BEL Framework V1.2
Web API Users Guide

Table of Contents

Introduction

This document will help you get started using the BEL Framework V1.2 Web API. The BEL Framework Web API is a SOAP 1.1 based Web Service API that enables remote client applications access Knowledge Assembly Models (KAMs) and services on hosted versions of the BEL Framework. This User Guide is targeted at computer programmers who wish to write computer programs to access the BEL Framework services.

This document describes the BEL Framework V1.2 Web API and is not intended to be an introduction to SOAP, computer programming, or the BEL Framework.

Version Changes

Updated for BEL Framework Release 1.2.3.

Getting Started

This section provides the basic information necessary to access and use the BEL Framework V1.2 Web API.

Prerequisites

In order to use the Web API you must have access to a computer running the Web API services. The Web API services are bundled with the BEL Framework distribution and must be started. See the *BEL Framework V1.2 Getting Started Guide* to learn how to start the Web Services bundled with the BEL Framework V1.2 distribution.

Additionally you must be able to access the remote service endpoints over the Internet from the computer you are working on and be able to write computer programs that can access the Web Services API and share information with the client.

SOAP 1.1

The Simple Object Access Protocol (SOAP) is a W3C standard protocol specification for exchanging information between two geographically separated computers using Extensible Markup Language (XML) as the message body and relying on other network protocols such as HTTP(s) as the for message transmission.

For more information about the SOAP specification see

http://www.w3.org/TR/2000/NOTE-SOAP-20000508/

In order to effectively use the GTP Web Services API you should be familiar with the basic use of SOAP-based remote services

BEL Framework Web API Endpoint

SOAP services are available at service endpoints. Like most SOAP-based APIs the BEL Framework V1.2 Web API provides a Web Service Description Language (WSDL) document describing the entities, services, service endpoints, and allowable transport mechanisms available. More information about the WSDL 1.1 specification is available at:

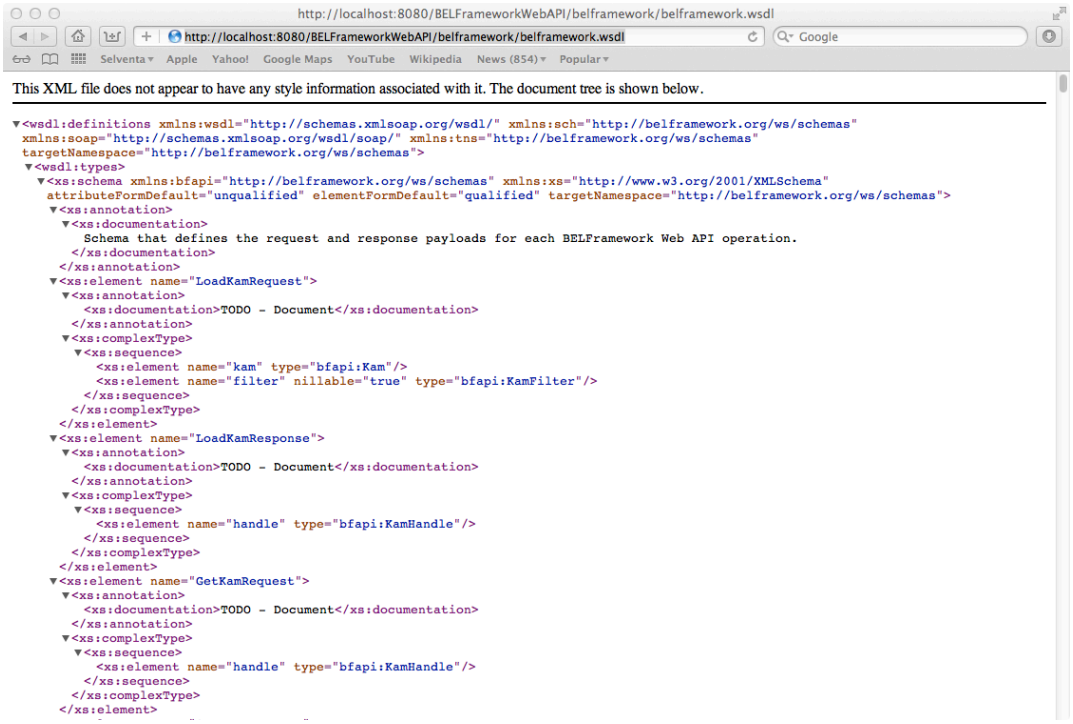
http://www.w3.org/TR/wsdl

WSDL documents are designed to be consumed by computer applications that can translate the document into a set of services (methods) on the remote server that can be accessed, and entities (objects) that can be passed between the client and the server.

The actual location of the BEL Framework endpoint will depend on how the service is configured on your network. Using the Web Service bundled with the BEL Framework, the WSDL is available at the following URL:

http://localhost:8080/BELFrameworkWebAPI/belframework/belframework.wsdl

where *localhost* is the network address of the server and 8080 is the port the service is running at. Accessing the URL with a Web Browser will display the BEL Framework Web API WSDL.



Supported Programming Languages

Most modern computer programming languages support the development of SOAP clients using native extensions or third-party plugins. The BEL Framework Web API has been tested using Java 1.6, Perl, Python (SUDS), and Ruby 1.8.7 (Savon).

Client Library

As part of the BEL Framework V1.2 Web API, Selventa provides a Java library that wraps the SOAP client and provides access to the services without needing to know the details of the networking, encoding, and implementations. Using the client library, mathematical modeling platforms such as R and MATLAB that can load and use a Java library can directly access the Services. The client library has been tested using R 2.13 and MATLAB 2005a.

Web API Entities

BEL Framework V1.2 Web API Entities provide the objects that are transferred between the client and the remote Web API service.

Entities are one of two types, complex entities that correspond to an object type associated with a KAM such as a KamEdge, BEL Statement, or BEL Document, and simple entities which correspond to an enumerated type, such as list of Kam relationship types.

Simple Types

Simple Types are enumerations specifying the allowable domain of a parameter used in a method call or used to describe a specific characteristic of an object.

AnnotationDefinitionType

Describes the type of annotation associated with a BEL Statement. Values are:

ENUMERATION – The annotation uses an enumerated list of allowable values.

REGULAR_EXPRESSION – The annotation uses a regular expression to define the domain of allowable values.

URL – The annotation uses a pre-defined list of allowable values. The list is defined using a Annotation file referenced by a URL.

Entity Definition

```
<xs:simpleType name="AnnotationDefinitionType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="ENUMERATION" />
        <xs:enumeration value="REGULAR_EXPRESSION" />
        <xs:enumeration value="URL" />
    </xs:restriction>
</xs:simpleType>
```

CitationType

Describes the type of reference that a citation was drawn from. Values are:

BOOK – The citation was drawn from a Book.

JOURNAL – The citation was drawn from a Journal other than a PubMed.

ONLINE_RESOURCE – The citation was drawn from an online resource such as Wikipedia or other generally accessible source.

