

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 of 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 cover the sky as well as cover 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 VODataService data types will be particularly useful in describing services that support standard IVOA service protocols.

Status of this document

This document has been produced by the IVOA Registry Working Group. It has been reviewed by IVOA Members and other interested parties, and has been endorsed by the IVOA Executive Committee as an IVOA Recommendation as 01 Oct 2010. It is a stable document and may be used as reference material or cited as a normative reference from another document. IVOA's role in making the Recommendation is to draw attention to the specification and to promote its widespread deployment. This enhances the functionality and interoperability inside the Astronomical Community.

A list of <u>current IVOA Recommendations and other technical documents</u> can be found at http://www.ivoa.net/Documents/.

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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 go beyond common Schema-aware parsers which ensure conformance with this document.

Syntax Notation Using XML Schema

The eXtensible Markup Language, or XML, is a document syntax for marking textual

information with named tags and is defined by the World Wide Web Consortium (W3C) Recommendation, XML 1.0 [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 <u>Appendix A</u>. Parts of the schema appear within the main sections of this document; however, documentation nodes have been left out for the sake of brevity.

References 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). References 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 modular way without deprecating the core schema or other extensions. This document defines one such extension referred to as **VODataService**.

1.1. The Role in the IVOA Architecture

The IVOA Architecture [Arch] provides a high-level view of how IVOA standards work together to connect users and applications with providers of data and services, as depicted in the diagram in Fig. 1.

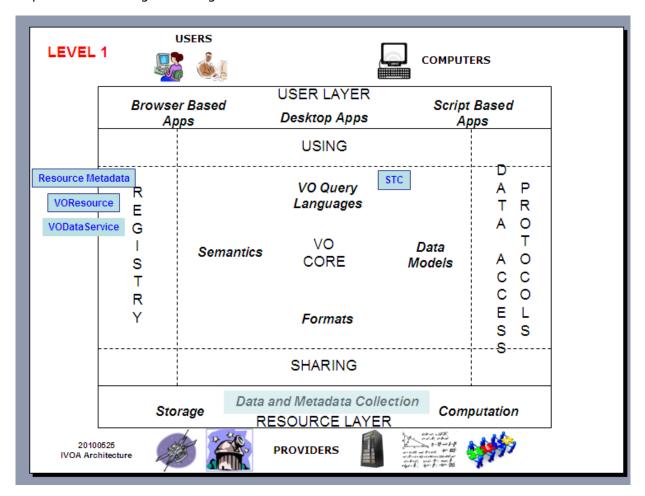


Figure 1. VODataService in the IVOA Architecture. The Registry enables applications in the User Layer to discover archives and services in the Resource Layer. The metadata and data model standards (in blue text and boxes) gives structure to the information that enables that discovery.

In this architecture, users can leverage a variety of tools (from the User Layer) to discover archives and services of interest (represented in the Resource Layer); registries provide the means for this discovery. A registry is a repository of descriptions of resources that can be searched based on the metadata in those descriptions. The Resource Metadata standard [RM] defines the core concepts used in the resource descriptions, and the VOResource standard [VOR] defines the XML format. As an extension of VOResource, the VODataService standard, defined in this document, specifically supports descriptions of data collections and services.

1.2. Purpose

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 contain 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 [<u>VOR</u>], 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, <u>catalogservice.xml</u>
    <?xml version="1.0" encoding="UTF-8"?>
    <ri:Resource xmlns=""
                 xsi:type="vs:CatalogService" status="active"
                 updated="2008-04-29T14:51:54" created="2005-10-14T01:46:00"
                 xmlns:ri="http://www.ivoa.net/xml/RegistryInterface/v1.0"
                 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"
1
                 xmlns:xlink="http://www.w3.org/1999/xlink"
1
                 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
                 xsi:schemaLocation="http://www.ivoa.net/xml/VOResource/v1.0
3
3
                                      http://www.ivoa.net/xml/VOResource/v1.0
3
                                      http://www.ivoa.net/xml/VODataService/v1.1
3
                                      http://www.ivoa.net/xml/VODataService/v1.1
3
                                      http://www.ivoa.net/xml/STC/stc-v1.30.xsd
3
                                      http://www.ivoa.net/xml/STC/stc-v1.30.xsd">
4
      <title>The NASA/IPAC Extragalactic Database</title>
4
      <shortName>NED redshift</shortName>
4
      <identifier>ivo://ned.ipac/Redshift_By_Object_Name</identifier>
4
      <curation>
 4
        <publisher>The NASA/IPAC Extragalactic Database/publisher>
4
        <contact>
4
           <name>0lga Pevunova</name>
4
           <email>contact@datacenter.edu</email>
4
        </contact>
4
      </curation>
4
      <content>
4
        <subject>redshift</subject>
4
        <subject>galaxies</subject>
4
        <description>
          NED is built around a master list of extragalactic objects for
```

