC Service Component rather than an EOSC Service) and the "how" (i.e. service provisioning is regulated by an Underpinning Agreement).

[30] Note: According to FitSM, a Service Portfolio is an "Internal list that details all the services offered by a service provider, including those in preparation, live and discontinued". This is expected to be a key component enacting the definition of the overall offering the EOSC System is focusing on, e.g. to define new services to be delivered as well as services that are going to be dismissed. For EOSC Services offered by EOSC Service Providers to EOSC System End Users, the scope of responsibility of the EOSC Service Portfolio Management is mainly to ensure the verification of the compliance with the EOSC Rules of Participation and that the service correctly integrates into the EOSC System. The EOSC Service Provider retains full control of the functional evolution of the service in accordance to users' needs. For EOSC Services offered by EOSC Service Providers to enable the EOSC System, the EOSC Service Portfolio Management can retain a higher level of control on the planning, design and release of those services.

EOSC Service Portfolio Management: The process performed by the EOSC Service Portfolio Management Committee to drive the development of the EOSC Service Portfolio.

EOSC Service Provider: An EOSC System Manager managing and delivering an EOSC Service[31].

EOSC Supplier: An EOSC System User responsible for the provisioning of one or more EOSC Service and Resource Component(s) enacting an EOSC Service within the EOSC System. It is further specialised in the following sub-roles: EOSC Service Component Supplier, Data Service Supplier, and EOSC Service Developer.

EOSC System: The IT system implementing EOSC. Such a system is called to put in place the policies, procedures and technical solutions needed to enact the delivery of the EOSC Services in accordance with the EOSC Governance guidelines[32].

Escalation: Change of responsibility for a case (such as an incident, service and resource request, problem or change) or activity to another individual or group[33].

Federation: Situation in which multiple parties, the federation members, jointly contribute to the delivery of service and resources to customers without being organised in a strict hierarchical setup or supply chain.

Federation member: Individual, organisation or body that works together with other federation members in a federation to provide one or more services and resources[34].

Federator: Body that acts to coordinate a set of federation members.

Improvement: Action or set of actions carried out to increase the level of conformity, effectiveness or efficiency of a management system, process or activity, or to increase the quality or performance of a service and resource or service and resource component[35].

Incident: Unplanned disruption of operation in a service and resource or service and resource component, or degradation of service and resource quality versus the expected or agreed service and resource level or operational level according to service and resource level agreements (SLAs), operational level agreements (OLAs) and underpinning agreements (UAs).

Information security: Preservation of confidentiality, integrity and accessibility of information.

Information security control: Means of controlling or treating one or more risks to information security.

Information security event: Occurrence or previously unknown situation indicating a possible

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[31] Note: According to FitSM, a Service Provider is defined as an "Organisation or federation (or part of an organisation or federation) that manages and delivers a service or services to customers". An EOSC Service Provider is a FitSM Service Provider called to manage and deliver an EOSC Service.

[32] Note: Such a system is not a monolithic, stand-alone and centralised IT system. Rather the EOSC System is designed and developed to be a system of systems distributed across EOSC Nodes.

[33] Note: There are two basic types of escalation: Hierarchical escalation transfers responsibility (temporarily) to someone with a higher level of authority. Functional escalation transfers responsibility to someone with a different set of competencies or privileges required to handle the case or activity.

[34] Note: Often, federation members will not be bound together by strict contractual agreements.

[35] Note: An improvement is usually implemented after an opportunity for improvement has been identified, for instance during a service/resource review, audit or management review.

breach of information security[36].

Information security incident: Single information security event or a series of information security events with a significant probability of having a negative impact on the delivery of service and resources to customers, and therefore on the customers' business operations.

Integrity of information: Property of information not being subject to unauthorized modification, duplication or deletion.

IT service and resource: Service and resource that is enabled by the use of information technology (IT).

IT service management (ITSM): Entirety of activities performed by an IT service and resource provider to plan, deliver, operate and control IT service and resources offered to customers[37].

Key performance indicator (KPI): Metric that is used to track the performance, effectiveness or efficiency of a service and resource or process[38].

Known error: Problem which has not (yet) been corrected, but for which there is a documented workaround or temporary fix to prevent (excessive) negative impact on service and resources.

Management review: Periodic evaluation of the suitability, maturity and efficiency of the entire management system by its accountable owner(s), from which opportunities for improvement are identified and follow-up actions are determined[39].

Management system: Entirety of policies, processes, procedures and related resources and capabilities aiming at effectively performing management tasks in a given context and for a given subject[40].

Maturity level: Achieved overall effectiveness of a service and resource management system, based on the combination of the capability levels of its processes and general aspects of management.

Nonconformity: Case or situation where a requirement is not fulfilled[41].

Operational level agreement (OLA): Documented agreement between a provider and an-

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[36] Note: An occurrence or situation is considered a potential breach of information security if it may lead to a negative impact on the confidentiality, integrity and/or accessibility of one or more information assets.

[37] Note: The activities carried out in the ITSM context should be directed by policies and structured and organised by processes and supporting procedures.

[38] Note: KPIs are generally important metrics that will be aligned to critical success factors and important goals. KPIs are therefore a subset of all possible metrics, intended to allow for monitoring a service/resource or process.

[39] Note: The accountable owner of a management system is usually a top management representative of the organisation operating the management system. In a federation, the accountable owner is usually one person nominated by top management representatives of all organisations (i.e. federation members) involved.

[40] Note 1: A management system is generally intangible. It is based on the idea of a systematic, structured and process-oriented way of managing.
Note 2: While documentation (such as process definitions, procedures and records) and tools (such as workflow support and monitoring tools) can be parts of a management system, management system considerations are not limited to the questions of documentation and tool support.
Note 3: With respect to (IT) service/resource management and the FitSM standard series, the idea of a service/resource management system (SMS) is a central concept, where the context of the management system is the organisational context of the service/resource provider, and the subject is to plan, deliver, operate and control (IT) service/resources.