PUBMED – The citation was drawn from a PubMed article.

OTHER – The citation was drawn from some other source.

Entity Definition

```
<xs:simpleType name="CitationType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="BOOK" />
        <xs:enumeration value="JOURNAL" />
        <xs:enumeration value="ONLINE_RESOURCE" />
        <xs:enumeration value="PUBMED" />
        <xs:enumeration value="OTHER" />
    </xs:restriction>
</xs:simpleType>
```

EdgeDirectionType

Identifies the direction in which an edge can be traversed. Values are:

FORWARD – The edge can be traversed in a forward (source to target) direction.

REVERSE – The edge can be traversed in a reverse (target to source) direction.

BOTH – The edge can be traversed in both a forward or reverse direction.

Entity Definition

```
<xs:simpleType name="EdgeDirectionType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="FORWARD" />
        <xs:enumeration value="REVERSE" />
        <xs:enumeration value="BOTH" />
    </xs:restriction>
</xs:simpleType>
```

FunctionReturnType
Identifies the type of abundance or biological process that is expressed by a KamNode. This is generally the type of entity that the outer-most function of the BEL Term(s) that are used to create the KamNode returns. Values are:

ABUNDANCE – The KamNode expresses a general abundance.

PROTEIN_ABUNDANCE – The KamNode expresses a protein abundance.

GENE_ABUNDANCE – The KamNode m expresses a gene abundance.

MICRORNA_ABUNDANCE – The KamNode expresses a micro RNA abundance.

RNA_ABUNDANCE – The KamNode expresses a RNA abundance.

PATHOLOGY – The KamNode expresses a pathology.

COMPLEX_ABUNDANCE – The KamNode expresses a complex abundance.

COMPOSITE_ABUNDANCE – The KamNode expresses a composite abundance.

Entity Definition

```
<xs:simpleType name="FunctionReturnType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="ABUNDANCE" />
        <xs:enumeration value="PROTEIN_ABUNDANCE" />
        <xs:enumeration value="GENE_ABUNDANCE" />
        <xs:enumeration value="MICRORNA_ABUNDANCE" />
        <xs:enumeration value="RNA_ABUNDANCE" />
        <xs:enumeration value="BIOLOGICAL_PROCESS" />
        <xs:enumeration value="PATHOLOGY" />
        <xs:enumeration value="COMPLEX_ABUNDANCE" />
        <xs:enumeration value="COMPOSITE_ABUNDANCE" />
    </xs:restriction>
</xs:simpleType>
```

FunctionType
Describes the function type of a BEL Term used to define a KamNode. Refer to the *Biological Expression Language V1.0 Guide* for a complete description of each BEL function type.

Entity Definition

```
<xs:simpleType name="FunctionType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="ABUNDANCE" />
        <xs:enumeration value="BIOLOGICAL_PROCESS" />
        <xs:enumeration value="CATALYTIC_ACTIVITY" />
        <xs:enumeration value="CELL_SECRETION" />
        <xs:enumeration value="CELL_SURFACE_EXPRESSION" />
        <xs:enumeration value="CHAPERONE_ACTIVITY" />
        <xs:enumeration value="COMPLEX_ABUNDANCE" />
        <xs:enumeration value="COMPOSITE_ABUNDANCE" />
        <xs:enumeration value="DEGRADATION" />
        <xs:enumeration value="FUSION" />
        <xs:enumeration value="GENE_ABUNDANCE" />
        <xs:enumeration value="GTP_BOUND_ACTIVITY" />
        <xs:enumeration value="KINASE_ACTIVITY" />
        <xs:enumeration value="LIST" />
        <xs:enumeration value="MICRORNA_ABUNDANCE" />
```

```
            <xs:enumeration value="MOLECULAR_ACTIVITY" />
            <xs:enumeration value="PATHOLOGY" />
            <xs:enumeration value="PEPTIDASE_ACTIVITY" />
            <xs:enumeration value="PHOSPHATASE_ACTIVITY" />
            <xs:enumeration value="PRODUCTS" />
            <xs:enumeration value="PROTEIN_ABUNDANCE" />
            <xs:enumeration value="PROTEIN_MODIFICATION" />
            <xs:enumeration value="REACTANTS" />
            <xs:enumeration value="REACTION" />
            <xs:enumeration value="RIBOSYLATION_ACTIVITY" />
            <xs:enumeration value="RNA_ABUNDANCE" />
            <xs:enumeration value="SUBSTITUTION" />
            <xs:enumeration value="TRANSCRIPTIONAL_ACTIVITY" />
            <xs:enumeration value="TRANSLOCATION" />
            <xs:enumeration value="TRANSPORT_ACTIVITY" />
            <xs:enumeration value="TRUNCATION" />
        </xs:restriction>
    </xs:simpleType>
```

KAMLoadStatus
Describes the current status of a KAM loading process. Values are:

IN_PROCESS – A request to load a specific KAM has been received but loading has not yet completed.

FAILED – A request to load a KAM failed.

COMPLETE – A request to load a KAM has been completed.

Entity Definition

```
    <xs:simpleType name="KAMLoadStatus">
        <xs:restriction base="xs:string">
            <xs:enumeration value="IN_PROCESS" />
            <xs:enumeration value="FAILED" />
            <xs:enumeration value="COMPLETE" />
        </xs:restriction>
    </xs:simpleType>
```

RelationshipType
Describes a type of relationship for a KAM Edge. Refer to the *Biological Expression Language V1.0 Guide* for a complete description of each BEL relationship type.

Entity Definition

```
    <xs:simpleType name="RelationshipType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="ACTS_IN" />
            <xs:enumeration value="ANALOGOUS" />
            <xs:enumeration value="ASSOCIATION" />
            <xs:enumeration value="BIOMARKER_FOR" />
            <xs:enumeration value="CAUSES_NO_CHANGE" />
            <xs:enumeration value="DECREASES" />
            <xs:enumeration value="DIRECTLY_DECREASES" />
            <xs:enumeration value="DIRECTLY_INCREASES" />
            <xs:enumeration value="HAS_COMPONENT" />
            <xs:enumeration value="HAS_COMPONENTS" />
            <xs:enumeration value="HAS_MEMBER" />
            <xs:enumeration value="HAS_MEMBERS" />
            <xs:enumeration value="HAS_MODIFICATION" />
            <xs:enumeration value="HAS_PRODUCT" />
            <xs:enumeration value="HAS_VARIANT" />
            <xs:enumeration value="INCLUDES" />
            <xs:enumeration value="INCREASES" />
            <xs:enumeration value="IS_A" />
            <xs:enumeration value="NEGATIVE_CORRELATION" />
            <xs:enumeration value="ORTHOLOGOUS" />
            <xs:enumeration value="POSITIVE_CORRELATION" />
            <xs:enumeration value="PROGNOSTIC_BIOMARKER_FOR" />
            <xs:enumeration value="RATE_LIMITING_STEP_OF" />
```

```
            <xs:enumeration value="REACTANT_IN" />
            <xs:enumeration value="SUB_PROCESS_OF" />
            <xs:enumeration value="TRANSCRIBED_TO" />
            <xs:enumeration value="TRANSLATED_TO" />
            <xs:enumeration value="TRANSLOCATES" />
        </xs:restriction>
    </xs:simpleType>
```

KamStore Complex Types

These entities represent objects associated with the BEL Framework KamStore.