```
4
          which cross-identifications of names have been established,
4
          accurate positions and redshifts entered to the extent possible,
          and some basic data collected. This service will return recorded
4
4
         redshifts for a given object.
4
       </description>
4
       <referenceURL>http://nedwww.ipac.caltech.edu/help/data help.html#zdat</referenceURL>
4
       <type>BasicData</type>
4
       <contentLevel>Research</contentLevel>
4
     </content>
4
     <capability>
       <interface xsi:type="vs:ParamHTTP">
5
5
         <accessURL use="base">
5
             http://nedwww.ipac.caltech.edu/cgi-bin/nph-datasearch?search_type=Redshifts&
5
         </accessURL>
5
          <queryType>GET</queryType>
5
          <resultType>application/xml+votable</resultType>
5
          <param use="required">
5
            <name>objname</name>
5
           <description>Name of object</description>
5
           <dataType>string</dataType>
5
5
         <param use="required">
5
           <name>of</name>
5
            <description>Output format parameter, must be "xml main" for VOTable output./description>
5
            <dataType>string</dataType>
5
         </param>
5
       </interface>
4
     </capability>
6
     <coverage>
6
        <stc:STCResourceProfile>
6
          <stc:AstroCoordSystem xlink:type="simple"</pre>
6
                                 xlink:href="ivo://STClib/CoordSys#UTC-FK5-TOPO"
                                 id="UTC-FK5-TOPO"/>
6
6
          <stc:AstroCoordArea coord_system_id="UTC-FK5-TOPO">
6
             <stc:AllSky/>
6
           </stc:AstroCoordArea>
6
        </stc:STCResourceProfile>
6
        <waveband>Radio</waveband>
6
        <waveband>Optical</waveband>
6
      </coverage>
7
     <tableset>
7
       <schema>
7
         <name>default</name>
7
         7
           <name>default</name>
7
            <column>
7
             <name>No.</name>
7
             <description>
7
                A sequential data-point number applicable to this list only.
7
             </description>
7
             <ucd>meta.number</ucd>
7
             <dataType xsi:type="vs:VOTableType">int</dataType>
7
            </column>
7
            <column>
7
             <name>Name in Publication
             <description>
7
                 The object's name in NED's standard format, of the object to which the data apply.
7
             </description>
7
             <ucd>meta.id;name</ucd>
7
             <dataType xsi:type="vs:V0TableType">string</dataType>
7
            </column>
7
            <column>
```

```
<name>Published Velocity
             <description>
              The radial velocity , derived from derived from the shift of some spectral feature, in km/sec
7
             </description>
             <unit>km/sec</unit>
             <ucd>src.spect.dopplerVeloc</ucd>
7
             <dataType xsi:type="vs:V0TableType">int</dataType>
7
           </column>
7
         7
       </schema>
7
     </tableset>
   </ri:Resource>
```

This example illustrates some of the features of the VODataService extension:

- 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 <u>coverage</u>, 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,

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 VODataService schema, version 1.1, is because it is already in defined to represent VODataService v1.0 and cannot be overridden. At this writing, there are no IVOA applications in which this is the case. Consult Appendix B for more details on compatibility issues.

As recommend 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 systems 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 <u>coverage</u> 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 of 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 \underline{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 comprising 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
 <xs:complexType name="DataCollection">
    <xs:complexContent>
       <xs:extension base="vr:Resource">
           <xs:sequence>
             <xs:element name="facility" type="vr:ResourceName"</pre>
                        minOccurs="0" maxOccurs="unbounded"/>
             <xs:element name="instrument" type="vr:ResourceName"</pre>
                        minOccurs="0" maxOccurs="unbounded"/>
             <xs:element name="rights" type="vr:Rights"</pre>
                        minOccurs="0" maxOccurs="unbounded"/>
             <xs:element name="format" type="vs:Format"</pre>
                        min0ccurs="0" max0ccurs="unbounded"/>
             <xs:element name="coverage" type="vs:Coverage" min0ccurs="0"/>
             <xs:element name="tableset" type="vs:TableSet" min0ccurs="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" min0ccurs="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			
Element	Definition		
	RM Name: Facility Value type: string with optional ID attribute: vr:ResourceName Semantic Meaning: the observatory or facility used to collect the data contained or managed by this resource.		

vs:DataCo	Collection Extension Metadata Elements			
Element	Definition			
	Occurrences:	optional; multiple occurrences allowed		
instrument	Value type:	Instrument string with optional ID attribute: vr:ResourceName the instrument used to collect the data contained or managed by this resource. optional; multiple occurrences allowed		
rights	RM Name: Value type: Semantic Meaning: Occurrences: Allowed Values:	Rights string, controlled vocabulary: xs:token : Information about rights held in and over the resource. optional; multiple occurrences allowed public unrestricted, public access is allowed without authentication. secure authenticated, public access is allowed. proprietary only proprietary access is allowed with authentication.		
format	RM Name: Value type: Semantic Meaning: Occurrences: Comments:	Format string with optional isMIMEType attribute, vs:Format g: The physical or digital manifestation of the information supported by a resource. optional; multiple occurrences allowed 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 networke.g. CDROM, poster, slides, video cassette, etc.		
coverage	RM Name: Value type: Semantic Meaning: Occurrences:	Coverage composite; vs:Coverage g: Extent of the content of the resource over space, time, and frequency. optional		
tableset	Value type: Semantic Meaning: Occurrences:	composite; vs:TableSet g: A description of tables that are part of this collection. optional.		
accessURL	RM Name: Value type: Semantic Meaning: Occurrences:	Service.AccessURL URL with optional use attribute: vr:AccessURL The URL can be used to download the data contained in this data collection. required; multiple occurrences allowed.		

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

The isminetype 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 by 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.

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			
Element	Definition		
stcDefintions	Value type: composite; stc:stcDescriptionType		
	Semantic Meaning: the definitions of systems, positions, and regions th are available for referencing.		
	Occurrences:	required; multiple occurrences allowed	

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.

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

vs:DataSe	Service Extension Metadata Elements			
Element	Definition			
facility	RM Name:	Facility		
	Value type:	string with optional ID attribute: vr:ResourceName		
	Semantic Meaning:	the observatory or facility used to collect the data contained or managed by this resource.		
	Occurrences:	optional; multiple occurrences allowed		
instrument	RM Name:	Instrument		
	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	RM Name:	Coverage		
	Value type:	composite; vs:Coverage		
	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.

