VODataService: a VOResource Schema Extension for Describing Collections and Services
Version 1.1

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Abstract

VODataService refers to an XML encoding standard for a specialized extension of the IVOA Resource Metadata that is useful for describing data collections and the services that access them. It is defined as an extension the core resource metadata encoding standard known as VOResource [Plante et al. 2008] using XML Schema. The specialized resource types defined by the VODataService schema allow one to describe how the data underlying the resource covers the sky as well as frequency and time. This coverage description leverages heavily the Space-Time Coordinates (STC) standard schema [Rots 2007]. VODataService also enables detailed descriptions of tables that includes...
information useful to the discovery of tabular data. It is intended that the VODa
data types will be particularly useful in describing services that support standard IVOA
service protocols.

### Status of this document

This is an IVOA Proposed Recommendation available for public review by all interested
parties. Comments on this document should be made via the IVOA Request For Comment (RFC) Twiki page, [http://www.ivoa.net/cgi-bin/twiki/bin/view/IVOA/VODaServiceV11RFC](http://www.ivoa.net/cgi-bin/twiki/bin/view/IVOA/VODaServiceV11RFC) or by via email to registry at ivoa.net. The deadline comments can be found on the RFC page.

A list of current IVOA Recommendations and other technical documents can be found at [http://www.ivoa.net/Documents/](http://www.ivoa.net/Documents/).

### Acknowledgements

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### Conformance-related definitions

The words "MUST", "SHALL", "SHOULD", "MAY", "RECOMMENDED", and "OPTIONAL" (in upper or lower case) used in this document are to be interpreted as described in IETF standard, RFC 2119 [RFC 2119].

The Virtual Observatory (VO) is general term for a collection of federated resources that can be used to conduct astronomical research, education, and outreach. The International Virtual Observatory Alliance (IVOA) is a global collaboration of separately funded projects to develop standards and infrastructure that enable VO applications.

XML document validation is a software process that checks that an XML document is not only well-formed XML but also conforms to the syntax rules defined by the applicable schema. Typically, when the schema is defined by one or more XML Schema [schema] documents (see next section), validation refers to checking for conformance to the syntax described in those Schema documents. This document describes additional syntax constraints that cannot be enforced solely by the rules of XML Schema; thus, in this document, use of the term validation includes the extra checks that goes beyond common Schema-aware parsers which ensure conformance with this document.

### Syntax Notation Using XML Schema

The eXtensible Markup Language, or XML, is document syntax for marking textual information with named tags and is defined by the World Wide Web Consortium (W3C) Recommendation, [XML 1.0](http://www.w3.org/XML/). The set of XML tag names and the syntax rules for their use is referred to as the document schema. One way to formally define a schema for XML documents is using the W3C standard known as XML Schema [schema].

This document defines the VOResource schema using XML Schema. The full Schema
document is listed in Appendix A. Parts of the schema appear within the main sections of this document; however, documentation nodes have been left out for the sake of brevity.

Reference to specific elements and types defined in the VOResource schema include the namespaces prefix, vr, as in vr:Resource (a type defined in the VOResource schema). Reference to specific elements and types defined in the VODataService extension schema include the namespaces prefix, vs, as in vs:DataCollection (a type defined in the VODataService schema). Use of the vs prefix in compliant instance documents is strongly recommended, particularly in the applications that involve IVOA Registries (see [RI], section 3.1.2). Elsewhere, the use is not required.

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1. Introduction

The VOResource standard [VOR] provides a means of encoding IVOA Resource Metadata [RM] in XML. VOResource uses XML Schema [schema] to define most of the XML syntax rules (while a few of the syntax rules are outside the scope of Schema). VOResource also describes mechanisms for creating extensions to the core VOResource metadata. This allows for the standardization of new metadata for describing specialized kinds of resources in a piecemeal way without deprecating the core schema or other extensions. This document defines one such extension referred to as VODataService.

The purpose of this extension is to define common XML Schema types--particularly new resource types--that are useful for describing data collections and services that access data. In particular, it allows one to describe the data's coverage: the parts of the sky with which the data are associated and the time and frequency ranges that were observed or modeled to create the data. It also allows one to describe tables in detail. In particular, one can describe each of the columns of a table--providing, for example, its name, type, UCD [UCD], and textual description. When this metadata is part of a resource description in a registry [VOR], it becomes possible to discover tables that contains particular kinds of data.
It is intended that VODataService will be central to describing services that support standard IVOA data access layer protocols such as Simple Image Access [SIA] and Simple Cone Search [SCS]. While other VOResource extensions would define the protocol-specific metadata (encapsulated as a standard capability [VOR]), the general service resource description would share the common data concepts such as coverage and tabular data. Note, however, that a service described using the VODataService schema need not support any standard protocols. With the VODataService extension schema plus the core VOResource schema, it is possible to describe a custom service interface that accesses data.

As a legal extension of VOResource [VOR], the use of VODataService is subject to the rules and recommendations for XML [xml], XML Schema [schema], and VOResource itself.

2. The VODataService Data Model

The VODataService extension in general enables the description of two types of resources: data collections and services that access data. Here's an example of a VOResource document (abbreviated for the purposes of illustration) that describes a service from the NASA Extragalactic Database (NED) that provides measured redshifts for a given object.

Example
A description of a service returning tabular data, catalogservice.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<Resource xmlns="">
  <title>The NASA/IPAC Extragalactic Database</title>
  <identifier>ivo://ned.ipac/Redshift_By_Object_Name</identifier>
  <description>
    NED is built around a master list of extragalactic objects for which cross-identifications of names have been established, accurate positions and redshifts entered to the extent possible, and some basic data collected. This service will return recorded redshifts for a given object.
  </description>
  </Resource>
```
<type>BasicData</type>
<contentLevel>Research</contentLevel>
</content>

<capability>
@interface xsi:type="vs:ParamHTTP"
<accessURL use="base">
http://nedwww.ipac.caltech.edu/cgi-bin/nph-datasetsearch?search_type=Redshifts&
</accessURL>
<queryType>GET</queryType>
<resultType>application/xml+votable</resultType>
<param use="required">
<name>objname</name>
<description>Name of object</description>
<dataType>string</dataType>
</param>
<param use="required">
<name>of</name>
<description>Output format parameter, must be "xml_main" for VOTable output.</description>
<dataType>string</dataType>
</param>
</interface>
</capability>

<coverage>
<stc:STCResourceProfile>
<stc:AstroCoordSystem xlink:type="simple"
  xlink:href="ivo://STClib/CoordSys#UTC-FK5-TOPO"
  id="UTC-FK5-TOPO"/>
<stc:AstroCoordArea coord_system_id="UTC-FK5-TOPO">
<stc:AllSky/>
</stc:AstroCoordArea>
</stc:STCResourceProfile>
<waveband>Radio</waveband>
<waveband>Optical</waveband>
</coverage>

<tableset>
<schema>
<table type="output">
<name>default</name>
<column>
<name>No.</name>
<description>
A sequential data-point number applicable to this list only.
</description>
<ucd>meta.number</ucd>
<dataType xsi:type="vs:VOTableType">int</dataType>
</column>
<column>
<name>Name in Publication</name>
<description>
The object's name in NED's standard format, of the object to which the data apply.
</description>
<ucd>meta.id;name</ucd>
<dataType xsi:type="vs:VOTableType">string</dataType>
</column>
<column>
<name>Published Velocity</name>
<description>
The radial velocity, derived from the shift of some spectral feature, in km/sec
</description>
<unit>km/sec</unit>
<ucd>src.spect.dopplerVeloc</ucd>
</column>
</table>
</schema>
</tableset>
This example illustrates some of the features of the VODataService extension:

1. the extra namespaces associated with VODataService metadata; if STC coverage information [STC] is not included, then only the VODataService namespaced is needed.
2. the specific type of resource indicated by the value of the xsi:type attribute; in this case vs:CatalogService indicates that this is describing a service that accesses tabular data.
3. the location of the VOResource-related schema documents used by this description,
4. the core VOResource metadata,
5. an interface described by the VODataService interface type, vs:ParamHTTP; this type can indicate input arguments it supports.
6. a description of the coverage, including an STC description plus waveband keywords.
7. a description of the table that is returned by the service.

2.1. The Schema Namespace and Location

The namespace associated with VODataService extensions is "http://www.ivoa.net/xml/VODataService/v1.1". Just like the namespace URI for the VOResource schema, the VODataService namespace URI can be interpreted as a URL. Resolving it will return the XML Schema document (given in Appendix A) that defines the VODataService schema.

Authors of VOResource instance documents may choose to provide a location for the VOResource XML Schema document and its extensions using the xsi:schemaLocation attribute. While the choice of the location value is the choice of the author, this specification recommends using the VODataService namespace URI as its location URL (as illustrated in the example above), as in:

xsi:schemaLocation="http://www.ivoa.net/xml/VODataService/v1.1
http://www.ivoa.net/xml/VODataService/v1.1"

Note:
The IVOA Registry Interface standard [RI] actually requires that the VOResource records it shares with other registries provide location URLs via xsi:schemaLocation for the VOResource schema and all legal extension schemas that are used in the records. This rule would apply to the VODataService schema.

The prefix, vs, is used by convention as the prefix defined for the VODataService schema; however, instance documents may use any prefix. In applications where common use of prefixes is recommended (such as with the Registry Interface specification [RI]), use of the vs prefix is recommended. Note also that in this document, the vr prefix is used to label, as shorthand, a type or element name that is defined in the VOResource schema, as in vr:Resource.

Note:
One reason one may not be able to use vs to represent the
As recommended by the VOResource standard [VOR], the VODataService schema sets `elementFormDefault="unqualified"`. This means that it is not necessary to qualify element names defined in this schema with a namespace prefix (as there are no global elements defined). The only place it is usually needed is as a qualifier to a VODataService type name given as the value of an `xsi:type` attribute.

### 2.2. Summary of Metadata Concepts

The VODataService extension defines four new types of resources. Two inherit directly from `vr:Resource`:

- **vs:DataCollection**
  This resource declares the existence of a collection of data, what it represents, and how to get it. The access to the data may be limited to a human-readable web page (given by `content/referenceURL`); however, if the contents of the collection are available statically via a URL (e.g. an FTP URL to a directory containing all the files), that URL can be provided. It can also provide pointers to other IVOA registered services that can be used to access the data.

- **vs:StandardSTC**
  This resource type declares one or more coordinate systems described using STC [STC] such that each can be assigned a globally unique identifier (based on the IVOA identifier for the resource record itself). This identifier can then be referenced in any other STC description in lieu of a fully described coordinate system. Coordinate system described in this way become reusable standards once they are registered in an IVOA registry.

The other two resource types represent specialized services:

- **vs:DataService**
  Inheriting from `vr:Service`, this type is for services that access astronomical data. It adds the ability to describe the data's coverage of the sky, frequency, and time.

- **vs:CatalogService**
  Inheriting from `vs:DataService`, this type specifically refers to a service that accesses tabular data. In addition to the coverage information, this type adds the ability to describe the tables and their columns. This is intended for describing services that support the "simple" IVOA data access layer protocols such as Simple Image Access [SIA] and Simple Cone Search [SCS].

In general, coverage refers to the extent that data samples the measurement range of the sky (space), frequency, and time. The coverage metadata (encoded via the `vs:Coverage` type) has two parts. The first part allows a full STC profile description (via the imported STC element, `<stc:STCResourceProfile>`). The second part captures key coverage metadata defined in the IVOA Resource Metadata standard [RM]. The RM-derived coverage elements can be considered summarizing metadata for many of the details that may appear within
the STC description, and enables simpler searching of high-level coverage information.

The detailed STC profile contained within the `<stc:STCResourceProfile>` element is capable of describing coverage not only in space, time, and frequency but also velocity and redshift. The profile contains up to three types of component descriptions ([STC], section 4.1): coordinate systems, coordinate values, and coordinate areas or ranges. The first component describes the coordinate systems to which coordinate values, areas, and regions are referenced. While any arbitrary system can be described in this first part, it is expected that most VODataService instances will provide a simple pointer to a predefined system in a registered `vs:StandardSTC` record (using the mechanism summarized in section 3.1.2 below). The coordinate values part will usually be used to describe the coordinate resolution, errors, or typical sizes. The coordinate areas part describes actual regions or ranges covered by the resource in any of the given coordinate systems.

Table descriptions appear within a single `<tableset>` element. This element can in turn can contain one or more `<schema>` element in which each `schema` represents a set of logically related tables. It is not required that that the schema grouping match the underlying database's catalogs or schemas (as defined in [SQLGuide]), though it may. In some cases, such as when describing the table that is returned from an SIA service, the terms catalog and schema may have little relevance; in this case, the table can be considered part of a sole "default" schema.

For each table in a schema, one can describe each of the columns, providing such information as its name, type, UCD ([UCD]), units, and a textual description. Providing this information makes it possible to select a resource based on the kind data contained in its tables.

Finally, the VODataService defines specialized interface type (inheriting from `vr:Interface`) called `vs:ParamHTTP`. This type is used to describe the commonly used interface that is invoked over HTTP as either a GET or a POST ([HTTP]) in which the arguments are encoded as `name=value` pairs. In addition to the access URL, it can include not only the mime-type of the returned response, it can also enumerate the input arguments that are supported by the service implementation. Much like table columns, one can indicate for each argument the name, the UCD, the data type, the units, whether it is required, and a textual description the argument. Note that this does not capture any interdependencies between arguments. For example, it cannot indicate if one argument only makes sense in the presence of another argument.

3. The VODataService Metadata

This section enumerates the types and elements defined in the VODataService extension schema and describes their meaning. Where a term matches a term in the RM, its meaning is given in terms of the RM definition.

3.1. Resource Type Extensions

3.1.1. DataCollection

A data collection, which is describable with the `vs:DataCollection` resource type, is a logical group of data composed of one or more accessible datasets. A collection can contain any combination of images, spectra, catalogs, time-series, or other data. (In contrast, we talk about a dataset as being a set of digitally-encoded data that is normally accessible as a single unit--e.g., a file.)
The `vs:DataCollection` type adds seven additional metadata elements beyond the core VOResource metadata [VOR].

### vs:DataCollection Type Schema Definition

