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# SERVICE METADATA MODEL (UMM-S)



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**Goddard Space Flight Center**  
**Greenbelt, Maryland**

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National Aeronautics and  
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## Preface

This document is under ESDIS Project configuration control. Once this document is approved, ESDIS approved changes are handled in accordance with Class I and Class II change control requirements described in the ESDIS Configuration Management Procedures, and changes to this document shall be made by change bars or by complete revision.

Any questions should be addressed to: [esdis-esmo-cmo@lists.nasa.gov](mailto:esdis-esmo-cmo@lists.nasa.gov)

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## Abstract

This document describes the Service Metadata Profile to be used by the NASA Earth Science community and addresses the need for search and discovery of data which have services, as an extension to collections and/or variables search and discovery. Implementers of Earth Science Data and Information System's (ESDIS) CMR, its clients, and service providers should reference this document and the Unified Metadata Model (UMM) as a guide while implementing the system, its clients, compatible tools or generating metadata.

Note: the previous service design addressed the Service Entry Resource Format (SERF) standard. NASA's Earth Observing System Data and Information System (EOSDIS) is evolving to expose data and services using standards based protocols in order to keep pace with evolving standards in Web Services, i.e. OPeNDAP, WCS, WMS. In recent work we sought to understand how data was being accessed and for what purpose, and how this could be achieved more simply via services. To this end, we have developed a UI/UX driven approach to services. We have called this model: "End-to-End Services". Here, the user experience guides what selections and choices a user makes at the UI for typical data transformations, e.g. spatial subsetting, reprojection, reformatting, etc. In this model, the user only cares about what choices are available for a specific data set and the back-end services take care of any needed processing.

This version of the service design describes the Minimal Viable Product (MVP). Hence, we focus on what is the minimum service metadata needed to support the UI/UX, specifically for the EarthData Search Client (EDSC)..

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## Change History Log

<b>Revision</b>	<b>Effective Date</b>	<b>Description of Changes</b> (Reference the CCR & CCB Approval Date)
<b>V1.0</b>	February 2015	<ul style="list-style-type: none"><li>• Provisional Release</li></ul>
<b>V1.1</b>	February 2015	<ul style="list-style-type: none"><li>• Added ISO 19115-1</li></ul>
<b>V1.2</b>	May 2015	<ul style="list-style-type: none"><li>• Added Normalize to Publication Reference</li></ul>
<b>V1.3</b>	July 2015	<ul style="list-style-type: none"><li>• Updated from June 2015 Earth Science Data and Information System (ESDIS) Standards Office (ESO) review comments.</li><li>• Changed the Parameter Search tag to Search API.</li><li>• Removed Metadata Standard</li><li>• Changed Metadata Dates to Metadata Date</li><li>• Removed Lineage</li><li>• Removed Data Dates</li></ul>
<b>V1.4</b>	Dec 2016 – Sept 2017	<ul style="list-style-type: none"><li>• Revised for End-to-End Services Design</li></ul>

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# 1 INTRODUCTION

## 1.1 Purpose

Earth Observing System Data and Information System (EOSDIS) generates, archives, and distributes enormous amounts of Earth Science data via its Distributed Active Archive Centers (DAACs). These data are accessed and employed by a broad user community. It is therefore imperative that reliable, consistent, and high-quality metadata be maintained in order to enable accurate cataloging, discovery, accessibility, and interpretation. To increase the level of quality and consistency among its metadata holdings, EOSDIS has developed a model for various metadata concepts that it archives and maintains. This model aims to document vital elements that may be represented across various metadata formats and standards and unify them through core fields useful for data discovery and service invocations. This unified model, aptly named the Unified Metadata Model, has been developed as part of the EOSDIS Metadata Architecture Studies (MAS I and II) conducted between 2012 and 2013.

The UMM will be used by the CMR and will drive search and retrieval of metadata cataloged within that system.

This document is intended to serve as a reference profile – a part of the UMM model - for geospatial science metadata for collections. This reference profile is referred to as the UMM-S, where 'S' indicates that this is the services profile.

This document provides information to the National Aeronautics and Space Administration (NASA) Earth Science community. Distribution is unlimited.

## 1.2 Scope

This document is related to the Service Metadata Model. It describes elements that are specific to this metadata model.