```
vs:CatalogService Type Schema Definition
 <xs:complexType name="CatalogService">
       <xs:complexContent>
          <xs:extension base="vs:DataService">
             <xs:sequence>
                <xs:element name="tableset" type="vs:TableSet" min0ccurs="0">
                   <xs:unique name="CatalogService-schemaName">
                      <xs:selector xpath="schema" />
                      <xs:field xpath="name" />
                   </xs:unique>
                   <xs:unique name="CatalogService-tableName">
                      <xs:selector xpath="schema/table" />
                      <xs:field xpath="name" />
                   </xs:unique>
                 <xs:element>
             </xs:sequence>
          </xs:extension>
       </xs:complexContent>
    </xs:complexType>
```

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			
Element	Definition		
tableset	/alue type: composite; <u>vs:TableSet</u>		
	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.

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.

Note:

The STC scheme provides rich mark-up for expressing the details of the coverage. In particular, the mark-up is quite flexible in the units that can be used. For example, spectral coverage can be given in terms of frequency, wavelength, or energy. While it is recommended that the overall description given in the <stc:STCResourceProfile> be fairly general and approximate, leveraging the richness for a detailed description is allowed.

The remaining elements provide some summary information about the coverage.

Definition		
Value type:	composite: an stc:STCResourceProfile element from the <u>STC</u> 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.	
RM Name:	Coverage.Spectral	
Value type:	string with controlled vocabulary: vs:Waveband	
	Semantic Meaning: Occurrences: Comments: Value type: Semantic Meaning: Occurrences: Comments:	

_	tadata Elements		Definition	
Element	Definition			
	Semantic Meaning:		I spectral region of the electro-magnetic n that the resource's spectral coverage 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	
		UV	0.1 micron <= wavelength <= 0.3 microns; 100 nm <= wavelength <= 300 nm; 1000 Angstroms <= wavelength <= 3000 Angstroms	
		EUV	100 Angstroms <= wavelength <= 1000 Angstroms; 12 eV <= energy <= 120 eV	
		X-ray	0.1 Angstroms <= wavelength <= 100 Angstroms; 0.12 keV <= energy <= 120 keV	
		Gamma-ray	energy >= 120 keV	
regionOfRegard	RM Name:	Coverage	e.RegionOfRegard	
	Value type:	_	g point number: xs:float	
	Semantic Meaning:	given in query ag	numeric value representing the angle, decimal degrees, by which a positional gainst this resource should be "blurred" to get an appropriate match.	
	Occurrences:	optional		
	Comments:	In the ca might re primary data. In regard s typical s	ase of image repositories, this value of the to a typical field-of-view size, or the beam size for radio aperture synthesis the case of object catalogs, region of thould normally be the largest of the size of the objects, the astrometric errors ositions, 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 Metadata Elements				
Element	Definition			
schema	Value type: composite; vs:TableSchema			
	Semantic Meaning: A named description of a set of logically related tables.			
	Occurrences:	Occurrences: required; multiple occurrences are allowed.		
	Comments:	See <u>section 3.3.1</u> regarding unique names for schemas.		

The vs:TableSchema type collects tables together that are logically related. For example, a single resource may provide access 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:TableS	Schema Metadata Elements		
Element		Definition	
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	
	Comments:	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.	
description	Value type:	string: xs:token	
	Semantic Meaning:	A free text description of the tableset that should explain in general how all of the tables are related.	
	Occurrences:	optional	
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	
	Comments:	The format defined in the VOTable standard, section 4.1 [VOTable] is strongly recommended; see "Note on UType Format below.	
table	Value type:	composite: vs:Table	
	Semantic Meaning:	A marked description of one of the tables that makes up the set.	
	Occurrences:	optional; multiple occurrences are allowed.	
	Comments:	See <u>section 3.3.1</u> regarding unique names for schemas.	

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.

Element	Definition		
name	Value type: Semantic Meaning:	string: xs:token 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.	
	Occurrences: Comments:	required 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 "default", 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 "default". See $\underline{\text{section } 3.3.1}$ regarding the uniqueness of this name.	
title	Value type: Semantic Meaning:	string: xs:token a descriptive, human-interpretable name for the table set.	
	Occurrences: Comments:	optional 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.	
description	Value type: Semantic Meaning:	string: xs:token A free-text description of the table's contents.	

vs:Table M	e Metadata Elements			
Element	Definition			
	Occurrences:	optional		
utype	Value type: Semantic Meaning. Occurrences:	string: xs:token can identifier for a concept in a data model that the data in this table as a whole represent.		
	Comments:	optional The format defined in the VOTable standard, section 4.3 [VOTable] is strongly recommended; see "Note on UType Format above.		
column	Value type: Semantic Meaning. Occurrences: Comments:	composite: vs:TableParam A marked description of one of the table's columns. optional; multiple occurrences are allowed. See section 3.5 for the description of this element's contents.		
foreignKey	Value type: Semantic Meaning. Occurrences: Comments:	composite: vs:ForeignKey A description of a foreign keys, one or more columns from the current table that can be used to join with another table. optional; multiple occurrences are allowed. See section 3.5.2 for the description of this element's contents.		

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:

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

3.3.1. Unique Names for Tables

The definitions of the <tableset> elements used in the <s:DataCollection and <s: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 returned:

```
schema[@name="default"]
schema/table[@name="default"]
```

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.

In this model, the source of the foreign key is the current table being described (i.e. represented by the 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		
Element		Definition
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

vs:Foreign	vs:ForeignKey Metadata Elements		
Element	Definition		
	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.</fkcolumn>	
description	Value type:	string: xs:token	
	Semantic Meaning	a free-text description of what this key points to and what the relationship means	
	Occurrences:	optional	
utype	Value type:	string: xs:token	
	Semantic Meaning	an identifier for a concept in a data model that the association enabled by this key represents.	
	Occurrences:	optional	
	Comments:	The format defined in the VOTable standard, section 4.1 [VOTable] is strongly recommended; see "Note on UType Format" above.	

vs:FKColumn Metadata Elements		
Element		Definition
fromColumn	Value type:	string: xs:token
	Semantic Meaning:	The unqualified name of the column from the current table.
	Occurrences:	required
targetColumn	Value type:	String: xs:token
	Semantic Meaning:	The unqualified name of the column from the target table.
	Occurrences:	required

Example

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

```
<tableset>
<schema>
<name> LSST </name>

<name> LSST.Filters </name>
```

```
<description> a description of the filters used in observations </description>
      <column>
         <name>ID</name>
      </column>
   <name> LSST.Observations </name>
      <description> a listing of the observations made </description>
      <column>
         <name>filterID</name>
         <description>
           the key into the Filter table pointing to the filter used
           in the observation.
         </description>
         . . .
      </column>
      <foreignKev>
         <targetTable> LSST.Filters </targetTable>
         <fkColumn>
            <fromColumn> filterID </fromColumn>
            <targetColumn> ID </targetColumn>
         </fkColumn>
      </foreignKey>
   </schema>
</tableset>
```

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:

- Use extended types by applying the xsi:type attribute to the <tableset>, <schema>, , <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>, , 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 then 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.