Annotation

An Annotation represents an annotation associated with a BEL Statement such as a tissue type or species. Each annotation is defined by an AnnotationType and has a value within the domain of values defined by the AnnotationType object.

The Annotation entity has the following properties:

id – The unique Id for the annotation associated with the KAM being referenced.

annotationType – The AnnotationType object for the annotation.

value – The value for the annotation such as the specific species Id or tissue type.

Entity Definition

```
    <xs:complexType name="Annotation">
        <xs:sequence>
            <xs:element name="id" type="xs:string" />
            <xs:element name="annotationType" type="bfapi:AnnotationType" />
            <xs:element name="value" type="xs:string" />
        </xs:sequence>
    </xs:complexType>
```

AnnotationType

An AnnotationType describes a type of annotation that has been applied to a BEL Statement such as a Tissue or Species reference.

The AnnotationType entity has the following properties:

id – The unique Id for the AnnotationType associated with the KAM being referenced.

name – A unique name for the AnnotationType.

description – An optional description for AnnotationType.

usage – An optional string which describes how the AnnotationType domain is defined. This information can be used to construct filters for filtering BEL Statements based on their Annotation values.

annotationDefinitionType – An AnnotationDefinitionType object that describes how the domain of allowable values is defined.

Entity Definition

```
    <xs:complexType name="AnnotationType">
        <xs:sequence>
            <xs:element name="id" type="xs:string" />
            <xs:element name="name" type="xs:string" />
            <xs:element name="description" type="xs:string" minOccurs="0" />
            <xs:element name="usage" type="xs:string" minOccurs="0" />
            <xs:element name="annotationDefinitionType"
type="bfapi:AnnotationDefinitionType" />
        </xs:sequence>
    </xs:complexType>
```

BelDocument
A BelDocument object describes one of the input BelDocuments used to compile the KAM. The information in the BelDocument object is drawn from the header information in the original BEL Document.

The BelDocument entity has the following properties:

id – The unique Id for the BelDocument associated with the KAM.

name – The name of the BelDocument.

description – An optional description for the BelDocument. This will be empty of the original document did not contain a description field.

version – An optional version number for the BelDocument. This will be empty of the original document did not contain a version field.

copyright – An optional copyright string for the BelDocument. This will be empty of the original document did not contain a copyright field.

disclaimer – An optional disclaimer string for the BelDocument. This will be empty of the original document did not contain a disclaimer field.

contactnfo – An optional string containing contact information for the BelDocument. This will be empty of the original document did not contain a contactInfo field.

licenseInfo – An optional license string for the BelDocument. This will be empty of the original document did not contain a licenseInfo field.

authors – An optional list of author names for the BelDocument. This list will be empty of the original document did not contain a list of authors.

annotationTypes – A list of AnnotationType objects defined within the BelDocument.

namespaces – A list of Namespace objects defined within the BelDocument.

Entity Definition

```
    <xs:complexType name="BelDocument">
        <xs:sequence>
            <xs:element name="id" type="xs:string" />
            <xs:element name="name" type="xs:string" />
            <xs:element name="description" type="xs:string" minOccurs="0" />
            <xs:element name="version" type="xs:string" minOccurs="0" />
            <xs:element name="copyright" type="xs:string" minOccurs="0" />
            <xs:element name="disclaimer" type="xs:string" minOccurs="0" />
            <xs:element name="contactInfo" type="xs:string" minOccurs="0" />
            <xs:element name="licenseInfo" type="xs:string" minOccurs="0" />
            <xs:element name="authors" type="xs:string" minOccurs="0"
maxOccurs="unbounded" />
            <xs:element name="annotationTypes" type="bfapi:AnnotationType"
nillable="true" minOccurs="0" maxOccurs="unbounded" />
            <xs:element name="namespaces" type="bfapi:Namespace" nillable="true"
minOccurs="0" maxOccurs="unbounded" />
        </xs:sequence>
    </xs:complexType>
```

BelStatement
A BelStatement represents a BelStatement that was used to create an edge in the KAM.

The BelStatement entity has the following properties:

id – The unique Id for the BelStatement associated with the KAM.

subjectTerm – A BelTerm object for the subject of the statement.

relationship – A RelationshipType object describing the type of relationship between the subject and object.

objectTerm – A BelTerm object describing the object of the BelStatement. This value will be null if the object is a nested BelStatement.

objectStatement – A BelStatement object describing the object of the BelStatement. This value will be null if the BelStatemetn is not a nested statement and the object is therefore a BelTerm.

citation – A Citation object describing the source that the BelStatement was derived from.

document – A BelDocument object describing the BelDocument that the BelStatement was compiled from.

Entity Definition

```
    <xs:complexType name="BelStatement">
        <xs:sequence>
            <xs:element name="id" type="xs:string" />
            <xs:element name="subjectTerm" type="bfapi:BelTerm" />
            <xs:element name="relationship" type="bfapi:RelationshipType"
minOccurs="0" />
            <xs:element name="objectTerm" type="bfapi:BelTerm" minOccurs="0" />
            <xs:element name="objectStatement" type="bfapi:BelStatement" minOccurs="0"
/>
            <xs:element name="annotations" type="bfapi:Annotation" minOccurs="0"
maxOccurs="unbounded" />
            <xs:element name="citation" type="bfapi:Citation" minOccurs="0" />
            <xs:element name="document" type="bfapi:BelDocument" />
        </xs:sequence>
    </xs:complexType>
```

BelTerm
A BelTerm represents the subject or object of a BelStatement that was used to create a KamNode in the KAM.

The BelTerm entity has the following properties:

id – The unique Id for the BelTerm associated with the KAM.

label – A string describing the BelTerm in BEL syntax.

Entity Definition

```
    <xs:complexType name="BelTerm">
        <xs:sequence>
            <xs:element name="id" type="xs:string" />
            <xs:element name="label" type="xs:string" />
        </xs:sequence>
    </xs:complexType>
```

Citation
A Citation represents the source of one or more BelStatement associated with the Kam.

The Citation entity has the following properties:

id – The unique Id for the Citation associated with the Kam.

name – The given name for the Citation. This will generally be the title of the journal article, book or reference for the citation.

citationType – A CitationType object describing the type of the citation.

comment – An optional string providing additional information for the citation.

publicationDate – The date that the article was published.

authors – An optional list of author names for the Citation. This list will be empty of the original citation did not contain a list of authors.