```xml
<xs:complexType name="DataCollection">
  <xs:complexContent>
    <xs:extension base="vr:Resource">
      <xs:sequence>
        <xs:element name="facility" type="vr:ResourceName" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="instrument" type="vr:ResourceName" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="rights" type="vr:Rights" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="format" type="vs:Format" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="coverage" type="vs:Coverage" minOccurs="0"/>
        <xs:element name="tableset" type="vs:TableSet" minOccurs="0">
          <xs:unique name="DataCollection-schemaName">
            <xs:selector xpath="schema" />
            <xs:field xpath="name" />
          </xs:unique>
          <xs:unique name="DataCollection-tableName">
            <xs:selector xpath="schema/table" />
            <xs:field xpath="name" />
          </xs:unique>
        </xs:element>
        <xs:element name="accessURL" type="vr:AccessURL" minOccurs="0"/>
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

The definition of `<tableset>` element places forces certain names within its description to be unique; these constraints are explained further in 3.3.1.

All of the child elements except `<tableset>` derive from RM terms. Four of the elements—`<facility>`, `<instrument>`, `<rights>`, and `<accessURL>`—are reuses of elements defined in the core VOResource schema, sharing the same syntax and similar semantics. In particular, the meanings of `<facility>` and `<instrument>` in the context of vs:DataCollection are different from that in `vr:Organisation` only in that in the former type, they refer to the origin of the data.

### vs:DataCollection Extension Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>RM Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>facility</td>
<td>Facility</td>
<td>string with optional ID attribute: <code>vr:ResourceName</code></td>
</tr>
<tr>
<td>instrument</td>
<td>Instrument</td>
<td>string with optional ID attribute: <code>vr:ResourceName</code></td>
</tr>
</tbody>
</table>
### vs:DataCollection Extension Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>the instrument used to collect the data contained or managed by this resource.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional; multiple occurrences allowed</td>
</tr>
<tr>
<td><strong>rights</strong></td>
<td></td>
</tr>
<tr>
<td><strong>RM Name:</strong></td>
<td>Rights</td>
</tr>
<tr>
<td><strong>Value type:</strong></td>
<td>string, controlled vocabulary: xs:token</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>Information about rights held in and over the resource.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional; multiple occurrences allowed</td>
</tr>
<tr>
<td><strong>Allowed Values:</strong></td>
<td>public</td>
</tr>
<tr>
<td></td>
<td>secure</td>
</tr>
<tr>
<td></td>
<td>proprietary</td>
</tr>
<tr>
<td><strong>format</strong></td>
<td></td>
</tr>
<tr>
<td><strong>RM Name:</strong></td>
<td>Format</td>
</tr>
<tr>
<td><strong>Value type:</strong></td>
<td>string with optional isMIMEType attribute, vs:Format</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>The physical or digital manifestation of the information supported by a resource.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional; multiple occurrences allowed</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
<td>MIME types should be used for network-retrievable, digital data, and the isMIMEType attribute should be set to explicitly to “true”. Non-MIME type values are used for media that cannot be retrieved over the network--e.g. CDROM, poster, slides, video cassette, etc.</td>
</tr>
<tr>
<td><strong>coverage</strong></td>
<td></td>
</tr>
<tr>
<td><strong>RM Name:</strong></td>
<td>Coverage</td>
</tr>
<tr>
<td><strong>Value type:</strong></td>
<td>composite; vs:Coverage</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>Extent of the content of the resource over space, time, and frequency.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional</td>
</tr>
<tr>
<td><strong>tableset</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Value type:</strong></td>
<td>composite; vs:TableSet</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>A description of tables that are part of this collection.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional</td>
</tr>
<tr>
<td><strong>accessURL</strong></td>
<td></td>
</tr>
<tr>
<td><strong>RM Name:</strong></td>
<td>Service.AccessURL</td>
</tr>
<tr>
<td><strong>Value type:</strong></td>
<td>URL with optional use attribute: vr:AccessURL</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>The URL can be used to download the data contained in this data collection.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>required; multiple occurrences allowed</td>
</tr>
</tbody>
</table>

The vs:Format type is used for providing a value to the <format> element:

### vs:Format Type Schema Definition

```xml
<xs:complexType name="Format">
  <xs:simpleContent>
    <xs:extension base="xs:token">
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
```
The `isMIMEType` attribute provides a flag to indicate if the value represents an actual MIME-type: if it is, this attribute should be explicitly set to "true".

See section 3.3 for a specification of the `vs:TableSet` type for describing tables.

### 3.1.2. StandardSTC

The `vs:StandardSTC` resource type is used to register standard coordinate systems, positions, or regions using the Space-Time Coordinate (STC, [STC]) standard schema so that they can be uniquely referenced by name by other resource descriptions or applications. This resource type extends the core metadata with a single element, `<stcDefinitions>`, which contains the STC definitions.

#### vs:StandardSTC Type Schema Definition

```xml
<xs:complexType name="StandardSTC">  
  <xs:complexContent>  
    <xs:extension base="vr:Resource">  
      <xs:sequence>  
        <xs:element name="stcDefinitions" type="stc:STCResourceProfile" minOccurs="0" maxOccurs="unbounded"/>  
      </xs:sequence>  
    </xs:extension>  
  </xs:complexContent>  
</xs:complexType>
```

The curation metadata that is part of the core VODataService should generally refer to the publishing organization and persons that are responsible for defining the systems, updating the definitions as needed, and responding to user questions about the definitions. The content metadata, in particular the textual contents of the `<description>` element, should describe the purpose of the definition and where references to the defined systems, positions, or regions may be used.

#### vs:StandardSTC Extension Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>stcDefinitions</code></td>
<td>Value type: composite; <code>stc:stcDescriptionType</code></td>
</tr>
<tr>
<td></td>
<td>Semantic Meaning: the definitions of systems, positions, and regions that are available for referencing.</td>
</tr>
<tr>
<td></td>
<td>Occurrences: required; multiple occurrences allowed</td>
</tr>
</tbody>
</table>

The content of the `<stcDefinitions>` element is controlled by the STC schema. Because that schema uses the `elementFormDefault="true"` and most of the STC elements are defined to be global [schema], `<stcDefinitions>` child elements must be qualified as being in the STC namespace (http://www.ivoa.net/xml/STC/stc-v1.30.xsd), by either setting the default namespace (via the xmlns attribute) or via explicit qualification via a prefix (see example).