```
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"</pre>
                          min0ccurs="0" max0ccurs="2"/>
              <xs:element name="resultType" type="xs:token"</pre>
                          min0ccurs="0" max0ccurs="1"/>
              <xs:element name="param" type="vs:InputParam" min0ccurs="0"</pre>
                          max0ccurs="unbounded"/>
              <xs:element name="testQuery" type="xs:string" min0ccurs="0"</pre>
                          max0ccurs="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
```

Element		Definition
queryType	Value type:	string with controlled values: vs:HTTPQueryType
	Semantic Meaning:	The type of HTTP request supported by the interface, either GET or POST.
	Occurrences:	optional; 2 occurrences are allowed to indicate that both GET and POST are supported
	Allowed Values:	GET OF POST
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 <i>name=value</i> argument to the service.
	Occurrences:	optional; multiple occurrences allowed
	Comments:	See <u>section 3.5</u> 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 concatonation 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),

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 <code>qparam></code> elements include the attribute <code>use="required"</code> (see 3.5.1). The <code>qparam></code> elements for custom parameters that are not part of the standard (but are rather local customizations) should include the attribute <code>std="false"</code>.

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:BasePa	vs:BaseParam Metadata Elements		
Element	Definition		
name	Value type: Semantic Meaning: Occurrences:	string: xs:token The name of the column. optional	
description	1	string: xs:token a free-text description of the column's contents optional	
unit	Value type: Semantic Meaning: Occurrences:	string: xs:token the unit associated with all values associated with this parameter or table column. optional	
ucd	Value type: Semantic Meaning: Occurrences: Comments:	string: xs:token the name of a unified content descriptor that describes the scientific content of the parameter. optional 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.	

vs:BaseParam Metadata Elements		
Element		Definition
utype	Value type:	string: xs:token
	Semantic Meanir	ng: an identifier for a concept in a data model that the data in this schema as a whole represent.
	Occurrences:	optional
	Comments:	The format defined in the VOTable standard, section 4.1 [VOTable] is strongly recommended; see "Note on UType Format" above.

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.

The content of an element of type vs:DataType 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 attribute 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	
Attribute	Definition

vs:DataTyp	e Attributes	
Attribute		Definition
arraysize	Value type:	the <u>VOTable</u> 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 integer, the last length can be set to "*" which indicates a variable length.
	Semantic Meaning: 	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.
	Occurrences:	optional
	Default Value:	1 (i.e. the parameter value is scalar)
delim	Value type: Semantic Meaning:	string: xs:string the string that is used to delimit element of an array
	Occurrences:	value when arraysize is not "1". optional.
	Comments:	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=",").
extendedType	Value type:	String: xs:string.
	l	The data value represented by this type can be interpreted as of a custom type identified by the value of this attribute.
	Occurrences:	optional
	Comments:	The name implies a particular expected format for the data value that can be parsed into a value in memory.
		If an application does not recognize this extendedType, it should attempt to handle value assuming the type given by the element's value. "string" (or its equivalent) is a recommended default type.
		This element may make use of the extendedSchema attribute and/or any arbitrary (qualified) attribute to refine the identification of the type.
extendedSchema	Value type: Semantic Meaning:	URI: xs:anyURI. An identifier for the schema that the value given by the
		extended attribute is drawn from.
	Occurrences: Comments:	This attribute is normally ignored if the extended element is not present.

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 parametr to a simple REST-like service or a function in a weakly-typed (e.g. scripting) language.

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		
Element		Definition
dataType	Value type: Semantic Meaning: Occurrences: Allowed Values:	string with optional attributes: vs:SimpleDataType a type of data contained in the column. optional 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			
Attribute		Definition	
use	1	string with controlled values: vs:ParamUse An indication of whether this parameter is required to be provided for the application or service to work properly.	
	Occurrences:	optional	

vs:InputP	vs:InputParam Attributes		
Attribute	Definition		
	Allowed Values:	required the parameter must be provided. optional the parameter need not be provided (default).	
std	Value type: Semantic Meaning Occurrences:	true Or false (xs:boolean) g: 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. optional	

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.

```
<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
 <xs:complexType name="TableParam">
    <xs:complexContent>
       <xs:extension base="vs:BaseParam">
          <xs:sequence>
             <xs:element name="dataType" type="vs:TableDataType"</pre>
                         min0ccurs="0"/>
             <xs:element name="flag" type="xs:token"</pre>
                         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 <code>dataType</code> element with a name drawn from a standard set of names. The <code>vs:TableParam</code> type is not restricted to a single standard set, and the VODataService schema defines two standard sets: one corresponding to VOTable data types [VOTable] and one for Table Access Protocol types. Because its XML type, <code>vs:TableDataType</code> is abstract, the <code>dataType</code> element MUST include an <code>xsi:type</code> attribute to indicate which standard set of type names is being used.

vs:Table	vs:TableParam Extension Metadata Elements		
Element		Definition	
dataType	Value type:	string with a required xsi:type attribute and additional optional attributes: vs:TableDataType	
	Semantic Meaning:	a type of data contained in the column.	
	Occurrences:	optional	
	Allowed Values:	The allowed type names are determined by value of the xsi:type; see section 3.5.3 below.	
flag	Value type:	string with optional attributes: vs:TableDataType	
	Semantic Meaning:	a keyword representing traits of the column.	
	Occurrences:	optional; multiple occurrences allowed	

vs:TableParam Extension Metadata Elements				
Element	Definition			
	Recommended Values: indexed The column has an index on it for faster search against its values.			
	primary The values column in the column represents in total or in part a primary key for its table.			
	nullable the column may contain null or empty values.			
	Other values are allowed.			

3.5.3. Table Column Data Types

The VODataService schema defines two XML types that derive from vs:TableDataType: vs:VOTableType and vs:TAPType.