Entity Definition

```
    <xs:complexType name="Citation">
        <xs:sequence>
            <xs:element name="id" type="xs:string" />
            <xs:element name="name" type="xs:string" />
            <xs:element name="citationType" type="bfapi:CitationType" />
            <xs:element name="comment" type="xs:string" minOccurs="0" />
            <xs:element name="publicationDate" type="xs:dateTime" minOccurs="0" />
            <xs:element name="authors" type="xs:string" minOccurs="0"
maxOccurs="unbounded" />
        </xs:sequence>
    </xs:complexType>
```

Edge

An Edge object represents an abstract concept of a directed edge in a BEL-centric network that could be used by any network based structure such as a pathway, model, or Kam.

The Edge entity has the following properties:

id – A unique Id for the edge. This Id will be defined with respect to its use.

source – A Node object describing the source (origin) of the edge.

relationship – A RelationshipType object describing the type of relationship between the source node and target node.

target – A Node object describing the target (destination) of the edge.

Entity Definition

```
    <xs:complexType name="Edge">
        <xs:sequence>
            <xs:element name="id" type="xs:string" minOccurs="0" />
            <xs:element name="source" type="bfapi:Node" />
            <xs:element name="relationship" type="bfapi:RelationshipType" />
            <xs:element name="target" type="bfapi:Node" />
        </xs:sequence>
    </xs:complexType>
```

KamEdge

A KamEdge represents an edge in a Kam. Each KamEdge is an Edge where the source and target objects are KamNodes and the id identifies a unique KamEdge in the Kam.

KamHandle

A KamHandle provides a reference to a Kam object that has been loaded on the server. KamHandles are returned from the server when a Kam has been loaded and are used to identify a specific Kam that can be used to perform operations against.

The KamHandle entity has the following properties:

handle – The unique handle for the loaded Kam.

Entity Definition

```
    <xs:complexType name="KamHandle">
        <xs:sequence>
            <xs:element name="handle" type="xs:string" />
        </xs:sequence>
    </xs:complexType>
```

Node

A Node object represents an abstract concept of a node in a BEL-centric network that could be used by any network based structure such as a pathway, model, or Kam.

The Node entity has the following properties:

id – A unique Id for the node. This Id will be defined with respect to its use.

label – A string describing the node.

function – A FunctionType associated with the Node.

Entity Definition

```
<xs:complexType name="Node">
    <xs:sequence>
        <xs:element name="id" type="xs:string" minOccurs="0" />
        <xs:element name="label" type="xs:string" />
        <xs:element name="function" type="bfapi:FunctionType" />
    </xs:sequence>
</xs:complexType>
```

KamNode
A KamNode represents a specific node in a KAM. Each KamNode is an Node where the id identifies a unique KamNode in the Kam.

Kam
A Kam represents a KAM that has been compiled and is accessible via the KamSore. Kams are graphs composed of lists of KamNodes and KamEdges.

The Kam entity has the following properties:

id – A unique Id for the Kam.

name – A logical name for the Kam.

description – A description for the Kam.

lastCompiled – The date and time that the Kam was compiled.

Entity Definition

```
<xs:complexType name="Kam">
    <xs:sequence>
        <xs:element name="id" type="xs:string" />
        <xs:element name="name" type="xs:string" />
        <xs:element name="description" type="xs:string" />
        <xs:element name="lastCompiled" type="xs:dateTime" />
    </xs:sequence>
</xs:complexType>
```

Namespace
A Namespace object describes a Namespace that was use to define one or more BelTerms in a BEL Document.

The Namepsace entity has the following properties:

id – The unique Id for the Namespace in the Kam.

prefix – A string prefix for the Namespace.

resourceLocation – A string describing the location of the Namespace values. This is usually a URL.

Entity Definition

```
<xs:complexType name="Namespace">
    <xs:sequence>
        <xs:element name="id" type="xs:string" />
        <xs:element name="prefix" type="xs:string" />
        <xs:element name="resourceLocation" type="xs:string" />
    </xs:sequence>
</xs:complexType>
```

NamespaceValue
A NamespaceValue is used to associate a domain value with a Namespace object.

The NamespaceValue entity has the following properties:

namespace – A Namespace object.

value – A string identifying a domain value within the Namespace.

Entity Definition

```
    <xs:complexType name="NamespaceValue">
        <xs:sequence>
            <xs:element name="namespace" type="bfapi:Namespace" />
            <xs:element name="value" type="xs:string" />
        </xs:sequence>
    </xs:complexType>
```

Searching/Filtering Complex Types

These entities represent objects that can be used to search for and filter objects when querying a Kam or KamStore.

FilterCriteria
An abstract concept of a filter criteria. All FitlerCriteria types are derived from the filter type.

The AnnotationFilterCriteria entity has the following properties:

isInclude – A Boolean value determining if a specific filter should be used to include matches or exclude matches. The default is to include if not specified.

Entity Definition

```
    <xs:complexType name="FilterCriteria">
        <xs:attribute name="isInclude" type="xs:boolean" use="optional" default="true"
/>
    </xs:complexType>
```

AnnotationFilterCriteria
A type of FilterCriteria object that is used to filter Annotation objects by their AnnotationType.

The AnnotationFilterCriteria entity has the following properties:

annotationType – An AnnotationType object identifying the type of Annotation to filter.

valueSet – A list of string values defining allowable values to return.