### 3.1.3. DataService
The vs:DataService resource type is for describing a service that provides access to astronomical data. This service adds to the core VOResource service metadata the ability to associate an observing facility and/or instrument with the data as well as describe the coordinate coverage of data via its child <coverage> element. Note that while these elements are all optional, a resource of this type still implies access to astronomical data.

```xml
<xs:complexType name="DataService">
  <xs:complexContent>
    <xs:extension base="vr:Service">
      <xs:sequence>
        <xs:element name="facility" type="vr:ResourceName" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="instrument" type="vr:ResourceName" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="coverage" type="vs:Coverage" minOccurs="0"/>
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

The use and meaning of the <facility> and <instrument> elements are the same as for vs:DataCollection.

**vs:DataService Extension Metadata Elements**

<table>
<thead>
<tr>
<th>Element</th>
<th>RM Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>facility</td>
<td>Facility</td>
<td>Facility with optional ID attribute: vr:ResourceName</td>
</tr>
<tr>
<td>Value type</td>
<td>string with optional ID attribute: vr:ResourceName</td>
<td></td>
</tr>
<tr>
<td>Semantic Meaning</td>
<td>the observatory or facility used to collect the data contained or managed by this resource.</td>
<td></td>
</tr>
<tr>
<td>Occurrences</td>
<td>optional; multiple occurrences allowed</td>
<td></td>
</tr>
</tbody>
</table>

| instrument | Instrument | Instrument with optional ID attribute: vr:ResourceName |
| Value type | string with optional ID attribute: vr:ResourceName |
| Semantic Meaning | the instrument used to collect the data contained or managed by this resource. |
| Occurrences | optional; multiple occurrences allowed |

| coverage | Coverage | Coverage, composite: vs:Coverage |
| Value type | | |
| Semantic Meaning | Extent of the content of the resource over space, time, and frequency. |
| Occurrences | optional |

The contents of the <coverage> element are detailed in section 3.2.

### 3.1.4. CatalogService

The vs:CatalogService resource type is for describing a service that interacts with astronomical data through one or more specified tables. Because it extends the vs:DataService type, a catalog service can have a coverage description as well. The tabular data may optionally be described via a <tableset> element.
The definition of `<tableset>` element forces certain names within its description to be unique; these constraints are explained further in 3.3.1.

### vs:CatalogService Extension Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| `tableset` | Value type: composite; vs:TableSet  
Semantic Meaning: A description of the tables that are accessible through this service.  
Occurrences: optional |

#### 3.2. Coverage

The vs:Coverage type describes how the data samples the sky, frequency, and time.

### vs:Coverage Type Schema Definition

```xml
<x:s:complexType name="Coverage">
  <x:s:sequence>
    <x:s:element ref="stc:STCResourceProfile" minOccurs="0"/>
    <x:s:element name="footprint" type="vs:ServiceReference" minOccurs="0" maxOccurs="unbounded"/>
    <x:s:element name="waveband" type="vs:Waveband" minOccurs="0" maxOccurs="unbounded"/>
    <x:s:element name="regionOfRegard" type="xs:float" minOccurs="0" maxOccurs="unbounded"/>
  </x:s:sequence>
</x:s:complexType>
```

A detailed, systematic description of coverage is provided via the child `<stc:STCResourceProfile>` element, taken from the STC schema, version 1.3, with the namespace, `http://www.ivoa.net/xml/STC/stc-v1.30.xsd` (hereafter referred using the stc: prefix). This element is defined in the STC schema as a global element; furthermore, the STC
schema sets its global `elementFormDefault="qualified"`. Consequently, the `<stc:STCResourceProfile>` element and all its child elements must be qualified as part of the STC namespace as required by XML Schema [schema]. In applications where common use of XML prefixes is required or encouraged (e.g. the IVOA Registry Interfaces [RI]), use of the `stc:` prefix to represent the STC namespace is encouraged.

The remaining elements provide some summary information about the coverage.

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| STCResourceProfile | **Value type:** composite: an `stc:STCResourceProfile` element from the STC schema.  
**Semantic Meaning:** The STC description of the location of the resource's data (or behavior on data) on the sky, in time, and in frequency space, including resolution.  
**Occurrences:** optional  
**Comments:** In general, this description should be approximate; a more precise description can be provided by the service referred to by the `<footprint>` element. |
| footprint        | **Value type:** a URL with an optional IVOA identifier attribute:  
**Semantic Meaning:** a reference to a footprint service for retrieving precise and up-to-date description of coverage.  
**Occurrences:** optional  
**Comments:** the `ivo-id` attribute refers to a Service record having a footprint service capability. That is, the record will have a capability element describing the footprint service (see "Note on Footprint Service" below for further discussion). The resource referred to may be the current one. |
| waveband         | **RM Name:** Coverage.Spectral  
**Value type:** string with controlled vocabulary: `vs:Waveband`  
**Semantic Meaning:** a named spectral region of the electro-magnetic spectrum that the resource's spectral coverage overlaps with.  
**Occurrences:** optional; multiple occurrences allowed  
**Allowed Values:**  
Radio: any wavelength > 10 mm (or frequency < 30 GHz)  
Millimeter: 0.1 mm <= wavelength <= 10 mm; 3000 GHz >= frequency >= 30 GHz.  
Infrared: 1 micron <= wavelength <= 100 microns  
Optical: 0.3 microns <= wavelength <= 1 micron; 300 nm <= wavelength <= 1000 nm; 3000 Angstroms <= wavelength <= 10000 Angstroms |
### vs:Cov‌erage Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV</td>
<td>0.1 micron (\leq) wavelength (\leq) 0.3 microns; 100 nm (\leq) wavelength (\leq) 3000 nm; 1000 Angstroms (\leq) wavelength (\leq) 30000 Angstroms</td>
</tr>
<tr>
<td>EUV</td>
<td>100 Angstroms (\leq) wavelength (\leq) 1000 Angstroms; 12 eV (\leq) energy (\leq) 120 eV</td>
</tr>
<tr>
<td>X-ray</td>
<td>0.1 Angstroms (\leq) wavelength (\leq) 100 Angstroms; 0.12 keV (\leq) energy (\leq) 120 keV</td>
</tr>
<tr>
<td>Gamma-ray</td>
<td>energy (\geq) 120 keV</td>
</tr>
</tbody>
</table>
| regionOfRegard | **RM Name:** Coverage.RegionOfRegard  
**Value type:** a floating point number: xs:float  
**Semantic Meaning:** a single numeric value representing the angle, given in decimal degrees, by which a positional query against this resource should be "blurred" in order to get an appropriate match.  
**Occurrences:** optional  
**Comments:** In the case of image repositories, this value might refer to a typical field-of-view size, or the primary beam size for radio aperture synthesis data. In the case of object catalogs, region of regard should normally be the largest of the typical size of the objects, the astrometric errors in the positions, or the resolution of the data. |

#### Note on Footprint Service:

The `<footprint>` element has been defined in anticipation of a future standard IVOA footprint service protocol that can be used to respond to detailed spatial overlap queries. Consequently, in the future, applications may be able to assume the protocol that footprint service URL supports. When an application is unable to make any assumptions, the IVOA Identifier given by the attribute should be resolved and the returned resource description should be searched for a recognized footprint service capability.

### 3.3. Tabular Data

The `vs:TableSet` type can be used to describe a set of tables that are part of a single resource and can be consider functionally all located at a single site.

#### vs:TableSet Type Schema Definition

```
<xs:complexType name="TableSet">
  <xs:sequence>
    ...
  </xs:sequence>
</xs:complexType>
```
vs:TableSet Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| schema | Value type: composite; vs:TableSchema  
Semantic Meaning: A named description of a set of logically related tables.  
Occurrences: required; multiple occurrences are allowed.  
Comments: See section 3.3.1 regarding unique names for schemas. |

The vs:TableSchema type collects tables together that are logically related. For example, a single resource may provide access to several major astronomical catalogs (e.g. SDSS, 2MASS, and FIRST) from one site, enabling high-performance cross-correlations between them. Each catalog can be described in a separate <schema> element, using the elements from the vs:TableSchema type.

vs:TableSchema Type Schema Definition

```xml
<xs:complexType name="TableSchema">
    <xs:sequence>
        <xs:element name="name" type="xs:token" minOccurs="1" maxOccurs="1"/>
        <xs:element name="title" type="xs:token" minOccurs="0"/>
        <xs:element name="description" type="xs:token" minOccurs="0" maxOccurs="1"/>
        <xs:element name="utype" type="xs:token" minOccurs="0" maxOccurs="1"/>
        <xs:element name="table" type="vs:Table" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
</xs:complexType>
```

vs:TableSchema Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| name | Value type: string; xs:token  
Semantic Meaning: A name for the set of tables.  
Occurrences: required  
Comments: If there is no appropriate logical name associated with this set, the name should be explicitly set to "default". See section 3.3.1 regarding the uniqueness of this name. |
| title | Value type: string; xs:token  
Semantic Meaning: a descriptive, human-interpretable name for the table set.  
Occurrences: optional |
### vs:TableSchema Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments:</td>
<td>This is used for display purposes and is useful when there are multiple schemas in the context (e.g. within a tableset; otherwise, the resource title could be used instead). Note, however, that there is no requirement regarding uniqueness. If a title is not provided, the schema name can be used for display purposes.</td>
</tr>
<tr>
<td>description</td>
<td>Value type: string: xs:token  &lt;br&gt; Semantic Meaning: A free text description of the tableset that should explain in general how all of the tables are related.  &lt;br&gt; Occurrences: optional</td>
</tr>
<tr>
<td>utype</td>
<td>Value type: string: xs:token  &lt;br&gt; Semantic Meaning: an identifier for a concept in a data model that the data in this schema as a whole represent.  &lt;br&gt; Occurrences: optional  &lt;br&gt; Comments: The format defined in the VOTable standard, section 4.1 [VOTable] is strongly recommended; see <strong>Note on UType Format</strong> below.</td>
</tr>
<tr>
<td>table</td>
<td>Value type: composite: vs:Table  &lt;br&gt; Semantic Meaning: A marked description of one of the tables that makes up the set.  &lt;br&gt; Occurrences: optional; multiple occurrences are allowed.  &lt;br&gt; Comments: See section 3.3.1 regarding unique names for schemas.</td>
</tr>
</tbody>
</table>

### Note on UType Format:

As of this writing, an IVOA standard for the format of utypes is still under development. As a result, the most definitive documentation of the format is in section 4.1 of the VOTable specification [VOTable], which is expected to be a more general form to be spelled out in the eventual utype standard. Use of that latter standard is recommended once it becomes available.

Each table in a schema is described in detail using the vs:Table type.

### vs:TableSchema Type Schema Definition