Data Types derived from vs:TableDataType					
Value for xsi:type	Definition				
vs:VOTableType	Semantic Meaning:	data types that correspond to the parameter and column types defined in the VOTable schema [VOTable].			
	Allowed Values:	boolean, bit, unsignedByte, short, int, long, char, unicodeChar, float, double, floatComplex, and doubleComplex. String values of arbitrary length are represent by a value of char With arraysize="*"			
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					
Attribute	Definition				
	Value type: Semantic Meanin Occurrences: Comments:	a positive integer: xs:positiveInteger g: The length of the variable-length data type. optional In the context of TAP, this attribute is only meaning when the data type is CHAR or BINARY; see discussion below.			

Fxample

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

<column>

<name> id </name>

<description> the object identifier </description>

<ucd> meta.id </ucd>

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

```
The Complete VOResource Schema
```

```
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"</pre>
           schemaLocation="http://www.ivoa.net/xml/VOResource/v1.0"/>
<xs:import namespace="http://www.ivoa.net/xml/STC/stc-v1.30.xsd"</pre>
           schemaLocation="http://www.ivoa.net/xml/STC/stc-v1.30.xsd"/>
<xs:complexType name="DataCollection">
   <xs:annotation>
      <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:documentation>
        (A dataset is a collection of digitally-encoded data that
        is normally accessible as a single unit, e.g. a file.)
      </xs:documentation>
   </xs:annotation>
   <xs:complexContent>
      <xs:extension base="vr:Resource">
         <xs:sequence>
           <xs:element name="facility" type="vr:ResourceName"</pre>
                       minOccurs="0" maxOccurs="unbounded">
             <xs:annotation>
                <xs:appinfo>
                  <vm:dcterm>Subject</vm:dcterm>
                </xs:appinfo>
                <xs:documentation>
                  the observatory or facility used to collect the data
                  contained or managed by this resource.
                </xs:documentation>
             </xs:annotation>
           </xs:element>
           <xs:element name="instrument" type="vr:ResourceName"</pre>
                       minOccurs="0" maxOccurs="unbounded">
             <xs:annotation>
                <xs:appinfo>
                  <vm:dcterm>Subject</vm:dcterm>
                  <vm:dcterm>Subject.Instrument/vm:dcterm>
                </xs:appinfo>
                <xs:documentation>
                  the Instrument used to collect the data contain or
                  managed by a resource.
                </xs:documentation>
             </xs:annotation>
```

```
</xs:element>
<xs:element name="rights" type="vr:Rights"</pre>
            min0ccurs="0" max0ccurs="unbounded">
   <xs:annotation>
     <xs:appinfo>
       <vm:dcterm>Rights
      </xs:appinfo>
      <xs:documentation>
       Information about rights held in and over the resource.
      </xs:documentation>
      <xs:documentation>
       This should be repeated for all Rights values that apply.
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="format" type="vs:Format"</pre>
            min0ccurs="0" max0ccurs="unbounded">
   <xs:annotation>
      <xs:documentation>
       The physical or digital manifestation of the information
        supported by a resource.
      </xs:documentation>
      <xs:documentation>
       MIME types should be used for network-retrievable, digital
        data. Non-MIME type values are used for media that cannot
        be retrieved over the network--e.g. CDROM, poster, slides,
        video cassette, etc.
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="coverage" type="vs:Coverage" min0ccurs="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" min0ccurs="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" min0ccurs="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:sequence>
                     </xs:extension>
          </xs:complexContent>
</xs:complexType>
<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:sequence>
                     <xs:element ref="stc:STCResourceProfile" min0ccurs="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:documentation>
                                                   In general, this description should be approximate; a
                                                   more precise description can be provided by the
                                                  footprint service.
                                           </xs:documentation>
                                 </xs:annotation>
                      </xs:element>
                     <xs:element name="footprint" type="vs:ServiceReference"</pre>
                                                                 min0ccurs="0">
                                <xs:annotation>
                                           <xs:documentation>
                                                     a reference to a footprint service for retrieving
                                                     precise and up-to-date description of coverage.
                                           </xs:documentation>
                                           <xs:documentation>
                                                      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 refered to may be the % \left( 1\right) =\left( 1\right) \left( 1\right
                                                      current one.
                                           </xs:documentation>
                                </xs:annotation>
                     </xs:element>
                      <xs:element name="waveband" type="vs:Waveband"</pre>
                                                                 minOccurs="0" maxOccurs="unbounded">
                                <xs:annotation>
                                           <xs:appinfo>
                                                   <vm:dcterm>Coverage.Spectral</vm:dcterm>
                                           </xs:appinfo>
                                           <xs:documentation>
                                                      a named spectral region of the electro-magnetic spectrum
                                                      that the resource's spectral coverage overlaps with.
                                           </xs:documentation>
```

```
</xs:annotation>
      </xs:element>
      <xs:element name="regionOfRegard" type="xs:float" minOccurs="0">
         <xs:annotation>
            <xs:appinfo>
              <vm:dcterm>Coverage.RegionOfRegard</vm:dcterm>
            </xs:appinfo>
            <xs:documentation>
               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.
            </xs:documentation>
            <xs:documentation>
               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.
            </xs:documentation>
         </xs:annotation>
      </xs:element>
  </xs:sequence>
</xs:complexType>
<xs:complexType name="ServiceReference">
  <xs:annotation>
      <xs:documentation>
        the service URL for a potentially registerd service. That is,
        if an IVOA identifier is also provided, then the service is
       described in a registry.
     </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
     <xs:extension base="xs:anyURI">
         <xs:attribute name="ivo-id" type="vr:IdentifierURI">
            <xs:annotation>
              <xs:documentation>
                The URI form of the IVOA identifier for the service
                describing the capability refered to by this element.
              </xs:documentation>