[41] Note: This may also be referred to as noncompliance.

other part of the provider's organisation or a federation member to provide a service and resource component or subsidiary service and resource needed to allow provision of service and resources to customers.

Operational target: Reference/target value for a parameter used to measure the performance of a service and resource component, listed in an operational level agreement (OLA) or underpinning agreement (UA) related to this service and resource component[42].

Policy: Documented set of intentions, expectations, goals, rules and requirements, often formally expressed by top management representatives in an organisation or federation[43].

Physical RI Service and resource: RI Services and Resources that rely on the access to or use of a physical facility or instrument.

Portal: An online service implementing a web portal facilitating the access to and use of all live services and resources.

Portal End-User: Individual that primarily benefits from and uses a Portal.

Portal Operator: The organisation responsible for supplying one or more components of a Portal.

Post implementation review (PIR): Review after the implementation of a change that determines if the change was successful[44].

Priority: Relative importance of a target, object or activity[45].

Problem: Underlying cause of one or more incidents that requires further investigation to prevent incidents from recurring or reduce the negative impact on service and resources.

Procedure: Specified set of steps or instructions to be carried out by an individual or group to perform one or more activities of a process.

Process: Structured set of activities, with clearly defined responsibilities, that bring about a specific objective or set of results from a set of defined inputs[46].

Record: Documentation of an event or of the results of performing a process or activity.

Related Platforms: List of suites or thematic platforms in which the service and resource is engaged or providers (provider groups) contributing to this service are engaged.

Related Services: List of other services and resources that are commonly used with a specific service and resource.

Release: Set of one or more changes to configuration items (CIs) that are grouped together and deployed as a logical unit.

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[42] Note: Typical operational targets might include availability or allowed resolution times for incidents.

[43] Note: Policies are then realised in processes, which are in turn made up of activities that people carry out according to defined procedures.

[44] Note: Depending on the specific type and complexity of the change, the post implementation review may vary widely in its depth.

[45] Note: Often incidents, service/resource requests, problems and changes are given a priority. In the case of incidents and problems, priority is usually based on the specific impact and urgency of the situation.

[46] Note: Generally, a process consists of a number of activities used to manage service/resources, if the process is part of a service/resource management system (SMS).

Request for change (RFC): Documented proposal for a change to be made to one or more configuration items (CIs).

Required Services: List of other services and resources required with this service and resource.

Resource: Any physical or digital asset or infrastructure made available to users and customers[47].

Risk: Possible negative occurrence that would have a negative impact on the service and resource provider's ability to deliver agreed service and resources to customers, or that would decrease the value generated through some service and resource[48].

RI Service and resource: Services and resources provided by Research Infrastructures. They include among others access to and use of facilities and instruments, users support and training and other activities and resources that the RIs deliver to Users/Customers.

Role: Set of responsibilities and connected behaviours or actions collected into a logical unit that can be assigned to an individual or group[49].

Service: The means or a process that organisations use to deliver results that users/customers value and wish to achieve. These results are usually intangible although they may also include tangible elements. Services require instantiation by a Service Provider. Services include networking, compute, data & material storage, training, consultancy, etc[50].

Service component: Logical part of a service that provides a function enabling or enhancing a service[51].

Service and resource acceptance criteria (SAC): Criteria that must be fulfilled by the time a new or changed service and resource is deployed and made available to customers/users[52].

Service and resource catalogue: Customer-facing list of all live services and resources offered along with relevant information about these service and resources[53].

Service and resource component: Logical part of a service and resource that provides a function enabling or enhancing a service and resource[54].

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[47] Note: Resources are generally tangible elements and most of the times do not require an instantiation. Resources include instruments, data(sets), software, applications, samples, etc.

[48] Note: Risk is made up of the probability of the threat entailed, the vulnerability to that threat of some asset, and the impact the threat would have, if it occurred.

[49] Note: An individual may take over multiple roles.

[50] Note: In the context of the FitSM standard series, when referring to service/resources, usually IT service/resources are meant.

[51] Note 1: A service is usually composed of several service components. Note 2: A service component is usually built from one or more configuration items (CIs). Note 3: Although a service component underlies one or more services, it usually does not create value for a customer alone and is therefore not a service by itself.

[52] Note: SAC are defined when a new or changed service/resource is designed, and they may be updated or refined during the development or transition phase. They may cover functional and non-functional aspects of the specific service/resource to be deployed. SAC are part of the service/resource design and transition package (SDTP).

[53] Note: The service/resource catalogue can be regarded as a filtered version of and customers' view on the service/resource portfolio.

[54] Note 1: A service/resource is usually composed of several service/resource components. Note 2: A service/resource component is usually built from one or more configuration items (CIs). Note 3: Although a service/resource component underlies one or more service/resources, it usually does not create value for a customer alone and is therefore not a service/resource by itself.

Service and resource Change Log: Summary of the service and resource features updated from the previous version.

Service and resource design and transition package (SDTP): Entirety of plans for the design and transition of a specific new or changed service and resource[55].

Service and resource level agreement (SLA): Documented agreement between a customer and service and resource provider that specifies the service and resource to be provided and the service and resource targets that define how it will be provided.

Service management: Entirety of activities performed by a service provider to plan, deliver, operate and control services offered to customers[56].

Service and resource management plan: Overall plan for implementing and operating a service and resource management system (SMS).

Service and resource management system (SMS): Overall management system that controls and supports management of service and resources within an organisation or federation[57].

Service and resource portfolio: Internal list that details all the service and resources offered by a service and resource provider, including those in preparation, live and discontinued[58].