```xml
<xs:complexType name="Table">
  <xs:sequence>
    <xs:element name="name" type="xs:token" minOccurs="1" maxOccurs="1"/>
    <xs:element name="title" type="xs:token" minOccurs="0"/>
    <xs:element name="description" type="xs:token" minOccurs="0"/>
    <xs:element name="utype" type="xs:token" minOccurs="0"/>
    <xs:element name="column" type="vs:TableParam" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>
```
### vs:Table Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Value type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>string: xs:token</td>
<td><strong>Semantic Meaning:</strong> A fully qualified name for the table. This name should include all catalog or schema prefixes needed to sufficiently uniquely distinguish it in a query to the table. <strong>Occurrences:</strong> required <strong>Comments:</strong> In general, the format of the qualified name may depend on the on the context; however, when the table is intended to be queryable via ADQL [ADQL], then the catalog and schema qualifiers are delimited from the table name with dots (.). If this table is part of the schema named &quot;default&quot;, the schema name does not need to appear in this table name, unless it is required by an associated access service. If there is no appropriate logical name associated with this table, the name should be explicitly set to &quot;default&quot;. See <a href="#">section 3.3.1</a> regarding the uniqueness of this name.</td>
</tr>
<tr>
<td>title</td>
<td>string: xs:token</td>
<td><strong>Semantic Meaning:</strong> a descriptive, human-interpretable name for the table set. <strong>Occurrences:</strong> optional <strong>Comments:</strong> This is used for display purposes. There is no requirement regarding uniqueness. If a title is not provided, the table name can be used for display purposes.</td>
</tr>
<tr>
<td>description</td>
<td>string: xs:token</td>
<td><strong>Semantic Meaning:</strong> A free-text description of the table's contents. <strong>Occurrences:</strong> optional</td>
</tr>
<tr>
<td>utype</td>
<td>string: xs:token</td>
<td><strong>Semantic Meaning:</strong> an identifier for a concept in a data model that the data in this table as a whole represent. <strong>Occurrences:</strong> optional <strong>Comments:</strong> The format defined in the VOTable standard, section 4.1 [VOTable] is strongly recommended; see &quot;Note on UType Format&quot; above.</td>
</tr>
<tr>
<td>column</td>
<td>composite: vs:TableParam</td>
<td></td>
</tr>
</tbody>
</table>
## vs:Table Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Meaning</strong>: A marked description of one of the table's columns.</td>
<td><strong>Occurrences</strong>: optional; multiple occurrences are allowed.</td>
</tr>
<tr>
<td><strong>Comments</strong>: See section 3.5 for the description of this element's contents.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ForeignKey</th>
<th><strong>Value type</strong>: composite: vs:ForeignKey</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Meaning</strong>: A description of a foreign keys, one or more columns from the current table that can be used to join with another table.</td>
<td><strong>Occurrences</strong>: optional; multiple occurrences are allowed.</td>
</tr>
<tr>
<td><strong>Comments</strong>: See section 3.5.2 for the description of this element's contents.</td>
<td></td>
</tr>
</tbody>
</table>

Each column in a table can be described using the vs:TableParam type which is described in section 3.5. The foreign keys in the table that can be used to join it with another table can be described with the vs:ForeignKey type (section 3.3.2). A foreign key description should only refer to tables described within the current table set.

The vs:Table also provides an attribute for indicating the role a table plays in the schema:

<table>
<thead>
<tr>
<th>vs:Table Attributes</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attribute</strong></td>
<td><strong>Value type</strong>: string: xs:token</td>
</tr>
<tr>
<td><strong>Semantic Meaning</strong>: a name indicating the role this table plays.</td>
<td><strong>Occurrences</strong>: optional</td>
</tr>
<tr>
<td><strong>Recommended Values</strong>: output</td>
<td>this table structure is used to format the output from a query</td>
</tr>
<tr>
<td>base_table</td>
<td>this table contains records that represent the main subjects of the parent schema; other tables contain ancillary data.</td>
</tr>
<tr>
<td>view</td>
<td>the table represents a useful combination or subset of other tables.</td>
</tr>
<tr>
<td>Other values are allowed.</td>
<td></td>
</tr>
</tbody>
</table>

### 3.3.1. Unique Names for Tables

The definitions of the <tableset> elements used in the vs:DataCollection and vs:CatalogService types constrain certain names to be unique. In particular, all schema names within a <tableset> element must be unique, and all table names within a <tableset> element must be unique. (A schema and table may share a common name, such as "default"). These constraints makes it possible to uniquely locate the description of a schema or table within a VOResource description.

#### Example

The uniqueness constraints for names within table sets guarantee that when the following XPath queries are applied to a <tableset> element, zero or one node only will be
Name uniqueness is only required when the table set description is part of a VOResource description. The name uniqueness rules should also be applied to other uses of the vs:TableSet element outside of a VOResource description.

### 3.3.2. Foreign Keys

The vs:ForeignKey type allows one to describe foreign keys in a table that allow it to be joined effectively with another table. A foreign key is a set of columns that map to a corresponding set of columns in another table.

#### vs:ForeignKey Type Schema Definition

```xml
<xs:complexType name="ForeignKey">
  <xs:sequence>
    <xs:element name="targetTable" type="xs:token"/>
    <xs:element name="fkColumn" type="vs:FKColumn" minOccurs="1" maxOccurs="unbounded"/>
    <xs:element name="description" type="xs:token" minOccurs="0"/>
    <xs:element name="utype" type="xs:token" minOccurs="0"/>
  </xs:sequence>
</xs:complexType>
```

In this model, the source of the foreign key is the current table being described (i.e. represented by the `<table>` element that contains the vs:ForeignKey description, and thus doesn't need to be named explicitly). The key that is described points to the table given by the `<targetTable>` child element. Each child `<fkColumn>` element then gives a pair of columns, one from the source table and one from the target table, that can be constrained to be equal in a query that joins the two tables.

#### vs:ForeignKey Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| **targetTable** | Value type: string: xs:token  
  **Semantic Meaning:** the fully-qualified name (including catalog and schema, as applicable) of the table that can be joined with the table containing this foreign key.  
  **Occurrences:** required |
| **fkColumn** | Value type: composite: vs:FKColumn  
  **Semantic Meaning:** a pair of column names, one from this table and one from the target table that should be used to join the tables in a query.  
  **Occurrences:** required; multiple occurrences are allowed.  
  **Comments:** There should be one `<fkColumn>` element for each column that makes up the foreign key. |
| **description** | Value type: string: xs:token  
  **Semantic Meaning:** a free-text description of what this key points to and what the relationship means |
**vs:ForeignKey Metadata Elements**

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>utype</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional</td>
</tr>
<tr>
<td><strong>Value type:</strong></td>
<td>string: xs:token</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>an identifier for a concept in a data model that the association enabled by this key represents.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
<td>The format defined in the VOTable standard, section 4.1 [VOTable] is strongly recommended; see “Note on UType Format” above.</td>
</tr>
</tbody>
</table>

**vs:FKColumn Type Schema Definition**

```
<xs:complexType name="FKColumn">
    <xs:sequence>
        <xs:element name="fromColumn" type="xs:token"/>
        <xs:element name="targetColumn" type="xs:token"/>
    </xs:sequence>
</xs:complexType>
```

**vs:FKColumn Metadata Elements**

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>fromColumn</td>
<td>Value type: string: xs:token</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>The unqualified name of the column from the current table.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>required</td>
</tr>
<tr>
<td>targetColumn</td>
<td>Value type: string: xs:token</td>
</tr>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>The unqualified name of the column from the target table.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>required</td>
</tr>
</tbody>
</table>

**Example**

a description of a foreign key in an observation table pointing into a filter table.

```
<tableset>
    <schema>
        <name> LSST </name>
        <table>
            <name> LSST.Filters </name>
            <description> a description of the filters used in observations </description>
            <column>
                <name>ID</name>
                ...
            </column>
        </table>
        <table>
            <name> LSST.Observations </name>
            <description> a listing of the observations made </description>
            <column>
                <name>filterID</name>
                <description>...</description>
```
3.3.3. Extending Table Metadata

It is envisioned that it may be useful in the future to provide richer metadata for describing tables within a VOResource description than what are defined in this document. This document recommends the use of the following extension mechanisms when richer descriptions are desired:

1. Use extended types by applying the xsi:type attribute to the <tableset>, <schema>, <table>, <column> and/or <dataType> elements. The values provided in the attributes must refer to an XML type legally extended from the types associated with these elements according to the rules of XML Schema [schema] and the VOResource specification [VOR].

2. Apply a globally-defined attribute from a schema other than VODataservice (i.e. from a namespace other than "http://www.ivoa.net/xml/VODataservice/v1.1") to any of the <tableset>, <schema>, <table>, and/or <column> elements.

3. When the extended metadata is specific to how the table data is accessed via a particular service protocol, then the new metadata can be incorporated into a specific capability extension (as described in the VOResource specification [VOR]). This extension may make use of the various names within the <tableset> to indicate where the extension metadata apply.

4. Use the extendedType attribute of the <dataType> element (see section 3.5.3) to indicate a more specific data type than those defined by the vs:TableParam type.

3.4. Interface Type Extension: ParamHTTP

The vs:ParamHTTP type is a specialized service interface description that extends the VOResource vr:Interface type (as recommended by [VOR], section 2.3.2). It describes a service interface that is invoke over HTTP via a GET or a POST [HTTP] in which the inputs are parameters encoded as name=value pairs, delimited by ampersands (&) and URL-encoded [URI]. When the service is invoked as a GET service, this input list is appended to a base URL (where the result must form a legal URL. Usually, the URL contains a question mark (?) setting off a list of URL arguments to the URL:
Example
A service that takes 3 parameters: ra, dec, radius

http://data.archive.edu/cgi-bin/search?ra=12.32&dec=-10.3&radius=0.1

When the service is invoked as a POST, the encoded list of parameters are uploaded to the service as the HTTP Message Body.

Example
The above GET request example shown as an HTTP POST message.

POST /cgi-bin/search
User-Agent: Python script
Content-Type: application/x-www-form-urlencoded
Content-Lenth: 29
ra=12.32&dec=-10.3&radius=0.1

The vs:ParamHTTP type is intended for (but not limited to) use in describing an interface within a VOResource description of a service capability (as described in [VOR], section 2.2.2); that is, it can be invoked via the xsi:type attribute on an <interface> element.

vs:ParamHTTP Type Schema Definition