            </xs:annotation>
         </xs:attribute>
     </r></xs:extension>
   </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="Waveband">
  <xs:restriction base="xs:token">
     <xs:enumeration value="Radio">
         <xs:annotation>
            <xs:documentation>
              wavelength >= 10 mm; frequency <= 30 GHz.
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="Millimeter">
         <xs:annotation>
            <xs:documentation>
```

```
0.1 mm <= wavelength <= 10 mm;
               3000 \text{ GHz} >= \text{frequency} >= 30 \text{ GHz}.
             </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="Infrared">
         <xs:annotation>
             <xs:documentation>
               1 micron <= wavelength <= 100 micons
             </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="Optical">
         <xs:annotation>
             <xs:documentation>
               0.3 microns <= wavelength <= 1 micon;</pre>
               300 \text{ nm} \leftarrow \text{wavelength} \leftarrow 1000 \text{ nm};
               3000 Angstroms <= wavelength <= 10000 Angstroms
             </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="UV">
         <xs:annotation>
             <xs:documentation>
               0.1 microns <= wavelength <= 0.3 micon;</pre>
               1000 nm <= wavelength <= 3000 nm;
               1000 Angstroms <= wavelength <= 30000 Angstroms
             </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <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;</pre>
               0.12 \text{ keV} \leftarrow \text{energy} \leftarrow 120 \text{ 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"</pre>
```

```
minOccurs="1" maxOccurs="unbounded">
         <xs:annotation>
           <xs:documentation>
             A named description of a set of logically related tables.
           </xs:documentation>
           <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:annotation>
     </xs:element>
  </xs:sequence>
   <xs:anyAttribute namespace="##other" />
</xs:complexType>
<xs:complexType name="TableSchema">
  <xs:annotation>
      <xs:documentation>
       A detailed description of a logically-related set of tables
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="name" type="xs:token" min0ccurs="1" max0ccurs="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" min0ccurs="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>
         </r></xs:annotation>
```

```
</xs:element>
      <xs:element name="description" type="xs:token"</pre>
                  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" min0ccurs="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"</pre>
                 minOccurs="0" maxOccurs="unbounded">
        <xs:annotation>
          <xs:documentation>
           A description of one of the tables that makes up the set.
          </xs:documentation>
          <xs:documentation>
           The table names for the table should be unique.
          </xs:documentation>
        </xs:annotation>
      </xs:element>
   </xs:sequence>
   <xs:anyAttribute namespace="##other" />
</xs:complexType>
<xs:complexType name="Format">
  <xs:simpleContent>
     <xs:extension base="xs:token">
        <xs:attribute name="isMIMEType" type="xs:boolean" default="false">
          <xs:annotation>
            <xs:documentation>
              if true, then the content is a MIME Type
            </xs:documentation>
          </xs:annotation>
        </xs:attribute>
      </xs:extension>
  </xs:simpleContent>
</xs:complexType>
<xs:complexType name="DataService">
  <xs:annotation>
     <xs:documentation>
       A service for accessing astronomical data
     </xs:documentation>
  </xs:annotation>
  <xs:complexContent>
      <xs:extension base="vr:Service">
         <xs:sequence>
```

```
<xs:element name="facility" type="vr:ResourceName"</pre>
                       minOccurs="0" maxOccurs="unbounded">
             <xs:annotation>
                <xs:appinfo>
                  <vm:dcterm>Subject</vm:dcterm>
                </xs:appinfo>
                <xs:documentation>
                  the observatory or facility used to collect the data
                  contained or managed by this resource.
                </xs:documentation>
             </xs:annotation>
           </xs:element>
           <xs:element name="instrument" type="vr:ResourceName"</pre>
                       minOccurs="0" maxOccurs="unbounded">
             <xs:annotation>
                <xs:appinfo>
                  <vm:dcterm>Subject</vm:dcterm>
                  <vm:dcterm>Subject.Instrument
                </xs:appinfo>
                <xs:documentation>
                  the Instrument used to collect the data contain or
                  managed by a resource.
                </xs:documentation>
             </xs:annotation>
           </xs:element>
           <xs:element name="coverage" type="vs:Coverage" min0ccurs="0">
             <xs:annotation>
                <xs:documentation>
                  Extent of the content of the resource over space, time,
                  and frequency.
                </xs:documentation>
             </xs:annotation>
           </xs:element>
         </xs:sequence>
      </xs:extension>
   </xs:complexContent>
</xs:complexType>
<xs:complexType name="ParamHTTP">
  <xs:annotation>
     <xs:documentation>
        A service invoked via an HTTP Query (either Get or Post)
       with a set of arguments consisting of keyword name-value pairs.
     </xs:documentation>
     <xs:documentation>
        Note that the URL for help with this service can be put into
        the Service/ReferenceURL element.
     </xs:documentation>
   </xs:annotation>
   <xs:complexContent>
     <xs:extension base="vr:Interface">
         <xs:sequence>
            <xs:element name="queryType" type="vs:HTTPQueryType"</pre>
                        min0ccurs="0" max0ccurs="2">
               <xs:annotation>
                  <xs:documentation>
                    The type of HTTP request, either GET or POST.
                  </xs:documentation>
                  <xs:documentation>
                    The service may indicate support for both GET
                    and POST by providing 2 queryType elements, one
                    with GET and one with POST.
```

```
</xs:documentation>
               </xs:annotation>
            </xs:element>
            <xs:element name="resultType" type="xs:token"</pre>
                        min0ccurs="0" max0ccurs="1">
               <xs:annotation>
                  <xs:documentation>
                    The MIME type of a document returned in the HTTP response.
                  </xs:documentation>
               </xs:annotation>
            </xs:element>
            <xs:element name="param" type="vs:InputParam" min0ccurs="0"</pre>
                         max0ccurs="unbounded">
               <xs:annotation>
                 <xs:documentation>
                    a description of a input parameter that can be
                    provided as a name=value argument to the service.
                 </xs:documentation>
               </xs:annotation>
            </xs:element>
            <xs:element name="testQuery" type="xs:string" min0ccurs="0"</pre>
                        max0ccurs="unbounded">
               <xs:annotation>
                 <xs:documentation>
                    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.
                 </xs:documentation>
                 <xs:documentation>
                    When then interface supports GET, then the full
                    query URL is formed by the concatonation of the
                    base URL (given by the accessURL) and the value