## 1.3 Impact

This document outlines common elements used in the Unified Metadata Model that are intended to be backward-compatible with existing NASA earth science metadata implementations. It will impact providers from NASA Distributed Active Archive Centers (DAAC[s]), Common Metadata Repository (CMR) client developers, metadata catalog developers, and users.

## 1.4 Copyright Notice

The contents of this document are not protected by copyright in the United States and may be used without obtaining permission from NASA.

## 1.5 Feedback

Questions, comments and recommendations on the contents of this document should be directed to [support@earthdata.nasa.gov](mailto:support@earthdata.nasa.gov).

## 1.6 Document Conventions

This document contains UMM common elements, each of which contains the following components:

- **Element Name:** Provides the element name.
- **Element Specification:** Provides the sub-elements, cardinality of the sub-elements within (), any valid values within <>, applicable comments and notes within {}, and any other major factors that make up the element.
- **Description:** Provides background information on the purpose of the element and its intended use. Furthermore, any information about the element's current usage, recommendations for usage, or unresolved issues is also documented here. The term "resource" is also used mainly in the description section though it can be used elsewhere and it is meant to denote collections, granules, services, visualizations, variables, documents, etc.
- **Profile Utilization:** Lists which profiles use the specific element.
- **Cardinality:** Indicates the expectation of counts for this element, summarized in Table 1.
- **Analysis:** Gives an analysis of this element where needed and describes any necessary reconciliation.
- **Mapping:** Gives Extensible Markup Language (XML) Path Language (XPath) mappings for this element to the elements in other specifications. This can be considered as the "crosswalk" for this element. For a link to more information about XPaths please see [Related Documents](#).
- **Examples:** XML snippets from "cross-walked" data standards documenting sample values for the element. Whenever possible, a Uniform Resource Locator (URL) to the specific collection or service used for the metadata snippet, is provided.
- **Recommendations:** Provides any future recommendations for the element.

Value	Description
1	Exactly one of this element is required
0..N	Optionally, up to and including N number of this element may be present
0..*	Optionally, any number of this element may be present
1..*	At least one of this element is required, any number may be present

**Table 1. Cardinality**

## 1.7 Related Documentation

The latest versions of all documents below should be used. The latest ESDIS Project documents can be obtained from URL: <https://ops1-cm.ems.eosdis.nasa.gov>. ESDIS documents have a document number starting with either 423 or 505. Other documents are available for reference in the ESDIS project library website at: [http://esdisfmp01.gsfc.nasa.gov/esdis\\_lib/default.php](http://esdisfmp01.gsfc.nasa.gov/esdis_lib/default.php) unless indicated otherwise.



### 1.7.1 Applicable Documents [and Forms]

The following documents are referenced within or are directly applicable, or contain policies or other directive matters that are binding upon the content of this document.

DIF 9	<a href="https://gcmd.nasa.gov/Aboutus/xml/dif/dif.xsd">https://gcmd.nasa.gov/Aboutus/xml/dif/dif.xsd</a> <a href="https://gcmd.nasa.gov/add/difguide/index.html">https://gcmd.nasa.gov/add/difguide/index.html</a>
DIF 10	<a href="https://gcmd.gsfc.nasa.gov/Aboutus/xml/dif/dif_v10.2.xsd">https://gcmd.gsfc.nasa.gov/Aboutus/xml/dif/dif_v10.2.xsd</a> <a href="https://gcmd.gsfc.nasa.gov/DocumentBuilder/defaultDif10/guide/index.html">https://gcmd.gsfc.nasa.gov/DocumentBuilder/defaultDif10/guide/index.html</a>
ECHO 10	<a href="https://wiki.earthdata.nasa.gov/display/echo/Earth+Observing+System+Clearing+House+-+ECHO">https://wiki.earthdata.nasa.gov/display/echo/Earth+Observing+System+Clearing+House+-+ECHO</a>
SERF	<a href="https://gcmd.nasa.gov/Aboutus/xml/serf/serf.xsd">https://gcmd.nasa.gov/Aboutus/xml/serf/serf.xsd</a> <a href="https://gcmd.nasa.gov/add/serfguide/index.html">https://gcmd.nasa.gov/add/serfguide/index.html</a>
ISO 19115-2 (MENDS)	<a href="http://www.iso.org/iso/catalogue_detail.htm?csnumber=39229">http://www.iso.org/iso/catalogue_detail.htm?csnumber=39229</a> <a href="https://cdn.earthdata.nasa.gov/iso/">https://cdn.earthdata.nasa.gov/iso/</a>
ISO 19115-1	<a href="https://github.com/ISO-TC211/XML">https://github.com/ISO-TC211/XML</a>

**Table 2. Applicable Documents**

### 1.7.2 Reference Documents

The following documents are not binding on the content but referenced herein and, amplify or clarify the information presented in this document.