```
<xs:complexType name="ParamHTTP">
  <xs:complexContent>
    <xs:extension base="vr:Interface">
      <xs:sequence>
        <xs:element name="queryType" type="vs:HTTPQueryType"
                    minOccurs="0" maxOccurs="2"/>
        <xs:element name="resultType" type="xs:token"
                    minOccurs="0" maxOccurs="1"/>
        <xs:element name="param" type="vs:InputParam" minOccurs="0"
                    maxOccurs="unbounded"/>
        <xs:element name="testQuery" type="xs:string" minOccurs="0"
                    maxOccurs="unbounded"/>
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

The extension metadata defined in the schema definition above are all optional. Nevertheless, even when an <interface> instance does not include any of these extended child elements, the use of xsi:type="vs:ParamHTTP" indicates that the interface accessed via the URL given by the <accessURL> element complies with the general parameter-based protocol described in this section.

vs:ParamHTTP Extension Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>queryType</td>
<td><strong>Value type:</strong> string with controlled values: vs:HTTPQueryType</td>
</tr>
<tr>
<td></td>
<td><strong>Semantic Meaning:</strong> The type of HTTP request supported by the interface,</td>
</tr>
<tr>
<td></td>
<td>either GET or POST.</td>
</tr>
<tr>
<td></td>
<td><strong>Occurrences:</strong> optional; 2 occurrences are allowed to indicate that both</td>
</tr>
<tr>
<td></td>
<td>GET and POST are supported.</td>
</tr>
</tbody>
</table>
### vs:ParamHTTP Extension Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| **resultType** | Value type: a string in MIME type format: `xs:token`  
Semantic Meaning: The MIME type of a document returned in the HTTP response.  
Occurrences: optional |
| **param** | Value type: composite: `vs:InputParam`  
Semantic Meaning: a description of an input parameter that can be provided as a name=value argument to the service.  
Occurrences: optional; multiple occurrences allowed  
Comments: See section 3.5 for the description of this element's contents. |
| **testQuery** | Value type: a string in MIME type format: `xs:token`  
Semantic Meaning: an ampersand-delimited list of arguments that can be used to test this service interface; when provided as the input to this interface, it will produce a legal, non-null response.  
Occurrences: optional; multiple occurrences allowed  
Comments: When the interface supports GET, then the full query URL is formed by the concatenation of the base URL (given by the accessURL) and the value given by this testQuery element. |

A important intended use of the `vs:ParamHTTP` type is describing the interface of an IVOA standard service protocol of the "simple" variety, such as the Simple Image Access Protocol [SIA]. In particular, it is recommended that specifications that define how a standard service is registered in a registry require the use of the `vs:ParamHTTP` interface type when it is applicable.

Normally, a VOResource description indicates its support for a standard protocol with `<capability>` element having a `standardID` attribute set to specific URI representing the standard. The standard will usually spell out the HTTP query type, the returned MIME type, and input parameters required for compliance; therefore, it is not necessary that the `vs:ParamHTTP` description provide any of the optional extended metadata, as they are already implied by the `standardID`. The description need only reflect the optional or locally unique features of the interface. In particular, description may include:

- a `<queryType>` element for a type that is not required by the standard (as long as the required query type is supported as well),
- `<param>` elements for any optional parameters or local extended parameters (when allowed by the standard).

Of course, listing required parameters is always allowed, even when describing a standard interface as long as these are consistent with the service specification and the corresponding `<param>` elements include the attribute `use="required"` (see 3.5.1). The `<param>` elements for custom parameters that are not part of the standard (but are rather local customizations) should include the attribute `std="false"`. 
3.5. Data Parameters

The VODataService schema provides several element types for describing different kinds of data parameters used in datasets and services, including service input parameters and table columns. The parameter types allow one to fully describe a parameter in terms of metadata that includes name, data type, and meaning.

All the VODataService parameter types derive from a base type called `vs:BaseParam` which defines all the common parameter metadata except the data type.

### vs:BaseParam Type Schema Definition

```xml
<xs:complexType name="BaseParam">
  <xs:sequence>
    <xs:element name="name" type="xs:token" minOccurs="0"/>
    <xs:element name="description" type="xs:token" minOccurs="0"/>
    <xs:element name="unit" type="xs:token" minOccurs="0"/>
    <xs:element name="ucd" type="xs:token" minOccurs="0"/>
    <xs:element name="utype" type="xs:token" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##other" />
</xs:complexType>
```

### vs:BaseParam Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| name    | Value type: string: `xs:token`  
  *Semantic Meaning*: The name of the column.  
  *Occurrences*: optional |
| description | Value type: string: `xs:token`  
  *Semantic Meaning*: a free-text description of the column's contents  
  *Occurrences*: optional |
| unit    | Value type: string: `xs:token`  
  *Semantic Meaning*: the unit associated with all values associated with this parameter or table column.  
  *Occurrences*: optional |
| ucd     | Value type: string: `xs:token`  
  *Semantic Meaning*: the name of a unified content descriptor that describes the scientific content of the parameter.  
  *Occurrences*: optional  
  *Comments*: There are no requirements for compliance with any particular UCD standard. The format of the UCD can be used to distinguish between UCD1, UCD1+, and SIA-UCD. See [UCD] for the latest IVOA standard set. |
| utype   | Value type: string: `xs:token`  
  *Semantic Meaning*: an identifier for a concept in a data model that the data in this schema as a whole represent.  
  *Occurrences*: optional |
vs:BaseParam Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments:</td>
<td>The format defined in the VOTable standard, section 4.1 [VOTable] is strongly recommended; see &quot;Note on UType Format&quot; above.</td>
</tr>
</tbody>
</table>

Leaving the data type metadatum out of vs:BaseParam allows the different kinds of parameters derived from vs:BaseParam to restrict the allowed data types to specific sets. The subsections below describe the different data types associated with input parameters (vs:InputParam) and table columns (vs:TableParam). The XML types associated with their <dataType> elements derive from a common parent, vs:DataType.

vs:DataType Type Schema Definition

```xml
<xs:complexType name="DataType">
    <xs:simpleContent>
        <xs:extension base="xs:token">
            <xs:attribute name="arraysize" type="vs:ArrayShape" default="1"/>
            <xs:attribute name="delim" type="xs:string" default=" "/>
            <xs:attribute name="extendedType" type="xs:string"/>
            <xs:attribute name="extendedSchema" type="xs:anyURI"/>
            <xs:anyAttribute namespace="##other" />
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
```

The content of a data type element of this type is the name of the data type for the current parameter. When the element is explicitly a vs:DataType (as opposed to one of its derived types), there are no restrictions on the names that may be included.

A data type description can be augmented via a common set of vs:DataType attributes, defined below. The arraysize attribute indicates the parameter is an array of values of the named type. Its value describes the shape of the array, and the delim attribute may be used to indicate the delimiter that should appear between elements of an array value. Depending on the application context, these attributes may not be enough to effectively parse the array values, in which case more information must be brought to bear either through assumptions about a particular derived vs:DataType or through additional attributes.

More descriptive information about the type can be provided via extendedType and extendedSchema, which provide an alternate data type name. It's expected that this name will only be understood by a special subset of applications. The name given in the element content, then, represents a more commonly understood "fall-back" type. Arbitrary information can also be provided via any prefix-qualified, globally defined attribute drawn from an XML Schema other than VODataService (by virtue of the xs:anyAttribute specification shown above).

vs:DataType Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>arraysize</td>
<td>Value type: the VOTable arraysize format (vs:ArrayShape): LxMxN..., where each x-delimited positive integer is a length along a dimension of a multi-dimensional array. A single integer indicates a one dimensional array. Instead of an</td>
</tr>
</tbody>
</table>
### vs:DataType Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>integer</strong></td>
<td>integer, the last length can be set to &quot;*&quot; which indicates a variable length.</td>
</tr>
<tr>
<td><strong>Semantic Meaning</strong></td>
<td>The attribute's presence indicates that parameter holds an array values; the attribute's value indicates the length of the array along each dimension of the multi-dimensional array.</td>
</tr>
<tr>
<td><strong>Occurrences</strong></td>
<td>optional</td>
</tr>
<tr>
<td><strong>Default Value</strong></td>
<td>1 (i.e. the parameter value is scalar)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>delim</strong></th>
<th><strong>Value type</strong>: string: xs:string</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Meaning</strong></td>
<td>the string that is used to delimit element of an array value when arraysize is not &quot;1&quot;.</td>
</tr>
<tr>
<td><strong>Occurrences</strong></td>
<td>optional.</td>
</tr>
<tr>
<td><strong>Comments</strong></td>
<td>Unless specifically disallowed by the context, applications should allow optional spaces to appear in an actual data value before and after the delimiter (e.g. &quot;1, 5&quot; when delim=&quot;,&quot;).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>extendedType</strong></th>
<th><strong>Value type</strong>: string: xs:string.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Meaning</strong></td>
<td>The data value represented by this type can be interpreted as of a custom type identified by the value of this attribute.</td>
</tr>
<tr>
<td><strong>Occurrences</strong></td>
<td>optional</td>
</tr>
<tr>
<td><strong>Comments</strong></td>
<td>The name implies a particular expected format for the data value that can be parsed into a value in memory.</td>
</tr>
<tr>
<td></td>
<td>If an application does not recognize this extendedType, it should attempt to handle value assuming the type given by the element's value. &quot;string&quot; (or its equivalent) is a recommended default type.</td>
</tr>
<tr>
<td></td>
<td>This element may make use of the extendedSchema attribute and/or any arbitrary (qualified) attribute to refine the identification of the type.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>extendedSchema</strong></th>
<th><strong>Value type</strong>: URI: xs:anyURI.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Meaning</strong></td>
<td>An identifier for the schema that the value given by the extended attribute is drawn from.</td>
</tr>
<tr>
<td><strong>Occurrences</strong></td>
<td>optional</td>
</tr>
<tr>
<td><strong>Comments</strong></td>
<td>This attribute is normally ignored if the extended element is not present.</td>
</tr>
</tbody>
</table>

Note that in the derived parameter description types described below, the `<dataType>` element is optional. Its absence from the parameter description does not mean that the parameter can support any data type; rather, it means that the data type simply has not been provided (which may limit what an application can do with the parameter). If a parameter can truly support any data type, the `vs:BaseParam` type can be used directly when the context permits.
### 3.5.1. Input Parameters

Actual parameters are normally described with types derived from `vs:BaseParam`. The `vs:InputParam` is intended for describing an input parameter to a service or function. The allowed data type names (given in the metadata table below) do not imply a size or precise format; rather, they are intended to be sufficient for describing an input parameter to a simple REST-like service or a function in a weakly-typed (e.g. scripting) language.