                    given by this testQuery element.
                 </xs:documentation>
               </xs:annotation>
            </xs:element>
         </xs:sequence>
      </xs:extension>
   </xs:complexContent>
</xs:complexType>
<xs:simpleType name="HTTPQueryType">
   <xs:annotation>
      <xs:documentation>
       The type of HTTP request, either GET or POST.
      </xs:documentation>
   </xs:annotation>
   <xs:restriction base="xs:token">
      <xs:enumeration value="GET"/>
      <xs:enumeration value="POST"/>
   </xs:restriction>
</xs:simpleType>
<xs:complexType name="CatalogService">
   <xs:annotation>
      <xs:documentation>
         A service that interacts with with astronomical data
         through one or more specified tables.
      </xs:documentation>
      <xs:documentation>
         A table with sky coverage typically have columns that give
```

```
longitude-latitude positions in some coordinate system.
      </xs:documentation>
   </xs:annotation>
   <xs:complexContent>
      <xs:extension base="vs:DataService">
         <xs:sequence>
            <xs:element name="tableset" type="vs:TableSet" min0ccurs="0">
               <xs:annotation>
                  <xs:documentation>
                    A description of the tables that are accessible
                    through this service.
                  </xs:documentation>
                  <xs:documentation>
                    Each schema name and each table name must be
                    unique within this tableset.
                  </xs:documentation>
               </xs:annotation>
              <xs:unique name="CatalogService-schemaName">
                 <xs:selector xpath="schema" />
                 <xs:field xpath="name" />
              </xs:unique>
              <xs:unique name="CatalogService-tableName">
                 <xs:selector xpath="schema/table" />
                 <xs:field xpath="name" />
              </xs:unique>
            </xs:element>
         </xs:sequence>
      </xs:extension>
   </xs:complexContent>
</xs:complexType>
<xs:complexType name="Table">
  <xs:sequence>
      <xs:element name="name" type="xs:token"</pre>
                  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>
      </r></r></r>
      <xs:element name="title" type="xs:token" min0ccurs="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>
      </r></r></r>
```

```
<xs:element name="description" type="xs:token" min0ccurs="0">
         <xs:annotation>
            <xs:documentation>
               a free-text description of the table's contents
            </xs:documentation>
         </xs:annotation>
      </r></r></r>
      <xs:element name="utype" type="xs:token" min0ccurs="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"</pre>
                  minOccurs="0" maxOccurs="unbounded">
         <xs:annotation>
            <xs:documentation>
               a description of a table column.
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="foreignKey" type="vs:ForeignKey"</pre>
                  min0ccurs="0" max0ccurs="unbounded" >
         <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:sequence>
   <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:documentation>
     As the parameter's data type is usually important, schemas
     normally employ a sub-class of this type (e.g. Param),
     rather than this type directly.
  </xs:documentation>
</xs:annotation>
<xs:sequence>
  <xs:element name="name" type="xs:token" min0ccurs="0">
     <xs:annotation>
         <xs:documentation>
           the name of the column
         </xs:documentation>
     </xs:annotation>
  </xs:element>
   <xs:element name="description" type="xs:token" min0ccurs="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" min0ccurs="0">
     <xs:annotation>
        <xs:documentation>
            the unit associated with all values in the column
         </xs:documentation>
     </xs:annotation>
  </xs:element>
  <xs:element name="ucd" type="xs:token" min0ccurs="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" min0ccurs="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:sequence>
<xs:anyAttribute namespace="##other" />
```

```
</xs:complexType>
<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"</pre>
                        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"</pre>
                        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:documentation>
                     See the specification document for definitions
                     of recognized keywords.
                  </xs:documentation>
               </xs:annotation>
            </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:extension>
   </xs:complexContent>
</xs:complexType>
<xs:complexType name="InputParam">
   <xs:annotation>
     <xs:documentation>
         a description of a service or function parameter having a
         fixed data type.
      </xs:documentation>
      <xs:documentation>
         The allowed data type names do not imply a size or precise
         format. This type is intended to be sufficient for describing
         an input parameter to a simple REST service or a function
         written in a weakly-typed (e.g., scripting) language.
```

```
</xs:documentation>
   </xs:annotation>
  <xs:complexContent>
      <xs:extension base="vs:BaseParam">
            <xs:element name="dataType" type="vs:SimpleDataType"</pre>
                        min0ccurs="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>
               <xs:documentation>
                  An indication of whether this parameter is
                  required to be provided for the application
                  or service to work properly.
               </xs:documentation>
               <xs:documentation>
                  Allowed values are "required" and "optional".
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
         <xs:attribute name="std" type="xs:boolean" default="true">
            <xs:annotation>
               <xs:documentation>
                  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:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:extension>
  </xs:complexContent>
</xs:complexType>
<xs:simpleType name="ParamUse">
   <xs:restriction base="xs:string">
     <xs:enumeration value="required">
         <xs:annotation>
            <xs:documentation>
               the parameter is required for the application or
               service to work properly.
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="optional">
         <xs:annotation>
            <xs:documentation>
               the parameter is optional but supported by the application or
               service.
            </xs:documentation>
         </xs:annotation>
     </xs:enumeration>
      <xs:enumeration value="ignored">
         <xs:annotation>
            <xs:documentation>
```

```
the parameter is not supported and thus is ignored by the
               application or service.
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
   </xs:restriction>
</xs:simpleType>
<xs:complexType name="DataType">
  <xs:annotation>
     <xs:documentation>
         a type (in the computer language sense) associated with a
         parameter with an arbitrary name
      </xs:documentation>
      <xs:documentation>
         This XML type is used as a parent for defining data types
         with a restricted set of names.
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
     <xs:extension base="xs:token">
         <xs:attribute name="arraysize" type="vs:ArrayShape" default="1">
            <xs:annotation>
               <xs:documentation>
                  the shape of the array that constitutes the value
               </xs:documentation>
               <xs:documentation>