Tags	<a href="http://en.wikipedia.org/wiki/Tag_%28metadata%29">http://en.wikipedia.org/wiki/Tag_%28metadata%29</a>
XPath	XPath is a language for addressing parts of an XML document, designed for use with XSLT.
XLinks	<a href="http://en.wikipedia.org/wiki/XLink">http://en.wikipedia.org/wiki/XLink</a>

**Table 3. Reference Documents**

## 2 UNIFIED METADATA MODEL SERVICES

The following subsections apply to the Unified Metadata Model – Services profile.

### 2.1 Status of This Document

This document provides information to the National Aeronautics and Space Administration (NASA) Earth Science community. Distribution is unlimited.

### 2.2 Introduction to Unified Metadata Model for Variables (UMM-Services)

EOSDIS generates, archives, and distributes massive amounts of Earth Science data, which in turn is made available to the science community and the public at large. To aid in the search and

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discovery process, this data must be organized and cataloged, which makes accurate, complete, and consistent metadata a requirement for efficient accessibility. To improve the quality and consistency among its metadata holdings, EOSDIS has developed a model describing metadata that it archives and maintains. This model documents elements that may be represented across various metadata standards and unifies them through core elements useful for discovery. This unified model, aptly named the Unified Metadata Model (UMM), has been developed as part of the EOSDIS Metadata Architecture Studies (MAS I and II) conducted between 2012 and 2013. The UMM will be used by the Common Metadata Repository (CMR) and will drive search and retrieval of metadata cataloged within that system.

This document describes a UMM reference profile referred to as the UMM-S, where 'S' stands for services. The updated UMM-S provides metadata to support the UI/UX-driven approach to End-to-End Services. Specifically, when a user wants to know what services are available for a particular collection, he/she makes selections via the UI, e.g. subsetting, data transformations and the desired output file format. The UMM-S enables the population of the various options which are surfaced in the UI to support these selections. Each service record contains the identification of the service, i.e. name, type, version, description, and the service options for subsetting, available data transformations and formatting.

Since UMM-S is part of the UMM, there are common elements that are shared across the different UMM profiles and have already been documented in the UMM-Common document. When this is the case, a description of where the already documented element is located will be documented, followed by the mappings that differ.

This mapping is expected to evolve to support automated service invocation in the future. One approach to this is to request the capabilities provided by each service in order to auto-populate the UMM-S.

### **2.3 Motivation**

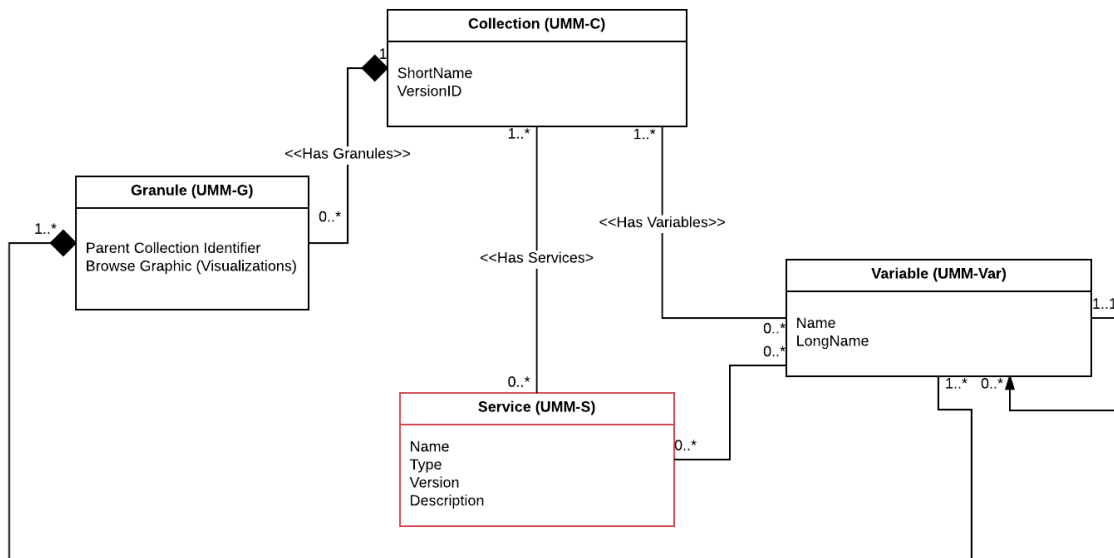
The motivation for UMM-S is to devise a services model applicable to CMR that 1) provides services to support the End-to-End Service model, and 2) permits user selection of service options for data transformations which are available from the service (or services) for any given collection. In addition, the CMR services profile can be tied into the other CMR metadata profiles, e.g. UMM-Var, through similar attributes and has the opportunity to mature as the other CMR models evolve.