#### `vs:InputParam` Type Schema Definition

```xml
<xs:complexType name="InputParam">
  <xs:complexContent>
    <xs:extension base="vs:BaseParam">
      <xs:sequence>
        <xs:element name="dataType" type="vs:SimpleDataType" minOccurs="0"/>
      </xs:sequence>
      <xs:attribute name="use" type="vs:ParamUse" default="optional"/>
      <xs:attribute name="std" type="xs:boolean" default="true"/>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

By fixing the `<dataType>` child element to that of the `vs:SimpleDataType`, the possible types are restricted to predefined set appropriate for input parameters.

#### `vs:InputParam` Extension Metadata Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Definition</th>
</tr>
</thead>
</table>
| `dataType` | **Value type:** string with optional attributes: `vs:SimpleDataType`
|           | **Semantic Meaning:** a type of data contained in the column.               |
|           | **Occurrences:** optional                                                   |
|           | **Allowed Values:** The following type names correspond to the same data   |
|           |   types defined in the VOTable standard [VOTable]:                         |
|           |   boolean, char, integer, real, and complex. The additional type, string,   |
|           |   is equivalent to char when the attribute arrayshape="*".                 |

The `vs:InputParam` type accepts two attributes that indicate the role that the parameter plays as input to the service or function:

#### `vs:InputParam` Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>use</code></td>
<td><strong>Value type:</strong> string with controlled values: <code>vs:ParamUse</code></td>
</tr>
<tr>
<td></td>
<td><strong>Semantic Meaning:</strong> An indication of whether this parameter is required to</td>
</tr>
<tr>
<td></td>
<td>be provided for the application or service to work properly.</td>
</tr>
<tr>
<td></td>
<td><strong>Occurrences:</strong> optional</td>
</tr>
<tr>
<td></td>
<td><strong>Allowed Values:</strong> required the parameter must be provided.</td>
</tr>
<tr>
<td></td>
<td><strong>Optional</strong> the parameter need not be provided (default).</td>
</tr>
<tr>
<td><code>std</code></td>
<td><strong>Value type:</strong> true or false (xs:boolean)</td>
</tr>
</tbody>
</table>
### vs:InputParam Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semantic Meaning:</strong></td>
<td>If true, the meaning and behavior of this parameter is reserved and defined by a standard interface. If false, it represents an implementation-specific parameter that effectively extends the behavior of the service or application. The default is true.</td>
</tr>
<tr>
<td><strong>Occurrences:</strong></td>
<td>optional</td>
</tr>
</tbody>
</table>

### Example

A description of an input parameter that might appear inside an vs:ParamHTTP interface description. As noted in section 3.4, a `<param>` element uses the `vs:InputParam` type to describe itself.

```xml
<param use="required">
  <name>radius</name>
  <description>
    search radius; returned objects are restricted to fall within this angular distance of the search position.
  </description>
  <ucd>phys.angSize</ucd>
  <dataType>real</dataType>
</param>
```

### 3.5.2. Table Columns

The `vs:TableParam` is also derived from `vs:BaseParam`, and is designed for describing a column of a table.

### vs:TableParam Type Schema Definition

```xml
<xs:complexType name="TableParam">
  <xs:complexContent>
    <xs:extension base="vs:BaseParam">
      <xs:sequence>
        <xs:element name="dataType" type="vs:TableDataType" minOccurs="0"/>
        <xs:element name="flag" type="xs:token" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="std" type="xs:boolean"/>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>

<xs:complexType name="TableDataType" abstract="true">
  <xs:simpleContent>
    <xs:extension base="vs:DataType"/>
  </xs:simpleContent>
</xs:complexType>
```

A table column’s data type is indicated with the `<dataType>` element with a name drawn from a standard set of names. The `vs:TableParam` type is not restricted to a single standard set, and the VODataset service schema defines two standard sets: one corresponding to
VODataService (Proposed Recommendation)  

http://www.ivoa.net/Documents/VODataService/2...
Data Types derived from vs:TableDataType

<table>
<thead>
<tr>
<th>Value for xsi:type</th>
<th>Definition</th>
</tr>
</thead>
</table>
| vs:TAPType         | **Semantic Meaning:** data types that correspond column types defined in the Table Access Protocol (v1.0) [TAP].
|                    | **Allowed Values:** BOOLEAN, SMALLINT, INTEGER, BIGINT, REAL, DOUBLE, TIMESTAMP, CHAR, VARCHAR, BINARY, VARBINARY, POINT, REGION, CLOB, and BLOB. String values are represented via VARCHAR. |

The vs:TAPType XML type provides an additional attribute, size, corresponding to the "size" column from the TAP_SCHEMA.columns defined by TAP:

**Additional Attribute for the vs:TAPType set of column data types**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
</tr>
</thead>
</table>
| size      | **Value type:** a positive integer: xs:positiveInteger  
**Semantic Meaning:** The length of the variable-length data type.  
**Occurrences:** optional  
**Comments:** In the context of TAP, this attribute is only meaning when the data type is CHAR or BINARY; see discussion below. |

**Example**

A representation of a string type using the vs:VOTableType set of types:

```xml
<column>
   <name> id </name>
   <description> the object identifier </description>
   <ucd> meta.id </ucd>
   <dataType xsi:type="vs:VOTableType" arraysize="*"> char </dataType>
</column>
```

The same column described using the vs:TAPType set of types:

```xml
<column>
   <name> id </name>
   <description> the object identifier </description>
   <ucd> meta.id </ucd>
   <dataType xsi:type="vs:TAPType"> VARCHAR </dataType>
</column>
```

The same column again described using the vs:TAPType set of types, assuming a fixed-length string:

```xml
<column>
   <name> id </name>
   <description> the object identifier </description>
   <ucd> meta.id </ucd>
   <dataType xsi:type="vs:TAPType" size="8"> CHAR </dataType>
</column>
```

In general, the vs:TableParam's <dataType> can support any non-abstract type legally derived from vs:TableDataType. However, in the context of a vs:DataCollection or vs:CatalogService resource description, it is strongly recommended that either vs:VOTableType or vs:TAPType (or some other IVOA standard type derived from vs:TableDataType) be used to ensure maximum interoperability. When the actual column type is not well matched to a type from one of these standard sets, authors are encouraged to use the extendedType attribute to refer to a more specific type. Note that the TAP standard [TAP] defines an explicit mapping between
TAP_SCHEMA types and VOTable types. Thus, in the context of a vs:CatalogService resource description that supports a TAP capability (perhaps in addition to other catalog services like Simple Cone Search [SCS]), use of the vs:TAPType data type is preferred.

**Note:**

The motivation for providing two standard data type sets, vs:VOTableType and vs:TAPType, is to maximize the ease of generating the table description, particular as part of the VO Standard Interface [VOSI] and for legacy services. The table description for "stand-alone" SIA, SCS, and SSA services can be readily generated using the vs:VOTableType data types from these interface's respective metadata queries. Newer services supporting TAP could generate its description using its TAP_SCHEMA queries.

The motivation for specifying a column's data type using the xsi:type mechanism is mainly to allow for the possibility that the official TAP data types will evolve. This allows the IVOA to define new data type sets without updating the VODataService standard. Using non-IVOA-standardized data type names is expected to undermine interoperability and so is therefore discouraged.

**Appendix A: The VODataService XML Schema**

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.ivoa.net/xml/VODataService/v1.1"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:vr="http://www.ivoa.net/xml/VOResource/v1.0"
    xmlns:vs="http://www.ivoa.net/xml/VODataService/v1.1"
    xmlns:stc="http://www.ivoa.net/xml/STC/stc-v1.30.xsd"
    xmlns:vm="http://www.ivoa.net/xml/VOMetadata/v0.1"
    elementFormDefault="unqualified" attributeFormDefault="unqualified"
    version="1.1pr2">

<xs:annotation>
    <xs:appinfo>
        <vm:schemaName>VODataService</vm:schemaName>
        <vm:schemaPrefix>xs</vm:schemaPrefix>
        <vm:targetPrefix>vs</vm:targetPrefix>
    </xs:appinfo>
    <xs:documentation>
        An extension to the core resource metadata (VOResource) for describing data collections and services.
    </xs:documentation>
</xs:annotation>

<xs:import namespace="http://www.ivoa.net/xml/VOResource/v1.0"
    schemaLocation="http://www.ivoa.net/xml/VOResource/v1.0"/>
<xs:import namespace="http://www.ivoa.net/xml/STC/stc-v1.30.xsd"
    schemaLocation="http://www.ivoa.net/xml/STC/stc-v1.30.xsd"/>

<xs:complexType name="DataCollection">
    <xs:documentation>
        A logical grouping of data which, in general, is composed of one or more accessible datasets. A collection can contain any combination of images, spectra, catalogs, or other data.
    </xs:documentation>
</xs:complexType>
```
(A dataset is a collection of digitally-encoded data that is normally accessible as a single unit, e.g. a file.)
<xs:element name="coverage" type="vs:Coverage" minOccurs="0">
  <xs:annotation>
    <xs:documentation>
      Extent of the content of the resource over space, time, and frequency.
    </xs:documentation>
  </xs:annotation>
</xs:element>

<xs:element name="tableset" type="vs:TableSet" minOccurs="0">
  <xs:annotation>
    <xs:documentation>
      A description of the tables that are part of this collection.
    </xs:documentation>
    <xs:documentation>
      Each schema name and each table name must be unique within this tableset.
    </xs:documentation>
  </xs:annotation>
  <xs:unique name="DataCollection-schemaName">
    <xs:selector xpath="schema" />
    <xs:field xpath="name" />
  </xs:unique>
  <xs:unique name="DataCollection-tableName">
    <xs:selector xpath="schema/table" />
    <xs:field xpath="name" />
  </xs:unique>
</xs:element>

<xs:element name="accessURL" type="vr:AccessURL" minOccurs="0">
  <xs:annotation>
    <xs:documentation>
      The URL that can be used to download the data contained in this data collection.
    </xs:documentation>
  </xs:annotation>
</xs:element>

<xs:complexType name="Coverage">
  <xs:annotation>
    <xs:documentation>
      A description of how a resource's contents or behavior maps to the sky, to time, and to frequency space, including coverage and resolution.
    </xs:documentation>
  </xs:annotation>

  <xs:element ref="stc:STCResourceProfile" minOccurs="0">
    <xs:annotation>
      <xs:documentation>
        The STC description of the location of the resource's data (or behavior on data) on the sky, in time, and in frequency space, including resolution.
      </xs:documentation>
    </xs:annotation>
  </xs:element>
</xs:complexType>
In general, this description should be approximate; a more precise description can be provided by the footprint service.