Service and resource provider: An organisation, a part of an organisation or a federation that manages and delivers services and resources to users/customers.

Service and resource report: Report that details the performance of a service and resource/resource versus the service and resource targets defined in service and resource level agreements (SLAs) – often based on key performance indicators (KPIs).

Service and resource request: A user request for information, advice and access to a service and resource.

Service and resource review: Periodic evaluation of the quality and performance of a service and resource together with the customer or under consideration of customer feedback, from which opportunities for improvement are identified, follow-up actions to increase the value of the service and resource are determined.

Service and resource target: Reference/target values for a parameter used to measure the performance of a service and resource, listed in a service and resource level agreement (SLA) related to this service and resource[59].

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[55] Note: An SDTP should be produced for every new or changed service/resource. It may consist of a number of documented plans and other relevant information, available in different formats, including a list of requirements and service/resource acceptance criteria (SAC), a project plan, communication and training plans, technical plans and specifications, resource plans, development and deployment schedules/timetables, etc.

[56] Note 1: The activities carried out in the service management context should be directed by policies and structured and organised by processes and supporting procedures.
Note 2: In the context of the FitSM standard series, when referring to service management, usually IT service management is meant.

[57] Note: The SMS can be regarded as the entirety of interconnected policies, processes, procedures, roles, agreements, plans, related resources and other elements needed and used by a service/resource provider to effectively manage the delivery of service/resources to customers.

[58] Note: For each service or resource, the service and resource portfolio may include information such as its value proposition, target customer base, service/resource description, relevant technical specifications, cost and price, risks to the service/resource provider, service/resource level packages offered, etc.

[59] Note: Typical service/resource targets might include availability or resolution time for incidents.

Supplier: External organisation that provides a (supporting) service and resource or service and resource component(s) to the service and resource provider, which they need in order to provide service and resources to their customers/users.

Thematic services: Scientific services (incl. data) that provide discipline-specific capabilities for researchers. (e.g. browsing and download data and apps, workflow development, execution, online analytics, result visualisation, sharing of result data, publications, applications).

Third-party EOSC Service Provider: An EOSC End-user willing to develop and operate a service by relying on one or more EOSC Services.

Top management: Senior management within an organisation who has authority to set policies and exercise overall control of the organisation.

Underpinning agreement (UA): Documented agreement between a service and resource provider and an external supplier that specifies the underpinning service and resource(s) or service and resource component(s) to be provided by the supplier, together with the related service and resource targets[60].

Underpinning contract (UC): See: Underpinning agreement (UA).

User: Individual that primarily benefits from and uses a service and resource.

Value: Benefit to a customer and their users delivered by a service and resource[61].

Workaround: Means of circumventing or mitigating the symptoms of a known error that helps to resolve incidents caused by this known error, while the underlying root cause is not permanently eliminated[62].

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[60] Note 1: A UA can be seen as a service level agreement (SLA) with an external supplier where the service provider is in the customer role. Note 2: A UA may also be referred to as an underpinning contract (UC).

[61] Note: Value should be considered as a composition of the utility (fitness for purpose) and warranty (fitness for use, covering sufficient availability/continuity, capacity/performance and information security) connected to a service.

[62] Note 1: Workarounds are often applied in a situation, when the actual root cause of (recurring) incidents cannot be resolved due to lack of resources or ability. Note 2: A workaround may consist of a set of actions to be carried out by either the provider or the user of the service or resource. Note 3: A workaround is also referred to as a temporary fix or temporary solution.

4. CatRIS Vocabulary as an Owl Ontology

In this section, the representation of the CatRIS Vocabulary as an Owl Ontology is presented. Ontologies are a formal way to describe taxonomies and classification networks, essentially defining the structure of knowledge for various domains: the nouns representing classes of objects and the verbs representing relations between the objects. The Web Ontology Language (OWL)[63] is an ontology language for the Semantic Web with formally defined meaning. OWL 2 ontologies provide classes, properties, individuals, and data values and are stored as Semantic Web documents. OWL 2 ontologies can be used along with information written in RDF, and OWL 2 ontologies themselves are primarily exchanged as RDF documents.

The ontology features were derived by analysing the SDT and mapping the concepts on to the formal structure of OWL. The process produced a specifications document (provided in the following chapters) that details all aspects of the new ontology by using linked data concepts.

The CatRIS consortium decided to use the www.semantics.gr system (developed by EKT) to implement the designed ontology. Semantics.gr is a platform where institutions (or projects) can create, establish & link their own vocabularies, classifications, thesauri, authority files and controlled lists. Vocabularies are published as Linked Data by using RDF (RDF/XML or JSON-LD serialization) and persistent dereferenceable URIs are provided for vocabulary entries. The platform supports hierarchies, links to other LD resources, preferable and alternative labels and other properties (e.g. definition) in multiple languages.

Institutions or projects are first registered and then institutional users have access to their own workspace where they can freely: create and manage their vocabularies, curate their vocabularies with collaborative tools (e.g. posting comments) and publish their vocabularies with the license of their choice.

Semantics.gr can support any schema profile for vocabularies. Schema profiles define in detail the structure, properties (fields) and validation rules of the vocabulary data entries. Each vocabulary is assigned with a schema profile and each schema profile defines the respective dynamic forms that the users can use to curate their data. Schema profiles are defined in a way that is compliant with Linked Data technology (RDF, RDF Schema, Owl ontologies) by using any popular, standard or custom data model (e.g. SKOS, Europeana EDM contextual classes, MAD/RDF etc).