### **2.4 Services Context Diagram**

Any service instance described by the UMM-S may have relationships to other metadata instances such as collections (UMM-C), granules (UMM-G), etc. In addition, as shown in Figure 1, each service may have associated variables and may be searched for via a collection. Furthermore, each service has a single instance of an OnlineResource, which contains a web services linkage (universal resource locator). This will enable data to be requested, accessed, subsetted and downloaded or streamed via the corresponding service. Finally, all UMM profiles and the CMR Lifecycle are documented separately. The CMR Lifecycle will govern this model

and related documentation and facilitate change. These documents can be found at the following location: <https://wiki.earthdata.nasa.gov/display/CMR/CMR+Documents>.

Figure 1 shows UMM-S metadata class at a high level and its relationships with the other key entities: Collection, Granule and Variable. It shows specifically the UMM-S, services role in the context of the Unified Metadata Model.



**Figure 1. Unified Metadata Model (UMM) Relationships**

## 2.5 Use Cases

This section provides information about different use cases identified for the UMM-S. A sequence diagram is presented after each use case.

### 2.5.1 a. Collection Search

As a user of the Earthdata Search Client (EDSC), I can perform a Collection Search and discover the available variables and service options in the CMR.

Scenario [a]: As a user of the Earthdata Search Client (EDSC), I can get a list of Collections from the CMR. For each collection I can make a request to determine whether it has variables, has (data) transforms or has formats.

Scenario [b]: As a user of the Earthdata Search Client (EDSC), I have a collection and I can make a request to return all the variables and service options from the CMR. The Service options include details of the available data transformations, and formats.

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Scenario [c]: As a user of the Earthdata Search Client (EDSC), I can select collection(s) and I can make a request to return all the variables and service options from the CMR for the selected collections.

Outcomes: As an EDSC user, with no knowledge of the Service capabilities captured in the CMR, I can perform a Collection search and subsequently discover the variables, the associated services and available service options. These enable the EDSC user to determine whether the collections have variables, transforms and formats, and to gather the details of these, make selections in the UI modals, which are captured in the user's project. These selections can be subsequently used to make a data transformation request.

Definitions:

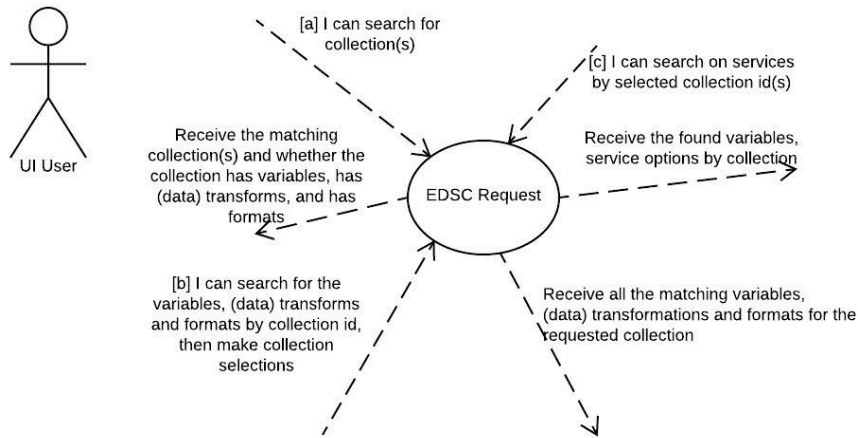
Variable: A variable is typically used to store a science value within a data file, e.g. radiances, brightness temperatures or sea surface temperatures, but can also be used to store geolocation information, e.g. latitude, longitude, or can store ancillary information, e.g. engineering values from an instrument. Typically, variables can be represented within a granule metadata structure, and are defined uniquely on a collection by collection basis. Variables are grouped into sets of variables, and are organized according to the order found within the metadata granule header. Within the UMM, the word "variable" is used in place of the word "parameter".