**footprint** element:

- Represents a reference to a footprint service for retrieving precise and up-to-date description of coverage.
- The `ivo-id` attribute refers to a Service record that describes the Footprint capability. That is, the record will have a capability element describing the service. The resource referred to may be the current one.

**waveband** element:

- A named spectral region of the electro-magnetic spectrum that the resource's spectral coverage overlaps with.

**regionOfRegard** element:

- A single numeric value representing the angle, given in decimal degrees, by which a positional query against this resource should be "blurred" in order to get an appropriate match.
- In the case of image repositories, it might refer to a typical field-of-view size, or the primary beam size for radio aperture synthesis data. In the case of object catalogs RoR should normally be the largest of the typical size of the objects, the astrometric errors in the positions, or the resolution of the data.
the service URL for a potentially registered service. That is, if an IVOA identifier is also provided, then the service is described in a registry.

```
<xs:documentation>
  The URI form of the IVOA identifier for the service describing the capability referred to by this element.
</xs:documentation>
```

```
<xs:attribute name="ivo-id" type="vr:IdentifierURI">
  <xs:documentation>
    The URI form of the IVOA identifier for the service describing the capability referred to by this element.
  </xs:documentation>
</xs:attribute>
```

```
<xs:simpleType name="Waveband">
  <xs:restriction base="xs:token">
    <xs:enumeration value="Radio">
      <xs:documentation>
        wavelength >= 10 mm; frequency <= 30 GHz.
      </xs:documentation>
    </xs:enumeration>
    <xs:enumeration value="Millimeter">
      <xs:documentation>
        0.1 mm <= wavelength <= 10 mm; 3000 GHz >= frequency >= 30 GHz.
      </xs:documentation>
    </xs:enumeration>
    <xs:enumeration value="Infrared">
      <xs:documentation>
        1 micron <= wavelength <= 100 micons
      </xs:documentation>
    </xs:enumeration>
    <xs:enumeration value="Optical">
      <xs:documentation>
        0.3 microns <= wavelength <= 1 micon; 300 nm <= wavelength <= 1000 nm; 3000 Angstroms <= wavelength <= 100000 Angstroms
      </xs:documentation>
    </xs:enumeration>
    <xs:enumeration value="UV">
      <xs:documentation>
        0.1 microns <= wavelength <= 0.3 micon; 1000 nm <= wavelength <= 3000 nm; 10000 Angstroms <= wavelength <= 30000 Angstroms
      </xs:documentation>
    </xs:enumeration>
  </xs:restriction>
</xs:simpleType>
```
<xs:enumeration value="EUV">
  <xs:annotation>
    <xs:documentation>
      100 Angstroms <= wavelength <= 1000 Angstroms;
      12 eV <= energy <= 120 eV
    </xs:documentation>
  </xs:annotation>
</xs:enumeration>

<xs:enumeration value="X-ray">
  <xs:annotation>
    <xs:documentation>
      0.1 Angstroms <= wavelength <= 100 Angstroms;
      0.12 keV <= energy <= 120 keV
    </xs:documentation>
  </xs:annotation>
</xs:enumeration>

<xs:enumeration value="Gamma-ray">
  <xs:annotation>
    <xs:documentation>
      energy >= 120 keV
    </xs:documentation>
  </xs:annotation>
</xs:enumeration>
</xs:restriction>
</xs:simpleType>

<xs:complexType name="TableSet">
  <xs:annotation>
    <xs:documentation>
      The set of tables hosted by a resource.
    </xs:documentation>
  </xs:annotation>

  <xs:sequence>
    <xs:element name="schema" type="vs:TableSchema"
      minOccurs="1" maxOccurs="unbounded">
      <xs:annotation>
        <xs:documentation>
          A named description of a set of logically related tables.
        </xs:documentation>
      </xs:annotation>
      <xs:documentation>
        The name given by the "name" child element must be unique within this TableSet instance. If there is only one schema in this set and/or there's no locally appropriate name to provide, the name can be set to "default".
      </xs:documentation>
      <xs:documentation>
        This aggregation does not need to map to an actual database, catalog, or schema, though the publisher may choose to aggregate along such designations, or particular service protocol may recommend it.
      </xs:documentation>
    </xs:element>
  </xs:sequence>
  <xs:anyAttribute namespace="##other" />
</xs:complexType>

<xs:complexType name="TableSchema">
  <xs:annotation>
    <xs:documentation>
    </xs:documentation>
</xs:complexType>
A detailed description of a logically-related set of tables
</xs:documentation>
</xs:annotation>

<xs:sequence>
  <xs:element name="name" type="xs:token" minOccurs="1" maxOccurs="1">
    <xs:annotation>
      <xs:documentation>
        A name for the set of tables.
      </xs:documentation>
      <xs:documentation>
        This is used to uniquely identify the table set among several table sets. If a title is not present, this name can be used for display purposes.
      </xs:documentation>
      <xs:documentation>
        If there is no appropriate logical name associated with this set, the name should be explicitly set to "default".
      </xs:documentation>
    </xs:annotation>
  </xs:element>

  <xs:element name="title" type="xs:token" minOccurs="0">
    <xs:annotation>
      <xs:documentation>
        a descriptive, human-interpretable name for the table set.
      </xs:documentation>
      <xs:documentation>
        This is used for display purposes. There is no requirement regarding uniqueness. It is useful when there are multiple schemas in the context (e.g. within a tableset; otherwise, the resource title could be used instead).
      </xs:documentation>
    </xs:annotation>
  </xs:element>

  <xs:element name="description" type="xs:token" minOccurs="0" maxOccurs="1">
    <xs:annotation>
      <xs:documentation>
        A free text description of the tableset that should explain in general how all of the tables are related.
      </xs:documentation>
    </xs:annotation>
  </xs:element>

  <xs:element name="utype" type="xs:token" minOccurs="0">
    <xs:annotation>
      <xs:documentation>
        an identifier for a concept in a data model that the data in this schema as a whole represent.
      </xs:documentation>
      <xs:documentation>
        The format defined in the VOTable standard is strongly recommended.
      </xs:documentation>
    </xs:annotation>
  </xs:element>

  <xs:element name="table" type="vs:Table" minOccurs="0" maxOccurs="unbounded">
    <xs:annotation>
      <xs:documentation>
        A description of one of the tables that makes up the set.
      </xs:documentation>
    </xs:annotation>
  </xs:element>
</xs:sequence>
The table names for the table should be unique.
Extent of the content of the resource over space, time, and frequency.

A service invoked via an HTTP Query (either Get or Post) with a set of arguments consisting of keyword name-value pairs.

Note that the URL for help with this service can be put into the Service/ReferenceURL element.

A description of an input parameter that can be provided as a name=value argument to the service.

A ampersand-delimited list of arguments that can be used to test this service interface; when provided as the input to this interface,
it will produce a legal, non-null response.

When the interface supports GET, then the full query URL is formed by the concatenation of the base URL (given by the accessURL) and the value given by this testQuery element.

A table with sky coverage typically have columns that give longitude-latitude positions in some coordinate system.
<xs:complexType name="Table">
  <xs:sequence>
    <xs:element name="name" type="xs:token" minOccurs="1" maxOccurs="1">
      <xs:annotation>
        <xs:documentation>
          the fully qualified name of the table.  This name should include all catalog or schema prefixes needed to sufficiently uniquely distinguish it in a query.
          
        </xs:documentation>
        <xs:documentation>
          In general, the format of the qualified name may depend on the context; however, when the table is intended to be queryable via ADQL, then the catalog and schema qualifiers are delimited from the table name with dots (.).
          
        </xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="title" type="xs:token" minOccurs="0">
      <xs:annotation>
        <xs:documentation>
          a descriptive, human-interpretable name for the table.
          
        </xs:documentation>
        <xs:documentation>
          This is used for display purposes.  There is no requirement regarding uniqueness.
          
        </xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="description" type="xs:token" minOccurs="0">
      <xs:annotation>
        <xs:documentation>
          a free-text description of the table's contents
          
        </xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="utype" type="xs:token" minOccurs="0">
      <xs:annotation>
        <xs:documentation>
          an identifier for a concept in a data model that the data in this table represent.
          
        </xs:documentation>
        <xs:documentation>
          The format defined in the VOTable standard is highly recommended.
          
        </xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="column" type="vs:TableParam" minOccurs="0" maxOccurs="unbounded">
      <xs:annotation>
        <xs:documentation>
          a description of a table column.
          
        </xs:documentation>
      </xs:annotation>
    </xs:element>
  </xs:sequence>
</xs:complexType>
<xs:element name="foreignKey" type="vs:ForeignKey">
  <xs:annotation>
    <xs:documentation>
      a description of a foreign keys, one or more columns from the current table that can be used to join with another table.
    </xs:documentation>
  </xs:annotation>
</xs:element>

<xs:attribute name="type" type="xs:string">
  <xs:annotation>
    <xs:documentation>
      a name for the role this table plays. Recognized values include "output", indicating this table is output from a query; "base_table", indicating a table whose records represent the main subjects of its schema; and "view", indicating that the table represents a useful combination or subset of other tables. Other values are allowed.
    </xs:documentation>
  </xs:annotation>
</xs:attribute>

<xs:anyAttribute namespace="##other" />
</xs:complexType>

<xs:complexType name="BaseParam">
  <xs:annotation>
    <xs:documentation>
      a description of a parameter that places no restriction on the parameter's data type.
    </xs:documentation>
  </xs:annotation>
  <xs:sequence>
    <xs:element name="name" type="xs:token" minOccurs="0">
      <xs:annotation>
        <xs:documentation>
          the name of the column
        </xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="description" type="xs:token" minOccurs="0">
      <xs:annotation>
        <xs:documentation>
          a free-text description of the column's contents
        </xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="unit" type="xs:token" minOccurs="0">
      <xs:annotation>
        <xs:documentation>
          the unit associated with all values in the column
        </xs:documentation>
      </xs:annotation>
    </xs:element>
  </xs:sequence>
</xs:complexType>
<xs:element name="ucd" type="xs:token" minOccurs="0">
  <xs:annotation>
    <xs:documentation>
      the name of a unified content descriptor that describes the scientific content of the parameter.
    </xs:documentation>
    <xs:documentation>
      There are no requirements for compliance with any particular UCD standard. The format of the UCD can be used to distinguish between UCD1, UCD1+, and SIA-UCD. See http://www.ivoa.net/Documents/latest/UCDlist.html for the latest IVOA standard set.
    </xs:documentation>
  </xs:annotation>
</xs:element>