Figure 1 presents the core classes (as definitions of the vocabulary core entities):

- Provider
- Service
- ProviderClassification
- ProviderLocation
- ContactInfo
- ServiceClassification
- ServiceMaturityInfo
- ContractualInfo
- ServiceSupportInfo
- ServiceOption

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[63] W3C, OWL 2 Web Ontology Language Document Overview (Second Edition), https://www.w3.org/TR/owl2-overview/

each with the list of its properties as well as the relationships (aggregation, composition) and multiplicities between classes. The simple classes of the Vocabulary are also listed.
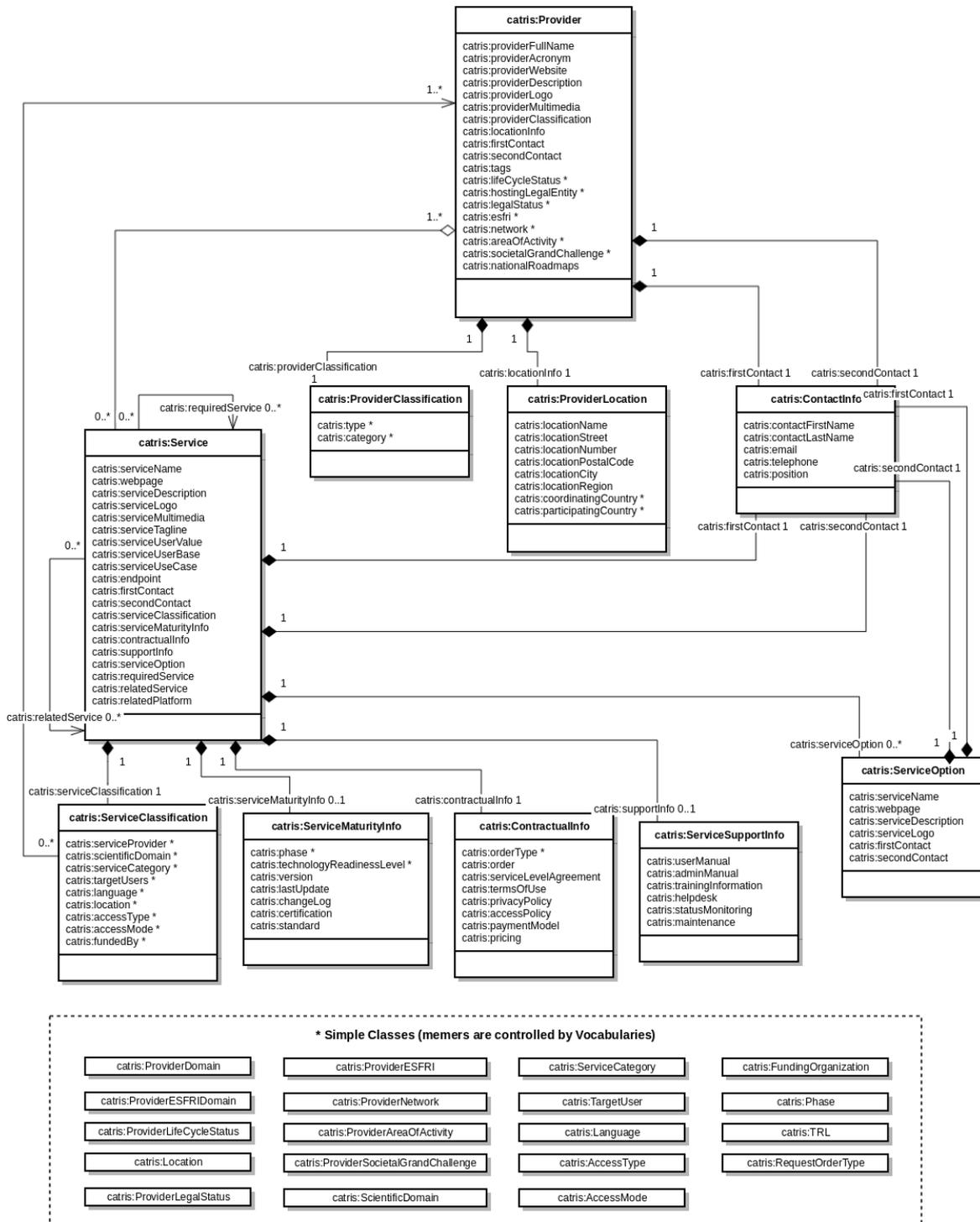
Figure 1. The representation of the CatRIS vocabulary as an Owl ontology

4.1 CatRIS Vocabulary Classes

The following tables provide a detailed description of the aforementioned classes. Each description includes a link to the corresponding semantics.gr page, the label (name) of the class, the definition of the class (as mentioned in the SDT) and a comment for further clarifications.

catris:AccessMode

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#AccessMode
Schema namespace: catris
Name: AccessMode
Label: Access Modes
Members controlled by Vocabulary: Access Modes

catris:AccessType

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#AccessType
Schema namespace: catris
Name: AccessType
Label: Access Types
Members controlled by Vocabulary: Access Types

catris:ContactInfo

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ContactInfo
Schema namespace: catris
Name: ContactInfo
Label: Contact Info
Comments: Contact Information
Properties:

Qualified name	Label	Type	Values
catris:contactFirstName	Contact First Name	RDF object	Literal
catris:contactLastName	Contact Last Name	RDF object	Literal
catris:email	Email	Data type	Text
catris:telephone	Telephone	Data type	Text
catris:position	Position	RDF object	Literal

catris:ContractualInfo

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ContractualInfo
Schema namespace: catris
Name: ContractualInfo
Label: Contractual Info
Comments: The Service/Resource Contractual Information.
Properties:

Qualified name	Label	Type	Values
catris:order	Order	Data type	URI
catris:orderType	Order Type	RDF object	Resource
catris:serviceLevelAgreement	Service Level Agreement	Data type	URI

catris:termsOfUse	Terms Of Use	Data type	URI
catris:privacyPolicy	Privacy Policy	Data type	URI
catris:accessPolicy	Access Policy	Data type	URI
catris:paymentModel	Payment Model	Data type	URI
catris:pricing	Pricing	Data type	URI

catris:FundingOrganization

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#FundingOrganization
Schema namespace: catris
Name: FundingOrganization
Label: RI Services/Resources Funding Organization
Members controlled by Vocabulary: RI Services/Resources Funding Organizations

catris:Language

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#Language
Schema namespace: catris
Name: Language
Label: Language
Members controlled by Vocabulary: CatRIS Languages

catris:Location

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#Location
Schema namespace: catris
Name: Location
Label: Locations
Members controlled by Vocabulary: Locations

catris:Phase

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#Phase
Schema namespace: catris
Name: Phase
Label: RI Service/Resource Phases
Members controlled by Vocabulary: RI Service/Resource Phases

catris:Provider

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#Provider
Schema namespace: catris
Name: Provider
Label: RI/Provider
Comments: The template is used during the first step of the registration process (after the Service/Resource Provider Manager or the Service/Resource Manager logins as an Authenticated User),The Service/Resource Provider represents an organisation, a part of an organisation or a federation that manages and delivers Services and Resources to Users/Customers.
Property for preference label: catris:providerFullName
Property for alternative labels: catris:providerAcronym
Other properties:

Qualified name	Label	Type	Values
catris:providerWebsite	Provider Web Site	Data type	URI
catris:providerClassification	Provider Classification	RDF object	Resource
catris:providerDescription	Provider Description	RDF object	Literal
catris:providerLogo	Provider Logo	Data type	URI
catris:providerMultimedia	Provider Multimedia	Data type	URI
catris:lifeCycleStatus	Life Cycle Status	RDF object	Resource
catris:locationInfo	Location Info	RDF object	Resource
catris:firstContact	First Contact	RDF object	Resource
catris:secondContact	Second Contact	RDF object	Resource
catris:hostingLegalEntity	Hosting Legal Entity	RDF object	Literal
catris:legalStatus	Legal Status	RDF object	Resource
catris:esfri	ESFRI	RDF object	Resource
catris:network	Network	RDF object	Multiple resources
catris:areaOfActivity	Area Of Activity	RDF object	Multiple resources
catris:societalGrandChallenge	Societal Grand Challenge	RDF object	Multiple resources
catris:nationalRoadmaps	National Roadmaps	Data type	Boolean
catris:hasService	Has Service	RDF object	Multiple resources

catris:ProviderAreaOfActivity
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderAreaOfActivity
Schema namespace: catris
Name: ProviderAreaOfActivity
Label: RI Areas Of Activity
Members controlled by Vocabulary: RI Areas Of Activity

catris:ProviderClassification
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderClassification
Schema namespace: catris
Name: ProviderClassification
Label: Provider Classification
Comments: The Provider (RI) classifications
Properties:

Qualified name	Label	Type	Values
catris:type	Type	RDF object	Multiple resources
catris:scientificDomain	Scientific Domain	RDF object	Multiple resources
catris:category	Category	RDF object	Multiple resources

catris:esfriDomain	ESFRI Domain	RDF object	Multiple resources
catris:tags	Tags	RDF object	Multiple literals

catris:ProviderDomain
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderDomain
Schema namespace: catris
Name: ProviderDomain
Label: RI Provider Domain/Category
Members controlled by Vocabulary: RI Provider Domains/Categories

catris:ProviderESFRI
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderESFRI
Schema namespace: catris
Name: ProviderESFRI
Label: RI relations with ESFRI
Members controlled by Vocabulary: RI relations with ESFRI

catris:ProviderESFRIDomain
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderESFRIDomain
Schema namespace: catris
Name: ProviderESFRIDomain
Label: RI ESFRI Domains
Members controlled by Vocabulary: RI ESFRI Domains

catris:ProviderLegalStatus
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderLegalStatus
Schema namespace: catris
Name: ProviderLegalStatus
Label: RI Legal Statuses
Members controlled by Vocabulary: RI Legal Statuses

catris:ProviderLifeCycleStatus
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderLifeCycleStatus
Schema namespace: catris
Name: ProviderLifeCycleStatus
Label: RI Life Cycle Statuses
Members controlled by Vocabulary: RI Life Cycle Statuses

catris:ProviderLocation
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderLocation
Schema namespace: catris
Name: ProviderLocation
Label: Provider Location
Comments: Location Information
Property for preference label: catris:locationName
Other properties:

Qualified name	Label	Type	Values

catris:locationStreet	Location Street	Data type	Text
catris:locationNumber	Location Number	Data type	Text
catris:locationPostalCode	Location Postal Code	Data type	Text
catris:locationCity	Location City	RDF object	Literal
catris:locationRegion	Location Region	RDF object	Literal
catris:coordinatingCountry	Coordinating Country	RDF object	Resource
catris:participatingCountry	Participating Country	RDF object	Multiple resources

catris:ProviderNetwork
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderNetwork
Schema namespace: catris
Name: ProviderNetwork
Label: RI Networks
Members controlled by Vocabulary: RI Networks

catris:ProviderSocietalGrandChallenge
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderSocietalGrandChallenge
Schema namespace: catris
Name: ProviderSocietalGrandChallenge
Label: RI Societal Grand Challenges
Members controlled by Vocabulary: RI Societal Grand Challenges

catris:ProviderType
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ProviderType
Schema namespace: catris
Name: ProviderType
Label: RI Types
Members controlled by Vocabulary: RI Types

catris:RequestOrderType
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#RequestOrderType
Schema namespace: catris
Name: RequestOrderType
Label: RI Service/Resource Request Order Types
Members controlled by Vocabulary: RI Service/Resource Request Order Types

catris:ScientificDomain
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ScientificDomain
Schema namespace: catris
Name: ScientificDomain
Label: RI Scientific Domains
Comments: RI Service/Resource Scientific Domains
Members controlled by Vocabulary: RI Service/Resource Scientific Domains

catris:Service
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#Service
Schema namespace: catris
Name: Service
Label: Service
Comments: RI Service/Resource
Property for preference label: catris:serviceName
Other properties