Service: A service provides various abilities to transform variables, which can be remotely accessed via a universal resource locator, e.g. a web service.

Data Transformation (or transform): A data transformation is a specific ability available from a service, e.g. spatial subsetting or reprojection. It is an umbrella term used to represent a method used to transform data from one form to another. An example of spatial subsetting, is where data exists with a global extent, and is subsetting to a regional extent. The list of data transformations available is service provider dependent, e.g. at GES DISC, a typical OPeNDAP service provides: spatial subsetting, variable subsetting and data format conversion. This list of data transformations will be available from the UMM-S.

Format: The file format used to store the data on the file system. The data can be saved to a different format through the use of a service, e.g. HDF4 -> GeoTIFF. The native file format and the list of available output file formats will be available from the UMM-S.

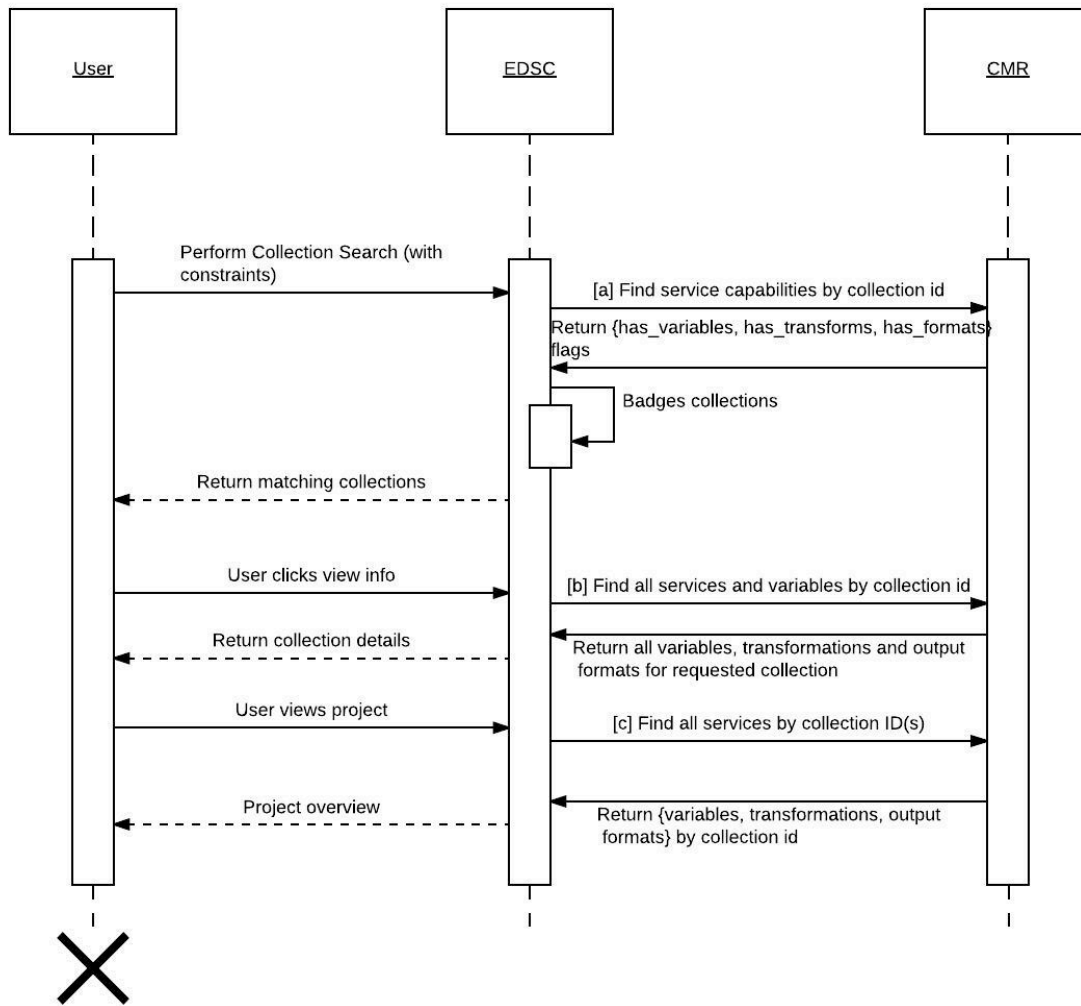
Use Case: see use case diagram below



**Figure 2. Use Case – Collection Search**

Workflow: see sequence diagram below

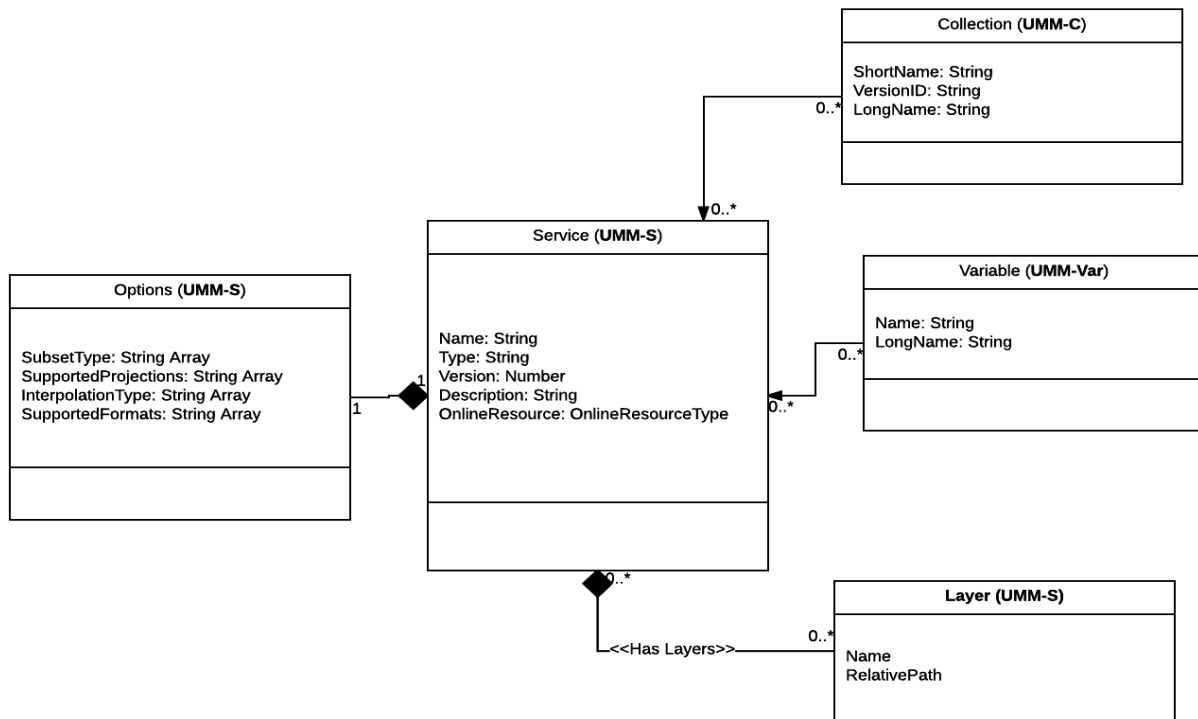
DRAFT



**Figure 3. Sequence Diagram – Collection Search**

## 2.6 UMM-S Metadata Model

The service metadata conceptual profile shown in Figure 4 is a high-level profile that has been broken down into three main classes for Services: Service, Options and Layers, with each class describing a different aspect of the service. The Collection and Variables classes are represented here to highlight these important relationships with the Service class. Each aspect is described in more detail in the subsequent sections of this document.



**Figure 4. Overall Service Model**

The function of the Service class is to enable the service to be specified in terms of its unique service metadata. Each service will be identified in terms of its name, type, version and description. A universal resource locator is used to capture the RESTful service endpoint for the service. The OnlineResource class has an attributes used to describe the universal resource locator. Within this class, the Linkage attribute is used to specify the service endpoint.

The function of the Options class is to capture the various data transformations and formats available from the service.

The function of the Layer class is to capture specific information about the layer (or identifier). If the service has layers, then the name and the path relative to the service endpoint may be specified, for each layer.