<xs:element name="utype" type="xs:token" minOccurs="0">
  <xs:annotation>
    <xs:documentation>
      an identifier for a concept in a data model that the data in this schema represent.
    </xs:documentation>
    <xs:documentation>
      The format defined in the VOTable standard is highly recommended.
    </xs:documentation>
  </xs:annotation>
</xs:element>

<xs:complexType name="TableParam">
  <xs:annotation>
    <xs:documentation>
      a description of a table parameter having a fixed data type.
    </xs:documentation>
    <xs:documentation>
      The allowed data type names match those supported by VOTable.
    </xs:documentation>
  </xs:annotation>
  <xs:complexContent>
    <xs:extension base="vs:BaseParam">
      <xs:sequence>
        <xs:element name="dataType" type="vs:TableDataType" minOccurs="0">
          <xs:annotation>
            <xs:documentation>
              a type of data contained in the column
            </xs:documentation>
          </xs:annotation>
        </xs:element>
        <xs:element name="flag" type="xs:token" minOccurs="0" maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>
              a keyword representing traits of the column. Recognized values include "indexed", "primary", and
"nullable".
</xs:documentation>
</xs:element>
</xs:sequence>

<xs:attribute name="std" type="xs:boolean">
  <xs:annotation>
    <xs:documentation>
      If true, the meaning and use of this parameter is reserved and defined by a standard model. If false, it represents a database-specific parameter that effectively extends beyond the standard. If not provided, then the value is unknown.
    </xs:documentation>
  </xs:annotation>
</xs:attribute>

<xs:complexContent>
<xs:extension base="vs:BaseParam">
<xs:sequence>
  <xs:element name="dataType" type="vs:SimpleDataType" minOccurs="0">
    <xs:annotation>
      <xs:documentation>
        a type of data contained in the column
      </xs:documentation>
    </xs:annotation>
  </xs:element>
</xs:sequence>

<xs:attribute name="use" type="vs:ParamUse" default="optional">
  <xs:annotation>
  An indication of whether this parameter is required to be provided for the application or service to work properly.
  </xs:annotation>
</xs:attribute>

<xs:attribute name="std" type="xs:boolean" default="true">

</xs:complexType>
If true, the meaning and behavior of this parameter is reserved and defined by a standard interface. If false, it represents an implementation-specific parameter that effectively extends the behavior of the service or application.
<xs:attribute name="delim" type="xs:string" default=" ">
    <xs:documentation>
        the string that is used to delimit elements of an array value when arraysize is not "1".
    </xs:documentation>
    <xs:documentation>
        Unless specifically disallowed by the context, applications should allow optional spaces to appear in an actual data value before and after the delimiter (e.g. "1, 5" when delim=",").
    </xs:documentation>
    <xs:documentation>
        the default is " "; i.e. the values are delimited by spaces.
    </xs:documentation>
</xs:attribute>

<xs:attribute name="extendedType" type="xs:string">
    <xs:annotation>
        <xs:documentation>
            The data value represented by this type can be interpreted as of a custom type identified by the value of this attribute.
        </xs:documentation>
        <xs:documentation>
            If an application does not recognize this extendedType, it should attempt to handle value assuming the type given by the element's value.
        </xs:documentation>
        <xs:documentation>
            This element may make use of the extendedSchema attribute and/or any arbitrary (qualified) attribute to refine the identification of the type.
        </xs:documentation>
    </xs:annotation>
</xs:attribute>

<xs:attribute name="extendedSchema" type="xs:anyURI">
    <xs:annotation>
        <xs:documentation>
            An identifier for the schema that the value given by the extended attribute is drawn from.
        </xs:documentation>
        <xs:documentation>
            This attribute is normally ignored if the extendedType attribute is not present.
        </xs:documentation>
    </xs:annotation>
</xs:attribute>

<xs:anyAttribute namespace="##other"/>
</xs:extension>
</xs:simpleContent>
</xs:complexType>

<!-- this definition is taken from the VOTable arrayDEF type -->
<xs:simpleType name="ArrayShape">
    <xs:annotation>
        <!--
            VODataService (Proposed Recommendation) http://www.ivoa.net/Documents/VODataService/2...
        -->
    </xs:annotation>
</xs:simpleType>
An expression of a the shape of a multi-dimensional array of the form \( L \times N \times M \ldots \) where each value between gives the integer length of the array along a dimension. An asterisk (*) as the last dimension of the shape indicates that the length of the last axis is variable or undetermined.
<xs:complexType name="TAPDataType" abstract="true">
  <xs:annotation>
    <xs:documentation>
    an abstract parent for the specific data types supported
    by the Table Access Protocol.
    </xs:documentation>
  </xs:annotation>
  <xs:simpleContent>
    <xs:extension base="vs:TableDataType">
      <xs:attribute name="size" type="xs:positiveInteger">
        <xs:annotation>
          <xs:documentation>
            the length of the fixed-length value
          </xs:documentation>
        </xs:annotation>
        <xs:documentation>
          This corresponds to the size Column attribute in
          the TAP_SCHEMA and can be used with data types
          that are defined with a length (CHAR, BINARY).
        </xs:documentation>
      </xs:attribute>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>

<xs:complexType name="TAPType">
  <xs:annotation>
    <xs:documentation>
    a data type supported explicitly by the Table Access
    Protocol (v1.0).
    </xs:documentation>
  </xs:annotation>
  <xs:simpleContent>
    <xs:restriction base="vs:TAPDataType">
      <xs:enumeration value="BOOLEAN"/>
      <xs:enumeration value="SMALLINT"/>
      <xs:enumeration value="INTEGER"/>
      <xs:enumeration value="BIGINT"/>
      <xs:enumeration value="REAL"/>
      <xs:enumeration value="DOUBLE"/>
      <xs:enumeration value="TIMESTAMP"/>
      <xs:enumeration value="CHAR"/>
      <xs:enumeration value="VARCHAR"/>
      <xs:enumeration value="BINARY"/>
      <xs:enumeration value="VARBINARY"/>
      <xs:enumeration value="POINT"/>
    </xs:restriction>
  </xs:simpleContent>
</xs:complexType>
<xs:complexType name="StandardSTC">
  <xs:annotation>
    <xs:documentation>
      a description of standard space-time coordinate systems,
      positions, and regions.
    </xs:documentation>
    <xs:documentation>
      This resource provides a mechanism for registering standard
      coordinate systems which other resources may reference as
      part of a coverage description. In particular, coverage
      descriptions will refer to components of the STC
      descriptions in this resource via an IVOA identifier. It
      is intended that an application consuming such coverage
      descriptions be able to semantically interpret the
      identifier without resolving it. For this reason, once a
      standard STC description is registered with this resource
      type, updating the description is strongly discouraged.
    </xs:documentation>
  </xs:annotation>
  <xs:complexContent>
    <xs:extension base="vr:Resource">
      <xs:sequence>
        <xs:element name="stcDefinitions"
          type="stc:stcDescriptionType"
          minOccurs="1" maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>
              An STC description of coordinate systems,
              positions, and/or regions
            </xs:documentation>
            <xs:documentation>
              Each system, position, and region description
              should have a an XML ID assigned to it.
            </xs:documentation>
            <xs:documentation>
              Because the STC schema sets
              elementFormDefault="qualified", it is
              recommended that this element specify the STC
              default namespace via an xmlns namespace.
            </xs:documentation>
          </xs:annotation>
          </xs:element>
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
A description of the mapping a foreign key—a set of columns from one table—to columns in another table.

This definition that the foreign key is being described within the context of the table containing the key.

The fully-qualified name (including catalog and schema, as applicable) of the table that can be joined with the table containing this foreign key.

A pair of column names, one from this table and one from the target table that should be used to join the tables in a query.

A free-text description of what this key points to and what the relationship means.

An identifier for a concept in a data model that the association enabled by this key represents.

The format defined in the VOTable standard is highly recommended.

A pair of columns that are used to join two tables.

To do an inner join of data from the two tables, a query should include a constraint that sets the value from the first column equal
Appendix B: Compatibility Issues with VODataService 1.0

The working draft version 1.0 of the VODataService schema has been in use in IVOA registries since about 2008. It is expected that registries will migrate over to version 1.1 gradually and during the transition, there may well be instances of both v1.1 and v1.0 in the same registry. While the metadata structures are the mostly the same (particularly the core VOResource metadata), it is worth enumerating where they are different as this can affect how queries against differing metadata are formed.

- In v1.1, `<schema>` replaces v1.0's `<catalog>`.  
- In v1.0, the root element of a table description in a `<vs:DataCollection WAS <catalog>`. Consequently, a `<table>` element in a v1.1 record is one level lower than in v1.0.  
- In v1.0, the root element of a table description in a `<vs:CatalogService WAS <table>`. Consequently, a `<table>` element in a v1.1 record is one level lower than in v1.0.  
- Version 1.1's `<vs:Coverage>` type now contains a `<regionOfRegard>` element. In v1.0, this metadatum was only available via `<coverage/stc:STCResourceProfile/stc:AstroCoord/stc:Size>`.  
- Version 1.1's `<vs:TableParam>` (for describing table columns) adds `<utype>` and `<flag>` elements. The v1.1 `<vs:InputParam>` adds a `<utype>` element.

Appendix C: Change History

Changes since PR-20090903:

- added `<:testQuery>` to `<vs:ParamHTTP>`  
- in text, added explanation of `<vs:Format>`  
- grammatical clean-up
Changes since WD-20090508 (v1.10):

- corrected errors in example in Introduction
- added `<description>` and `<utype>` elements to the `vs:ForeignKey` type for consistency with TAP.
- changed type names `vs:TAP` to `vs:TAPType` and `vs:VOTable vs:VOTableType`.

References


[VOR]

[VOSI]

[VOTable]

[xml]
Bray, Tim, Paoli, Jean, Sperberg-McQueen, C. M., Maler, Eve, Yergeau, Francois (editors) 2004, Extensible Markup Language (XML) 1.0 (Third Edition), W3C Recommendation 04 February 2004, http://www.w3.org/TR/REC-xml