Qualified name	Label	Type	Values
catris:firstContact	First Contact	RDF object	Resource
catris:secondContact	Second Contact	RDF object	Resource
catris:serviceWebpage	Service Webpage	Data type	URI
catris:serviceDescription	Service Description	RDF object	Literal
catris:serviceLogo	Service Logo	Data type	URI
catris:serviceMultimedia	Service Multimedia	Data type	URI
catris:serviceTagline	Service Tagline	RDF object	Literal
catris:serviceUserValue	Service User Value	RDF object	Literal
catris:serviceUserBase	Service User Base	RDF object	Multiple literals
catris:serviceUseCase	Service Use Case	RDF object	Multiple literals
catris:serviceOption	Service Option	RDF object	Multiple resources
catris:endpoint	Endpoint	Data type	URI
catris:serviceClassification	Service Classification	RDF object	Resource
catris:maturityInfo	Maturity Info	RDF object	Resource
catris:contractualInfo	Contractual Info	RDF object	Resource
catris:supportInfo	Support Info	RDF object	Resource
catris:requiredService	Required Service	RDF object	Multiple resources
catris:relatedService	Related Service	RDF object	Multiple resources
catris:relatedPlatform	Related Platform	RDF object	Literal

catris:ServiceCategory
URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ServiceCategory
Schema namespace: catris
Name: ServiceCategory
Label: RI Service/Resource Category
Members controlled by Vocabulary: RI Service/Resource Categories

catris:ServiceClassification
URI:https://www.semantics.gr/authorities/schemanamespaces/catris#ServiceClassification
Schema namespace: catris

Name: ServiceClassification
Label: Service Classification
Comments: The Service/Resource classifications.
Properties

Qualified name	Label	Type	Values
catris:serviceProvider	Service Provider	RDF object	Multiple resources
catris:scientificDomain	Scientific Domain	RDF object	Multiple resources
catris:serviceCategory	Service Category	RDF object	Multiple resources
catris:targetUsers	Target Users	RDF object	Multiple resources
catris:language	Language	RDF object	Multiple resources
catris:location	Location	RDF object	Multiple resources
catris:accessType	Access Type	RDF object	Multiple resources
catris:accessMode	Access Mode	RDF object	Multiple resources
catris:fundedBy	Funded By	RDF object	Multiple resources

catris:ServiceMaturityInfo

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ServiceMaturityInfo
Schema namespace: catris
Name: ServiceMaturityInfo
Label: Service Maturity Info
Comments: The Service/Resource Maturity Information.
Properties:

Qualified name	Label	Type	Values
catris:phase	Phase	RDF object	Resource
catris:technologyReadinessLevel	Technology Readiness Level	RDF object	Resource
catris:version	Version	Data type	Text
catris:lastUpdate	Last Update	Data type	Date
catris:changeLog	Change Log	RDF object	Literal
catris:certification	Certification	RDF object	Multiple literals
catris:standard	Standard	RDF object	Multiple literals

catris:ServiceOption

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ServiceOption
Schema namespace: catris
Name: ServiceOption
Label: Service Option
Comments: The Service/Resource Option is a different option (instantiation) offered for a specific service/resource registered.
Property for preference label: catris:serviceName
Other properties:

Qualified name	Label	Type	Values
catris:firstContact	First Contact	RDF object	Resource
catris:secondContact	Second Contact	RDF object	Resource
catris:serviceWebpage	Service Webpage	Data type	URI
catris:serviceDescription	Service Description	RDF object	Literal
catris:serviceLogo	Service Logo	Data type	URI
catris:serviceMultimedia	Service Multimedia	Data type	URI

catris:ServiceSupportInfo

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#ServiceSupportInfo
Schema namespace: catris
Name: ServiceSupportInfo
Label: Service Support Info
Comments: The Service/Resource Support Information.
Properties:

Qualified name	Label	Type	Values
catris:adminManual	Admin Manual	Data type	URI
catris:userManual	User Manual	Data type	URI
catris:trainingInformation	Training Information	Data type	URI
catris:helpdesk	Helpdesk	Data type	URI
catris:statusMonitoring	Status Monitoring	Data type	URI
catris:maintenance	Maintenance	Data type	URI

catris:TargetUser

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#TargetUser
Schema namespace: catris
Name: TargetUser
Label: RI Service/Resource Target User
Members controlled by Vocabulary: RI Service/Resource Target Users

catris:TRL

URI: https://www.semantics.gr/authorities/schemanamespaces/catris#TRL
Schema namespace: catris
Name: TRL
Label: Technology Readiness Levels
Members controlled by Vocabulary: Technology Readiness Levels

4.2   CatRIS Vocabulary Properties

The following list provide the various vocabulary properties. Each property includes a link to the corresponding semantics.gr page where the label (name) of the property, the definition of the property (as mentioned in the SDT), a comment for further clarifications, the ontology type, the super-properties (if any), the ontology domain, a number indicating if the property is obligatory and its multiplicity are shown.