Note: Typically, OPeNDAP service layers are mapped 1:1 with the variables represented in UMM-Var. By contrast, typical WMS or WCS coverages (identifiers) can be mapped 1:1 with the variables represented in UMM-Var, but the name of the layers sometimes differs from the variable names. This is dependent on choices in naming layers made by each service provider. Some layers or identifier names may not have a representation in UMM-Var, e.g. Map scales, or layers derived from non-EOSDIS variables. These associations are maintained elsewhere within the CMR.

## 2.6.1 Service

The Service class contains basic information about the service itself, its identifying information and its uniform resource locator. It contains five elements described below.

Service [1..N]  
Service /Name [R]  
Service /Type [R]  
Service /Version [R]  
Service /Description [R]  
Service /OnlineResource [R]

### 2.6.1.1 Name [R]

#### **Element Specification**

Service/Name (1)

#### **Description**

The name of the service.

Sample Value: "MOD10CM"

#### **Tags**

*Required*

### 2.6.1.2 Type [R]

#### **Element Specification**

Service/Type (1) <ESI, OPeNDAP, WMS, WCS>

#### **Description**

Specification of the type of the service.

Sample Value: WCS

#### **Tags**

*Required*

### 2.6.1.3 Version [R]

#### **Element Specification**

Service/Version (1)

#### **Description**

Specification of the version of the Service.



Sample Value: 1.1.1

**Tags**

*Required*

## 2.6.1.4 Description [R]

**Element Specification**

Service/Description (1)

**Description**

A brief description of the service.

Sample Value: "Monthly average snow cover in 0.05 degree (approx. 5km) resolution Climate Modeling Grid (CMG) cells. Monthly averages are computed from daily snow cover observations in the MODIS/Terra Snow Cover Daily L3 Global 0.005Deg CMG (MOD10CM) data set."

**Tags**

*Required*

## 2.6.1.5 OnlineResource [R]

**Element Specification**

Service/OnlineResource (1)

**Description**

This element contains important information about the Unique Resource Locator for the service. These include the following required elements: Linkage, Name, Description. The details can be found in the UMM-Common document.

Sample Value:

OnlineResource/Linkage:

"https://f5ftl01.edn.ecs.nasa.gov/arcgis/rest/services/MOD/MOD10CM/MapServer"

OnlineResource/Name: "MOD10CM"

OnlineResource/Description: "WCS Restful Service"

**Tags**

*Required*

## 2.6.2 Options

The Options class contains information about the service options available. It contains the four elements described below.

Options/ [0..N]  
Options /SubsetType [O]  
Options /SupportedProjections [O]  
Options /InterpolationType [O]  
Options /SupportedFormats [O]

### 2.6.2.1 SubsetType [O]

#### **Element Specification**

Options/SubsetType (0..\*) <Spatial, Temporal, Variable>

#### **Description**

This element is used to identify the list of supported subsetting requests.

Sample Value: "Spatial, Variable"

#### **Tags**

*Optional*

### 2.6.2.2 SupportedProjections [O]

#### **Element Specification**

Options/SupportedProjections (0..\*) <Geographic, Sinusoidal, Mercator, Transverse Mercator, Universal Transverse Mercator, State Plane Coordinates, Albers Equal-Area Conic, Lambert Conic Conformal, Lambert Azimuthal Equal Area, Cylindrical Equal Area, Polar Stereographic, EASE-Grid, EASE-Grid 2.0>

#### **Description**

This element is used to identify the list of supported projections types.

Sample Value: "Geographic, Sinusoidal"

#### **Tags**

*Optional*

### 2.6.2.3 InterpolationType [O]

#### **Element Specification**

---

Options/InterpolationType (0..\*) <Nearest Neighbor, Cubic Convolution, Distance-weighted average resampling, Bilinear Interpolation>

**Description**

This element is used to identify the list of supported interpolation types.

Sample Value: "Bilinear Interpolation, Nearest Neighbor, Cubic Convolution"

**Tags**

*Optional*

#### 2.6.2.4 SupportedFormats [O]

**Element Specification**

Options/SupportedFormats (0..\*) <HDF4, HDF5, HDF-EOS4, HDF-EOS5, netCDF-3, netCDF-4, Binary, ASCII, PNG, JPEG, GIF, TIFF, GeoTIFF, GeoTIFFInt16, GeoTIFFFloat32>

**Description**

The project element describes the list of names of the formats supported by the service.