                  the default is "1"; i.e. the value is a scalar.
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
         <xs:attribute name="delim" type="xs:string" default=" ">
            <xs:annotation>
               <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:annotation>
         </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.
                  string is a recommended default type.
               </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>
      <xs:documentation>
         An expression of a the shape of a multi-dimensional array
         of the form LxNxM... 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:documentation>
  </xs:annotation>
  <xs:restriction base="xs:token">
   <xs:pattern value="([0-9]+x)*[0-9]*[*]?"/>
  </xs:restriction>
</xs:simpleType>
<xs:complexType name="SimpleDataType">
   <xs:annotation>
      <xs:documentation>
         a data type restricted to a small set of names which is
         imprecise as to the format of the individual values.
     </xs:documentation>
      <xs:documentation>
         This set is intended for describing simple input parameters to
         a service or function.
     </xs:documentation>
  </xs:annotation>
   <xs:simpleContent>
    <xs:restriction base="vs:DataType">
        <xs:enumeration value="integer"/>
        <xs:enumeration value="real"/>
        <xs:enumeration value="complex"/>
       <xs:enumeration value="boolean"/>
       <xs:enumeration value="char"/>
        <xs:enumeration value="string"/>
        <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:restriction>
   </xs:simpleContent>
</xs:complexType>
<xs:complexType name="TableDataType" abstract="true">
  <xs:annotation>
     <xs:documentation>
         an abstract parent for a class of data types that can be
         used to specify the data type of a table column.
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
     <xs:extension base="vs:DataType"/>
   </xs:simpleContent>
</xs:complexType>
<xs:complexType name="V0TableType">
  <xs:annotation>
     <xs:documentation>
        a data type supported explicitly by the VOTable format
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
     <xs:restriction base="vs:TableDataType">
       <xs:enumeration value="boolean"/>
        <xs:enumeration value="bit"/>
       <xs:enumeration value="unsignedByte"/>
       <xs:enumeration value="short"/>
       <xs:enumeration value="int"/>
        <xs:enumeration value="long"/>
       <xs:enumeration value="char"/>
       <xs:enumeration value="unicodeChar"/>
        <xs:enumeration value="float"/>
        <xs:enumeration value="double"/>
        <xs:enumeration value="floatComplex"/>
        <xs:enumeration value="doubleComplex"/>
        <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:restriction>
   </xs:simpleContent>
</xs:complexType>
<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: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:annotation>
        </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:enumeration value="REGION"/>
        <xs:enumeration value="CLOB"/>
        <xs:enumeration value="BLOB"/>
        <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:attribute name="size" type="xs:positiveInteger"/>
        <xs:anyAttribute namespace="##other" />
     </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 descripiton. 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"</pre>
                        type="stc:stcDescriptionType"
                        min0ccurs="1" max0ccurs="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>
<xs:complexType name="ForeignKey">
   <xs:annotation>
      <xs:documentation>
        A description of the mapping a foreign key--a set of
        columns from one table--to columns in another table.
      </xs:documentation>
      <xs:documentation>
        This definition that the foreign key is being described
        within the context of the table containing the key.
      </xs:documentation>
  </xs:annotation>
   <xs:sequence>
      <xs:element name="targetTable" type="xs:token">
        <xs:annotation>
          <xs:documentation>
            the fully-qualified name (including catalog and schema, as
            applicable) of the table that can be joined with the
            table containing this foreign key.
          </xs:documentation>
        </xs:annotation>
      </xs:element>
      <xs:element name="fkColumn" type="vs:FKColumn"</pre>
                  min0ccurs="1" max0ccurs="unbounded">
        <xs:annotation>
          <xs:documentation>
            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.
          </xs:documentation>
        </xs:annotation>
      </xs:element>
      <xs:element name="description" type="xs:token" min0ccurs="0">
         <xs:annotation>
            <xs:documentation>
```

```
a free-text description of what this key points to
                  and what the relationship means.
               </xs:documentation>
            </xs:annotation>
         </xs:element>
         <xs:element name="utype" type="xs:token" min0ccurs="0">
            <xs:annotation>
               <xs:documentation>
                  an identifier for a concept in a data model that
                  the association enabled by this key represents.
               </xs:documentation>
               <xs:documentation>
                  The format defined in the VOTable standard is highly
                  recommended.
               </xs:documentation>
            </xs:annotation>
         </xs:element>
      </xs:sequence>
  </xs:complexType>
  <xs:complexType name="FKColumn">
     <xs:annotation>
        <xs:documentation>
          A pair of columns that are used to join two tables.
         </xs:documentation>
         <xs:documentation>
          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
          to the value in the second column.
         </xs:documentation>
         <xs:documentation>
          This type assumes that it is used in the context of
           implied source (i.e., current) and target tables, as in
           the ForeignKey type's fkColumn.
         </xs:documentation>
      </xs:annotation>
      <xs:sequence>
        <xs:element name="fromColumn" type="xs:token">
           <xs:annotation>
             <xs:documentation>
              The unqualified name of the column from the current table.
             </xs:documentation>
          </xs:annotation>
         </xs:element>
         <xs:element name="targetColumn" type="xs:token">
           <xs:annotation>
             <xs:documentation>
               The unqualified name of the column from the target table.
             </xs:documentation>
           </xs:annotation>
         </xs:element>
      </xs:sequence>
  </xs:complexType>
</xs:schema>
```

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 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 . Consequently, a 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-20100916:

- updated status for elevation to Recommendation.
- cleaned-up mis-labeled and mis-ordered change history.

Changes since PR-20100914:

- added change history for PR-20100412.
- added Note about STC mark-up in 3.2
- reworded sentence describing content of vs:DataType in section 3.5.

Changes since PR-20100412:

- fix numerous typos discovered in TCG review
- added section 1.1 to describe role of standard in the VO architecture, including diagram.
- corrected frequency range for the UV waveband
- corrected links to reference documents

Changes since PR-20090903:

- <u>\$3.4</u>: added <:testQuery> to vs:ParamHTTP
- <u>\$3.1.1</u>: 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.

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