Entity Definition

```
    <xs:complexType name="AnnotationFilterCriteria">
        <xs:complexContent>
            <xs:extension base="bfapi:FilterCriteria">
                <xs:sequence>
                    <xs:element name="annotationType" type="bfapi:AnnotationType" />
                    <xs:element name="valueSet" type="xs:string" maxOccurs="unbounded"
/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

BelDocumentFilterCriteria
A type of FilterCriteria that is used to filter BelDocument objects.

The BelDocumentFilterCriteria entity has the following properties:

valueSet – A list of BelDocument objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="BelDocumentFilterCriteria">
        <xs:complexContent>
            <xs:extension base="bfapi:FilterCriteria">
                <xs:sequence>
                    <xs:element name="valueSet" type="bfapi:BelDocument"
maxOccurs="unbounded" />
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

CitationFilterCriteria
A type of FilterCriteria that is used to filter Citation objects.

The CitationFilterCriteria entity has the following properties:

valueSet – A list of Citation objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="CitationFilterCriteria">
        <xs:complexContent>
            <xs:extension base="bfapi:FilterCriteria">
                <xs:sequence>
                    <xs:element name="valueSet" type="bfapi:Citation"
maxOccurs="unbounded" />
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

FunctionReturnTypeFilterCriteria
A type of FilterCriteria that is used to filter KamNodes based on their FunctionReturnType values.

The FunctionReturnTypeFilterCriteria entity has the following properties:

valueSet – A list of FunctionReturnType objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="FunctionReturnTypeFilterCriteria">
        <xs:complexContent>
            <xs:extension base="bfapi:FilterCriteria">
                <xs:sequence>
                    <xs:element name="valueSet" type="bfapi:FunctionReturnType"
maxOccurs="unbounded" />
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

FunctionTypeFilterCriteria
A type of FilterCriteria that is used to filter KamNodes based on their FunctionType values.

The FunctionTypeFilterCriteria entity has the following properties:

valueSet – A list of FunctionType objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="FunctionTypeFilterCriteria">
        <xs:complexContent>
            <xs:extension base="bfapi:FilterCriteria">
                <xs:sequence>
                    <xs:element name="valueSet" type="bfapi:FunctionType"
maxOccurs="unbounded" />
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

NamespaceFilterCriteria
A type of FilterCriteria that is used to filter Namespace objects.

The NamespaceFilterCriteria entity has the following properties:

valueSet – A list of Namespace objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="NamespaceFilterCriteria">
        <xs:complexContent>
            <xs:extension base="bfapi:FilterCriteria">
                <xs:sequence>
                    <xs:element name="valueSet" type="bfapi:Namespace"
maxOccurs="unbounded" />
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

RelationshipTypeFilterCriteria
A type of FilterCriteria that is used to filter KamEdges based on their RelationshipType object.

The RelationshipTypeFilterCriteria entity has the following properties:

valueSet – A list of RelationshipType objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="RelationshipTypeFilterCriteria">
        <xs:complexContent>
            <xs:extension base="bfapi:FilterCriteria">
                <xs:sequence>
                    <xs:element name="valueSet" type="bfapi:RelationshipType"
maxOccurs="unbounded" />
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

EdgeFilter
A type of Filter that is used to filter KamEdge objects.

The EdgeFilter entity has the following properties:

realtionshipCriteria – A list of RelationshipTypeFilterCriteria objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="EdgeFilter">
        <xs:sequence>
            <xs:element name="relationshipCriteria"
type="bfapi:RelationshipTypeFilterCriteria" maxOccurs="unbounded" />
        </xs:sequence>
    </xs:complexType>
```

NodeFilter
A type of Filter that is used to filter KamNode objects.

The NodeFilter entity has the following properties:

functionTypeCriteria – A list of 0 or more FunctionTypeFilterCriteria objects defining allowable values to return.

functionReturnCriteria – A list of 0 or more FunctionReturnTypeFilterCriteria objects defining allowable values to return.

Entity Definition

```
    <xs:complexType name="NodeFilter">
        <xs:sequence>
            <xs:element name="functionTypeCriteria"
type="bfapi:FunctionTypeFilterCriteria" minOccurs="0" maxOccurs="unbounded" />
            <xs:element name="functionReturnCriteria"
type="bfapi:FunctionReturnTypeFilterCriteria" minOccurs="0" maxOccurs="unbounded" />
        </xs:sequence>
    </xs:complexType>
```

KamFilter
A type of Filter that is used to filter a Kam as it is loaded from the KamStore. Any KamEdges which have no remaining BelStatements support the KamEdge after the filter has been applied will not be returned with the Kam. Similarly, and KamNodes which become disconnected after the filters have been applied will not be returned with the Kam.

The KamFilter entity has the following properties:

annotationCriteria – A list of AnnotationFilterCriteria objects. This set of objects are used to filter KamEdges by filtering on BelStatemetns supporting the KamEdges.

documentCriteria – A list of DocumentFilterCriteria objects. This set of objects are used to filter KamEdges by filtering on BelDocuments supporting the KamEdges.

citationCriteria – A list of CitationFilterCriteria objects. This set of objects are used to filter KamEdges by filtering on BelDocuments supporting the KamEdges.

relationshipCriteria – A list of RelationshipTypeFilterCriteria objects. This set of objects are used to filter KamEdges by their relationship type.

Entity Definition

```
    <xs:complexType name="KamFilter">
        <xs:sequence>
            <xs:element name="annotationCriteria"
type="bfapi:AnnotationFilterCriteria" minOccurs="0" maxOccurs="unbounded" />
            <xs:element name="documentCriteria" type="bfapi:BelDocumentFilterCriteria"
minOccurs="0" maxOccurs="unbounded" />
            <xs:element name="citationCriteria" type="bfapi:CitationFilterCriteria"
minOccurs="0" maxOccurs="unbounded" />
            <xs:element name="relationshipCriteria"
type="bfapi:RelationshipTypeFilterCriteria" minOccurs="0" maxOccurs="unbounded" />
        </xs:sequence>
    </xs:complexType>
```

Other Complex Types

These entities represent objects that are not stored in a KamStore but are otherwise associated with Kam objects.

SimplePath
A SimplePath object describes a traversal through a Kam from a source KamNode to a target KamNode. The path might be degenerate in which case the set of edges will be empty and the source and target nodes are identical.

The SimplePath entity has the following properties:

source – A KamNode identifying the start of the path.

target – A KamNode identifying the end of the path.

edges – An ordered list of KamEdges which are used to describe the path.

Entity Definition

```
    <xs:complexType name="SimplePath">
        <xs:sequence>
            <xs:element name="source" type="bfapi:KamNode" />
            <xs:element name="target" type="bfapi:KamNode" />
            <xs:element name="edges" type="bfapi:KamEdge" minOccurs="0"
maxOccurs="unbounded" />
        </xs:sequence>
    </xs:complexType>
```

Web API Services

The Web API services provide the methods that allow a client to interact with a remote BEL Framework server. Each service interface takes the form of a Request and returns a Response. Request methods generally take one or more entities to describe the type of operation to perform and the data to process. The Response objects return results back to the client.

KamStore Related Services

These services represent methods associated with the KamStore.

LoadKam

The LoadKam method loads a Kam into memory on the server. As of BEL Framework Version 1.2.3 this function is performed asynchronously to avoid client time-outs occurring when large KAMs are loaded. When a LoadKamRequest for a KAM is received the service will check to see if the KAM is already loaded or loading has already started. If either of these cases is true, the service will return a response containing the current status of the KAM. If neither case is true, the service will initiate the load prior to returning the response. Clients should continue to poll the service until a terminal status (FAILED or COMPLETED) is returned.

When a KAM has completed loading and is cached, subsequent calls to LoadKamRequest will return a response containing a KamHandle referencing the Kam.

If the Kam specified in the request is already loaded, the KamHandle associated with the pre-loaded Kam is returned.

If loading fails, the message property of the response will provide the reason for the failure.

The LoadKamRequest entity has the following properties:

kam – An Kam object specifying which Kam to load.

filter – An optional KamFilter object. If specified, the KamFilter will be used to filter the Kam before it is loaded on the server.

The LoadKamResponse entity has the following properties:

handle – A KamHandle object identifying the loaded Kam on the server.

loadStatus – A KAMLoadStatus object identifying status of the KAM load process.

message – A message indicating the cause if a load failure.

Request Definition

```
<xs:element name="LoadKamRequest">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="kam" type="bfapi:Kam" />
            <xs:element name="filter" type="bfapi:KamFilter" nillable="true" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
```

Response Definition

```
<xs:element name="LoadKamResponse">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="handle" type="bfapi:KamHandle" minOccurs="0"/>
            <xs:element name="loadStatus" type="bfapi:KAMLoadStatus" />
            <xs:element name="message" type="xs:string" minOccurs="0"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
```

GetKam

The GetKam method returns a descriptor object for the Kam specified by a KamHandle.