Sample Value: "HDF-EOS5, netCDF-4, GeoTIFF"

**Tags**

*Optional*

#### 2.6.3 Layer Information

The Layer class describes the layers available from the service. It contains the two elements described below.

Layer/ [0..N]

Layer /Name [O]

Layer /RelativePath [O]

##### 2.6.3.1 Name [O]

**Element Specification**

Layer/Name (0..\*)

**Description**

The name of the layer available from the service.

Sample Value: "cell\_antenna\_scan\_angle\_aft"

**Tags**

---

*Optional*

## 2.6.3.2 RelativePath [O]

**Element Specification**

Layer/RelativePath (0..\*)

**Description**

Path relative to the root universal resource locator for the layer.

Sample Value: "3000620815:/Global\_Projection/cell\_antenna\_scan\_angle\_aft"

**Tags***Optional***Appendix A: Deprecated Elements**

With the revisions needed for the End-to-End Services, UI/UX driven approach to services, the following elements were removed:

Metadata Language

Metadata Standard

Metadata Dates

Lineage

Entry ID

Entry Title

Abstract

Purpose

Service Language

Data Dates

Responsibility

Party

Related URL

Service Citation

Quality

Use Constraints

Access Constraints

Metadata Association

ISO Topic Category

Science Keywords

Service Keywords

Ancillary Keywords

Additional Attributes

Distribution

Platform

Instrument  
Project

These deprecated elements apply to the UMM-S model only.

**Appendix B: Tags Glossary**

<b>Tag Name</b>	<b>Description</b>
Required	This element is required.
Required (with option)	This element is required but can be implemented in several ways. For example, a Responsibility is required, but may be represented by either an organization or a person.
Controlled Vocabulary	This element will have a controlled vocabulary, which will be used to validate the value.
Keyword Search	This element will be indexed by the CMR as part of the free text keyword search.
Parameter Search	This element will be indexed by the CMR and will be exposed via the CMR API as a specific parameter. For example, the CMR will expose a "platform" search parameter, so the "Platform" element will have this tag. This is not to be confused with parameters (or variables) that are part of a collection's science data.
Faceted	This element should be exposed by the CMR catalog via a faceted search response.
Normalize	Existing metadata for these fields are uncontrolled, but should be brought under a controlled vocabulary or simple enumeration via a normalization process. For example, the product level is uncontrolled, so a Level 1 product may be identified as "Level 1", "L1" or simply "1". This is a good candidate for normalization.
Link	This element contains a URL that is used to link to external resources
Validated	This element gets validated to make sure associations exist or keywords match controlled vocabulary
Markdown Support	This element supports markdown-formatted text. Additional information on markdown can be found at <a href="http://en.wikipedia.org/wiki/Markdown">http://en.wikipedia.org/wiki/Markdown</a>

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## Appendix C: Abbreviations and Acronyms

ACL - Access Control List  
API - Application Programming Interface  
CMR - Common Metadata Repository  
DAAC - Distributed Active Archive Center  
DOI - Digital Object Identifier  
ECHO - Earth Observing System (EOS) Clearing House  
EOS - Earth Observing System  
EOSDIS - Earth Observing System Data and Information System  
ESDIS - Earth Science Data and Information System  
ESO - Earth Science Office  
GCMD - Global Change Master Directory  
ISO - International Organization for Standardization  
KMS - Keyword Management System  
MAS - Metadata Architecture Studies  
MENDS - Metadata Evolution for NASA Data Systems  
MVP - Minimum Viable Product  
NASA - National Aeronautics and Space Administration  
NOAA - National Oceanic and Atmospheric Administration  
OPeNDAP - Open Source Data Access Protocol  
SERF - Service Entry Resource Format  
UI - User Interface  
UML - Unified Modeling Language  
UMM - Unified Metadata Model  
UMM-C - Unified Metadata Model - Collections  
UMM-Common - Unified Metadata Model - Common Elements  
UMM-G - Unified Metadata Model - Granules  
UMM-M - Unified Metadata Model - Metadata  
UMM-S - Unified Metadata Model - Services  
UMM-Var - Unified Metadata Model - Variables  
UMM-Vis - Unified Metadata Model - Visualization  
URI - Uniform Resource Identifier  
URL - Uniform Resource Locator  
URS - User Registration System  
UX - User Experience  
WCS - Web Coverage Service  
WMS - Web Mapping Service  
XML - Extensible Markup Language  
XPath - XML Path Language

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