- catris:accessMode
- catris:accessPolicy
- catris:accessType
- catris:adminManual
- catris:areaOfActivity
- catris:category
- catris:certification
- catris:changeLog
- catris:contactFirstName
- catris:contactLastName
- catris:contractualInfo
- catris:coordinatingCountry
- catris:email
- catris:endpoint
- catris:esfri
- catris:esfriDomain
- catris:firstContact
- catris:fundedBy
- catris:hasService
- catris:helpdesk
- catris:hostingLegalEntity
- catris:language
- catris:lastUpdate
- catris:legalStatus
- catris:lifeCycleStatus
- catris:location
- catris:locationCity
- catris:locationInfo
- catris:locationName
- catris:locationNumber
- catris:locationPostalCode
- catris:locationRegion
- catris:locationStreet
- catris:maintenance
- catris:maturityInfo
- catris:nationalRoadmaps
- catris:network
- catris:order
- catris:orderType
- catris:participatingCountry
- catris:paymentModel
- catris:phase
- catris:position
- catris:pricing
- catris:privacyPolicy
- catris:providerAcronym
- catris:providerClassification
- catris:providerDescription

- catris:providerFullName
- catris:providerLogo
- catris:providerMultimedia
- catris:providerWebsite
- catris:relatedPlatform
- catris:relatedService
- catris:requiredService
- catris:scientificDomain
- catris:secondContact
- catris:serviceCategory
- catris:serviceClassification
- catris:serviceDescription
- catris:serviceLevelAgreement
- catris:serviceLogo
- catris:serviceMultimedia
- catris:serviceName
- catris:serviceOption
- catris:serviceProvider
- catris:serviceTagline
- catris:serviceUseCase
- catris:serviceUserBase
- catris:serviceUserValue
- catris:serviceWebpage
- catris:societalGrandChallenge
- catris:standard
- catris:statusMonitoring
- catris:supportInfo
- catris:tags
- catris:targetUsers
- catris:technologyReadinessLevel
- catris:telephone
- catris:termsOfUse
- catris:trainingInformation
- catris:type
- catris:userManual
- catris:version

4.3 Controlled Vocabularies

The following table provide a detailed description of the controlled vocabularies. Each description includes a link to the corresponding semantics.gr page, the label (name) of the vocabulary, the skos class that it belong to, the schema class for which the vocabulary is provided and a semantics.gr link to the page that provides the list of values.

Short name	Name	Provider/Creator	Owl class
CatRISAccessMode	Access Modes	**Provider:**CatRIS Project **Creator:**Meril-2 Project	skos:Concept catris:AccessMode
CatRISAccessType	Access Types	**Provider:**CatRIS Project **Creator:**Meril-2 Project	skos:Concept catris:AccessType
CatRISDefinitions	CatRIS Definitions	CatRIS Project	skos:Concept
CatRISFundingOrganizations	RI Services/Resources Funding Organizations	CatRIS Project	skos:Concept catris:FundingOrganization

CatRISLanguages	CatRIS Languages	CatRIS Project	skos:Concept catris:Language
CatRISLocation	Locations	CatRIS Project	skos:Concept catris:Location
CatRISMERILProvider	CatRIS MERIL Provider	**Provider:**CatRIS Project **Creator:**Meril-2 Project	catris:Provider
CatRISPhase	RI Service/Resource Phase	CatRIS Project	skos:Concept catris:Phase
CatRISProviderAreaOfActivity	RI Areas Of Activity	CatRIS Project	skos:Concept catris:ProviderAreaOfActivity
CatRISProviderDomain	RI Provider Domains/Categories	CatRIS Project	skos:Concept catris:ProviderDomain
CatRISProviderESFRI	RI relations with ESFRI	CatRIS Project	skos:Concept catris:ProviderESFRI
CatRISProviderESFRIDomain	RI ESFRI Domains	**Provider:**CatRIS Project **Creator:**Meril-2 Project	skos:Concept catris:ProviderESFRIDomain
CatRISProviderLegalStatus	RI Legal Statuses	**Provider:**CatRIS Project **Creator:**Meril-2 Project	skos:Concept catris:ProviderLegalStatus
CatRISProviderLifeCycleStatus	RI Life Cycle Statuses	CatRIS Project	skos:Concept catris:ProviderLifeCycleStatus
CatRISProviderNetwork	RI Networks	CatRIS Project	skos:Concept catris:ProviderNetwork
CatRISProviderSocietalGrandChallenge	RI Societal Grand Challenges	**Provider:**CatRIS Project **Creator:**Meril-2 Project	skos:Concept catris:ProviderSocietalGrandChallenge
CatRISProviderType	RI Types	**Provider:**CatRIS Project **Creator:**Meril-2 Project	skos:Concept catris:ProviderType
CatRISRequestOrderType	RI Service/Resource Request Order Types	CatRIS Project	skos:Concept catris:RequestOrderType
CatRISScientificDomain	RI Service/Resource Scientific Domains	CatRIS Project	skos:Concept catris:ScientificDomain
CatRISServiceCategory	RI Service/Resource Categories	CatRIS Project	skos:Concept catris:ServiceCategory
CatRISTargetUsers	RI Service/Resource Target Users	CatRIS Project	skos:Concept catris:TargetUser
CatRISTRL	Technology Readiness Levels	CatRIS Project	skos:Concept catris:TRL

4.4 Migration of SDT controlled vocabularies

The terms of the various SDT vocabularies were migrated in the semantics.gr database by implementing a custom migration process. Initially, the values lists were provided in the form of spreadsheet files. Those files were edited and re-stored as MS Excel files, in order to be compatible with the migration technical specifications. The terms then were migrated and the results were checked by using the semantics.gr view pages and forms.

5. Semantics Representation

Following the CatRIS Provider and Service Description presentation in the form of an Owl Ontology, the ontology's representation as a Semantic Vocabulary within Semantics.gr has been implemented. The following screenshots provide a brief overview of the implementation.

The CatRIS schema namespace is presented in Figure 2, including reusable elements and attributes.