The GetKam entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

The GetKamResponse entity has the following properties:

kam – A Kam object representing the Kam that has been loaded and referenced by the KamHandle.

Request Definition

```
<xs:element name="GetKamRequest">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="handle" type="bfapi:KamHandle" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
```

Response Definition

```
<xs:element name="GetKamResponse">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="kam" type="bfapi:Kam" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
```

GetBelDocuments

The GetBelDocuments method returns a list of BelDocument objects for a Kam. This list is the set of BelDocument objects that were used to compile the Kam.

The GetBelDocumentsRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

The GetBelDocumentsResponse entity has the following properties:

documents – A list of BelDocument objects.

Request Definition

```
    <xs:element name="GetBelDocumentsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetBelDocumentsResponse">
    <xs:complexType>
            <xs:sequence>
                <xs:element name="documents" type="bfapi:BelDocument" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

GetAnnotationTypes

The GetAnnotationTypes method returns a list of AnnotationType objects for a Kam. This list is the set of AnnotationType objects that were associated with the BelStatements used to compile the Kam.

The GetAnnotationTypesRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

The GetAnnotationTypesResponse entity has the following properties:

annotationTypes – A list of AnnotationType objects.

Request Definition

```
    <xs:element name="GetAnnotationTypesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
   <xs:element name="GetAnnotationTypesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="annotationTypes" type="bfapi:AnnotationType"
minOccurs="0" maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

GetNamespaces

The GetNamespaces method returns a list of Namespace objects for a Kam. This list is the set of Namespaces objects that were associated with the BelStatements used to compile the Kam.

The GetNamespacesRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

The GetNamespacesResponse entity has the following properties:

namespaces – A list of Namespace objects.

Request Definition

```
    <xs:element name="GetNamespacesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetNamespacesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="namespaces" type="bfapi:Namespace" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

GetCitations

The GetCitations method returns a list of Citation objects for a Kam. This list is the set of Citation objects that were associated with the BelStatements used to compile the Kam. The list can be filtered to include specific Citations.

The GetCitationsRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

citationType – A CitationType object used to filter the citations that are returned.

referenceIds – An optional list of referenceIds for the citations used the filter the citations that are returned.

Document – An optional BelDocument used to filter the citations. If specified, only citations associated with BelStatements contained in the specified BelDocument will be returned.

The GetCitationsResponse entity has the following properties:

citations – A list of Citation objects.

Request Definition

```
    <xs:element name="GetCitationsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="citationType" type="bfapi:CitationType" />
                <xs:element name="referenceIds" type="xs:string" nillable="true"
minOccurs="0" maxOccurs="unbounded" />
                <xs:element name="document" type="bfapi:BelDocument" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetCitationsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="citations" type="bfapi:Citation" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

GetCatalog
The GetCatalog method will return a list of Kams that are stored and available in the KamStore.

The GetCatalogRequest entity has the following properties:

project – A Project entity to be saved or updated in the GTP database.

The GetCatalogResponse entity has the following properties:

kams – A list of Kam objects.

Request Definition

```
    <xs:element name="GetCatalogRequest">
        <xs:complexType>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetCatalogResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kams" type="bfapi:Kam" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

GetSupportingEvidence
The GetSupportingEvidence method will return a list of BelStatements which support the assertion made by a KamEdge. The list of BelStatements can be optionally filtered using a KamFilter.

The GetSupportingEvidenceRequest entity has the following properties:

kamEdge – A KamEdge object.

kamFilter – An optional KamFilter object.

The GetSupportingEvidenceResponse entity has the following properties:

statements – A list of BelStatement objects supporting the assertion made by the KamEdge.

Request Definition

```
    <xs:element name="GetSupportingEvidenceRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamEdge" type="bfapi:KamEdge" />
                <xs:element name="filter" type="bfapi:KamFilter" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetSupportingEvidenceResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="statements" type="bfapi:BelStatement" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

GetSupportingTerms
The GetSupportingTerms method will return a list of BelTerm objects which support the assertion made by a KamNode. The list of BelStatements can be optionally filtered using a KamFilter.

The GetSupportingTermsRequest entity has the following properties:

kamNode – A KamNode object.

The GetSupportingTermsResponse entity has the following properties:

terms – A list of BelTerm objects supporting the assertion made by the KamNode.

Request Definition

```
    <xs:element name="GetSupportingTermsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNode" type="bfapi:KamNode" />
            </xs:sequence>
        </xs:complexType>
```

Response Definition

```
    <xs:element name="GetSupportingTermsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="terms" type="bfapi:BelTerm" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

FindEquivalences
The FindEquivalences method takes a source NamespaceValue object and attempts to equivalence it to other Namespace values known by the BEL Framework. As each NamespaceValue can be equivalenced to 0 or more other Namespaces the method will generally return a list of NamespaceValue objects for each source NamespaceValue.

The FindEquivalencesRequest entity has the following properties:

namespaceValue – A NamespaceValue object.

The FindEquivalencesResponse entity has the following properties:

namespaceValues – A list of NamespaceValue objects.

Request Definition

```
    <xs:element name="FindEquivalencesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="sourceNamespaceValue" type="bfapi:NamespaceValue" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="FindEquivalencesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="namespaceValues" type="bfapi:NamespaceValue"
minOccurs="0" maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

FindNamespaceEquivalence
The FindNamespaceEquivalence method takes a source NamespaceValue object and attempts to equivalence it to a specified target Namespace. As some Namespace values can map to multiple values in other Namespaces, the function returns a list of resulting mappings.

The FindNamespaceEquivalenceRequest entity has the following properties:

namespaceValue – A NamespaceValue object.

targetNamespace – A Namespace to equivalence the NamespaceValue to.

The FindNamespaceEquivalenceResponse entity has the following properties:

namespaceValues – A list of NamespaceValue objects.

Request Definition

```
    <xs:element name="FindNamespaceEquivalenceRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="namespaceValue" type="bfapi:NamespaceValue" />
                <xs:element name="targetNamespace" type="bfapi:Namespace" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="FindNamespaceEquivalenceResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="namespaceValue" type="bfapi:NamespaceValue"
minOccurs="0" maxOccurs="1" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Kam Related Services

These services represent methods that query or manipulate a Kam.

GetNewInstance
The GetNewInstance method creates an empty copy of a Kam on the server. The copy references the same Kam stored in the KamStore.

The GetNewInstanceRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

The GetAdjacentEdgesResponse entity has the following properties:

handle – A KamHandle object referencing the copy of the Kam on the server.

Request Definition

```
    <xs:element name="GetNewInstanceRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetNewInstanceResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

MapData

The MapData method takes a list of entities and attempts to map them to nodes in a Kam. This method is generally used to associate experimental observations, such as list of modulated genes, to nodes. The observations are defined as values associated with a specified Namespace.

The MapDataRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

namespace – A Namespace object.

values – A list of strings representing namespace values to map.

nodeFilter – An optional NodeFilter that can be used to control how observations are mapped to Nodes. If specified, the NodeFilter will limit the set of nodes that are candidates for mapping to.

The MapDataResponse entity has the following properties:

kamNodes – A list of KamNode objects.

Request Definition

```
    <xs:element name="MapDataRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="namespace" type="bfapi:Namespace" />
                <xs:element name="values" type="xs:string" minOccurs="1"
maxOccurs="unbounded" />
                <xs:element name="nodeFilter" type="bfapi:NodeFilter" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="MapDataResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNodes" type="bfapi:KamNode" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

UnionKams

The UnionKams method attempts to union two Kams together and generate a new Kam which combines the edges and nodes of both Kams. If kam2 is not specified, a list of KamEdges to union with the first Kam can be specified.

The UnionKamsRequest entity has the following properties:

kam1 – A KamHandle object for a pre-loaded Kam.

kam2 – A KamHandle object for a pre-loaded Kam. This Kam can be optional but if null, a set of KamEdges must be specified.

kamEdges – An optional list of KamEdge objects to be unioned with the Kam specified by kam1.

The UnionKamsResponse entity has the following properties:

handle – A KamHandle for the resulting union Kam.

Request Definition

```
    <xs:element name="UnionKamsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kam1" type="bfapi:KamHandle" />
                <xs:element name="kam2" type="bfapi:KamHandle" minOccurs="0" />
                <xs:element name="kamEdges" type="bfapi:KamEdge" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="UnionKamsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

IntersectKams

The IntersectKams method attempts to intersect two Kams together and generate a new Kam which contains the set of edges and nodes which exist in both Kams. If kam2 is not specified, a list of KamEdges to intersect with the first Kam can be specified.

The IntersectKamsRequest entity has the following properties:

kam1 – A KamHandle object for a pre-loaded Kam.

kam2 – A KamHandle object for a pre-loaded Kam. This Kam can be optional but if null, a set of KamEdges must be specified.

kamEdges – An optional list of KamEdge objects to be intersected with the Kam specified by kam1.

The IntersectKamsResponse entity has the following properties:

handle – A KamHandle for the resulting intersect Kam.

Request Definition

```
    <xs:element name="IntersectKamsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kam1" type="bfapi:KamHandle" />
                <xs:element name="kam2" type="bfapi:KamHandle" minOccurs="0" />
                <xs:element name="kamEdges" type="bfapi:KamEdge" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="IntersectKamsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

DifferenceKams
The DifferenceKams method attempts to determine the difference of two Kams and generate a new Kam which contains the set of edges and nodes which exist in one but not both Kams. If kam2 is not specified, a list of KamEdges to difference with the first Kam can be specified.

The DifferenceKamsRequest entity has the following properties:

kam1 – A KamHandle object for a pre-loaded Kam.

kam2 – A KamHandle object for a pre-loaded Kam. This Kam can be optional but if null, a set of KamEdges must be specified.

kamEdges – An optional list of KamEdge objects to be differenced with the Kam specified by kam1.

The DifferenceKamsResponse entity has the following properties:

handle – A KamHandle for the resulting difference Kam.

Request Definition

```
    <xs:element name="DifferenceKamsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kam1" type="bfapi:KamHandle" />
                <xs:element name="kam2" type="bfapi:KamHandle" minOccurs="0" />
                <xs:element name="kamEdges" type="bfapi:KamEdge" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="DifferenceKamsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

ResolveNodes
The ResolveNodes method attempts to match a set of generic Node objects to KamNodes in a Kam. The Node objects are matched to the Kam by their node label.

The ResolveNodesRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

nodes – A list of Node objects to match to the Kam.

The ResolveNodesResponse entity has the following properties:

kamNodes – A list of KamNode objects that the input nodes have been resolved to.

Request Definition

```
    <xs:element name="ResolveNodesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="nodes" type="bfapi:Node" maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="ResolveNodesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNodes" type="bfapi:KamNode" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

ResolveEdges

The ResolveEdges method attempts to match a set of generic Edge objects to KamEdges in a Kam. The Edge objects are matched to the Kam by their node label and relationship types.

The ResolveEdgesRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

edges – A list of Edge objects to match to the Kam.

The ResolveEdgesResponse entity has the following properties:

kamEdges – A list of KamEdge objects that the input edges have been resolved to.

Request Definition

```
    <xs:element name="ResolveEdgesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="edges" type="bfapi:Edge" maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="ResolveEdgesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamEdges" type="bfapi:KamEdge" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

ReleaseKam

The ReleaseKam method will remove a Kam from the cache on the server. Once a Kam has been released any KamHandle or Kam objects associated with the Kam will no longer be viable.

The ReleaseKamRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

The ReleaseKamResponse entity has the following properties:

Request Definition

```
    <xs:element name="ReleaseKamRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="ReleaseKamResponse">
        <xs:complexType>
            <xs:sequence>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

FindEdges

The FindEdges method will return a list of KamEdge objects from the specified Kam based on an EdgeFilter.

The FindEdgesRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

edgeFilter – An EdgeFilter object determining the type of KamEdge objects to return.

The FindEdgesResponse entity has the following properties:

kamEdges – A list of KamEdge objects.

Request Definition

```
    <xs:element name="FindEdgesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="filter" type="bfapi:EdgeFilter" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="FindEdgesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamEdges" type="bfapi:KamEdge" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

FindKamNodesByIds

The FindKamNodesByIds method will return a list of KamNode objects from the specified Kam based on a set of KamNode Ids. The resulting list can be filtered by specifying an optional KamNode filter object.

The FindKamNodesByIdsRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

ids – A list of strings representing KamNode Ids.

Filter – An optional NodeFilter object.

The FindKamNodesByIdsResponse entity has the following properties:

kamNodes – A list of KamNode objects.

Request Definition

```
    <xs:element name="FindKamNodesByIdsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="ids" type="xs:string" maxOccurs="unbounded" />
                <xs:element name="filter" type="bfapi:NodeFilter" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="FindKamNodesByIdsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNodes" type="bfapi:KamNode" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

FindKamNodesByLabels

The FindKamNodesByLabels method will return a list of KamNode objects from the specified Kam based on a set of KamNode labels. The resulting list can be filtered by specifying an optional KamNode filter object.

The FindKamNodesByLabelsRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

labels – A list of strings representing KamNode labels.

Filter – An optional NodeFilter object.

The FindKamNodesByLabelsResponse entity has the following properties:

kamNodes – A list of KamNode objects.

Request Definition

```
    <xs:element name="FindKamNodesByLabelsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="labels" type="xs:string" maxOccurs="unbounded" />
                <xs:element name="filter" type="bfapi:NodeFilter" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="FindKamNodesByLabelsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNodes" type="bfapi:KamNode" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

FindKamNodesByPatterns

The FindKamNodesByPatterns method will return a list of KamNode objects from the specified Kam based on a set of regular expressions that match against the KamNode labels. The resulting list can be filtered by specifying an optional KamNode filter object.