Figure 2. CatRIS schema namespace representation in Semantics.gr

Following that, the Provider class of the ontology as presented within the Semantics tool is shown in Figure 3.

catris:Provider	
URI	https://www.semantics.gr/authorities/schemanamespaces/catris#Provider
Schema namespace	catris
Name	Provider
Label	RI/Provider
Comments	The template is used during the first step of the registration process (after the Service/Resource Provider Manager or the Service/Resource Manager logins as an Authenticated User),The Service/Resource Provider represents an organisation, a part of an organisation or a federation that manages and delivers Services and Resources to Users/Customers.
Contextual category	Agents
Property for preference label	catris:providerFullName
Property for alternative labels	catris:providerAcronym

☰ Properties	Qualified name	Label	Type	Values
	catris:providerWebsite	Provider Web Site	Data type	URI
	catris:providerClassification	Provider Classification	RDF object	Resource
	catris:providerDescription	Provider Description	RDF object	Literal
	catris:providerLogo	Provider Logo	Data type	URI
	catris:providerMultimedia	Provider Multimedia	Data type	URI
	catris:lifeCycleStatus	Life Cycle Status	RDF object	Resource
	catris:locationInfo	Location Info	RDF object	Resource
	catris:firstContact	First Contact	RDF object	Resource
	catris:secondContact	Second Contact	RDF object	Resource
	catris:hostingLegalEntity	Hosting Legal Entity	RDF object	Literal
	catris:legalStatus	Legal Status	RDF object	Resource
	catris:esfri	ESFRI	RDF object	Resource
	catris:network	Network	RDF object	Multiple resources
	catris:areaOfActivity	Area Of Activity	RDF object	Multiple resources
	catris:societalGrandChallenge	Societal Grand Challenge	RDF object	Multiple resources
	catris:nationalRoadmaps	National Roadmaps	Data type	Boolean
	catris:hasService	Has Service	RDF object	Multiple resources

Figure 3. Representation of the Service Provider class of the ontology

Subsequently, the Service class of the ontology as presented within the Semantics tool is shown in Figure 4.

catris:Service

URI	https://www.semantics.gr/authorities/schemanamespaces/catris#Service
Schema namespace	catris
Name	Service
Label	Service
Comments	RI Service/Resource
Contextual category	Concepts
Property for preference label	catris:serviceName

Properties

Qualified name	Label	Type	Values
catris:firstContact	First Contact	RDF object	Resource
catris:secondContact	Second Contact	RDF object	Resource
catris:serviceWebpage	Service Webpage	Data type	URI
catris:serviceDescription	Service Description	RDF object	Literal
catris:serviceLogo	Service Logo	Data type	URI
catris:serviceMultimedia	Service Multimedia	Data type	URI
catris:serviceTagline	Service Tagline	RDF object	Literal
catris:serviceUserValue	Service User Value	RDF object	Literal
catris:serviceUserBase	Service User Base	RDF object	Multiple literals
catris:serviceUseCase	Service Use Case	RDF object	Multiple literals
catris:serviceOption	Service Option	RDF object	Multiple resources
catris:endpoint	Endpoint	Data type	URI
catris:serviceClassification	Service Classification	RDF object	Resource
catris:maturityInfo	Maturity Info	RDF object	Resource
catris:contractualInfo	Contractual Info	RDF object	Resource
catris:supportInfo	Support Info	RDF object	Resource
catris:requiredService	Required Service	RDF object	Multiple resources
catris:relatedService	Related Service	RDF object	Multiple resources
catris:relatedPlatform	Related Platform	RDF object	Literal

Figure 4. Representation of the Service class of the ontology in the Semantics tool

Looking further into the Semantics tool implementation, the vocabulary of RI Service and resource Order Types is presented in Figure 5, while an RDF/XML extract from the representation of the same vocabulary is presented in Figure 6.

Figure 5. Representation of the service and resource Order Types Vocabulary

```xml
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF
    xmlns:catris="https://www.semantics.gr/authorities/schemanamespaces/catris#"
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
    xmlns:skos="http://www.w3.org/2004/02/skos/core#">
    <skos:Concept rdf:about="http://semantics.gr/authorities/CatRISRequestOrderType/1947692209">
        <rdf:type rdf:resource="https://www.semantics.gr/authorities/schemanamespaces/catris#RequestOrderType"/>
        <skos:prefLabel xml:lang="en">Fully open access</skos:prefLabel>
        <skos:definition xml:lang="en">No ordering procedure necessary to access the service/resource and no user authentication required</skos:definition>
    </skos:Concept>
</rdf:RDF>
```

Figure 6. An extract of the RDF/XML representation of the service and resource Order Types Vocabulary as made available in semantics.gr

6. Conclusions

Following the specification of the CatRIS Service Description Templates and Classifications, the introduction of the service and resource management vocabulary for CatRIS, as presented in this document, is expected to facilitate the RIs decision-making process to adopt a common framework for service delivery.

The vocabulary also ensures alignment with the EOSC Catalogue and serves as a basis for the adoption and execution of the required service management processes between the RI service and resource providers and their beneficiaries as well as service delivery transactions within the wider EOSC stakeholders' community.

Additionally, the modelling of the CatRIS Vocabulary as an Owl Ontology, including the relevant CatRIS Classes, CatRIS Properties and Controlled Vocabularies and the implementation of a semantics representation of the ontology, as made freely available in the form of Open Linked Data, provide a formal description incorporating all necessary attributes, relations and rules.

This shareable and reusable representation will intensify common understanding and correctness of the adoption of CatRIS Service Description Templates and Classifications. It will thus contribute significantly to the next steps of CatRIS for widening the inclusion of RI communities and addition of their services to the CatRIS portal.