The FindKamNodesByPatternsRequest entity has the following properties:

handle – A KamHandle object for a pre-loaded Kam.

patterns – A list of strings representing regular expressions that will be applied to the KamNode labels.

Filter – An optional NodeFilter object.

The FindKamNodesByPatternsResponse entity has the following properties:

kamNodes – A list of KamNode objects.

Request Definition

```
    <xs:element name="FindKamNodesByLabelsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="handle" type="bfapi:KamHandle" />
                <xs:element name="patterns" type="xs:string" maxOccurs="unbounded" />
                <xs:element name="filter" type="bfapi:NodeFilter" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="FindKamNodesByPatternsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNodes" type="bfapi:KamNode" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Kam Topological Services

These services represent methods that perform topological operations on a Kam.

GetAdjacentNodes

The GetAdjacentNodes method returns a list of KamNodes that are topologically adjacent to another KamNode. The list of adjacent nodes can be optionally filtered by edge type, node type or direction.

The GetAdjacentNodesRequest entity has the following properties:

kamNode – A KamNode object.

direction – An optional DirectionType object specifying how adjacent nodes should be searched.

edgeFilter – An optional EdgeFilter object specifying how adjacent nodes should be searched.

nodeFilter – An optional NodeFilter object specifying which type of adjacent nodes should be returned.

The GetAdjacentNodesResponse entity has the following properties:

kamNodes – A list of KamNode objects.

Request Definition

```
    <xs:element name="GetAdjacentNodesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNode" type="bfapi:KamNode" />
                <xs:element name="direction" type="bfapi:EdgeDirectionType"
minOccurs="0" />
                <xs:element name="edgeFilter" type="bfapi:EdgeFilter" minOccurs="0" />
                <xs:element name="nodeFilter" type="bfapi:NodeFilter" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetAdjacentNodesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNodes" type="bfapi:KamNode" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

GetAdjacentEdges

The GetAdjacentEdges method returns a list of KamEdges that are topologically adjacent (incident) to a KamNode. The list of adjacent edges can be optionally filtered by edge type or direction.

The GetAdjacentEdgesRequest entity has the following properties:

kamNode – A KamNode object.

direction – An optional DirectionType object specifying how adjacent edges should be filtered.

edgeFilter – An optional EdgeFilter object specifying which type of edges should be returned.

The GetAdjacentEdgesResponse entity has the following properties:

kamEdges – A list of KamEdge objects.

Request Definition

```
    <xs:element name="GetAdjacentEdgesRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamNode" type="bfapi:KamNode" />
                <xs:element name="direction" type="bfapi:EdgeDirectionType"
minOccurs="0" />
                <xs:element name="filter" type="bfapi:EdgeFilter" minOccurs="0" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="GetAdjacentEdgesResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="kamEdges" type="bfapi:KamEdge" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

FindPaths
The FindPaths method returns a list of SimplePath objects representing traversals through the Kam from one or more source nodes to one or more target nodes. The FindPaths method uses a depth-first search through the Kam and attempts to find paths from each source node to each target node. The source nodes and target nodes must be associated with the same Kam object.

The FindPathsRequest entity has the following properties:

sources – A list of KamNode objects to use as source nodes.

targets – A list of KamNode objects to use as target nodes.

maxDepth – An optional integer indicating the maximum search depth. If not specified, the maxDepth will be set to 4.

The FindPathsResponse entity has the following properties:

paths – A list of SimplePath objects.

Request Definition

```
    <xs:element name="FindPathsRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="sources" type="bfapi:KamNode" minOccurs="1"
maxOccurs="unbounded" />
                <xs:element name="targets" type="bfapi:KamNode" minOccurs="1"
maxOccurs="unbounded" />
            </xs:sequence>
            <xs:attribute name="maxDepth" type="xs:int" use="optional" default="4" />
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="FindPathsResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="paths" type="bfapi:SimplePath" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Interconnect
The Interconnect method returns a list of SimplePath objects representing traversals through the Kam between two or more nodes. The Interconnect method uses a depth-first search through the Kam and attempts to find paths from each node to each other node. The nodes must be associated with the same Kam object.

The InterconnectRequest entity has the following properties:

sources – A list of KamNode objects to use as source nodes.

maxDepth – An optional integer indicating the maximum search depth. If not specified, the maxDepth will be set to 4.

The InterconnectResponse entity has the following properties:

paths – A list of SimplePath objects.

Request Definition

```
    <xs:element name="InterconnectRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="sources" type="bfapi:KamNode" minOccurs="2"
maxOccurs="unbounded" />
            </xs:sequence>
            <xs:attribute name="maxDepth" type="xs:int" use="optional" default="4" />
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="InterconnectResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="paths" type="bfapi:SimplePath" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Scan

The Scan method returns a list of SimplePath objects representing a depth-first search outward a specified number of steps from each specified node. The nodes must be associated with the same Kam object.

The ScanRequest entity has the following properties:

sources – A list of KamNode objects to use as source nodes.

maxDepth – An optional integer indicating the maximum search depth. If not specified, the maxDepth will be set to 4.

The ScanResponse entity has the following properties:

paths – A list of SimplePath objects.

Request Definition

```
    <xs:element name="ScanRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="sources" type="bfapi:KamNode" minOccurs="2"
maxOccurs="unbounded" />
            </xs:sequence>
            <xs:attribute name="maxDepth" type="xs:int" use="optional" default="4" />
        </xs:complexType>
    </xs:element>
```

Response Definition

```
    <xs:element name="ScanResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="paths" type="bfapi:SimplePath" minOccurs="0"
maxOccurs="unbounded" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Other Services

These services represent methods that do not fall into the other categories.

GetBELFrameworkVersion

The GetBELFrameworkVersionRequest method returns the current version of the BEL Framework.

The GetBELFrameworkVersionRequest entity has no properties.

The GetBELFrameworkVersionResponse entity has the following properties:

version – A string containing the BEL Framework version.

Request Definition

```
    <xs:element name="GetBELFrameworkVersionRequest">
    </xs:element>
```

Response Definition

```
    <xs:element name="GetBELFrameworkVersionResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="version" type="xs:string" />
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

Additional Information

This section provides additional information that might be helpful to you.

Obtaining Technical Support

Technical support is available by phone or email during normal business hours (8am to 5pm EST).

Email Support

Send an email to support@belframework.org. Please make sure to include your name, and a phone number where you can be reached and details about the issue.

Phone Support

Please call Selventa's technical support line at (617) 851-5273 during normal support hours.

Learning More About Selventa's Software and Services

For all sales and other inquires, please contact:

Louis Latino
EVP Sales and Marketing
One Alewife Center,
Cambridge MA 02140

Phone: (617) 547-5421 x237
Email: llatino@selventa.com